



# Exploring the Relationship Between Work and Travel Behavior on Weekdays: Analysis of Paris Region Travel Survey over 20 Years

Anne Aguilera, Marie-Hélène Massot, Laurent Proulhac

## ► To cite this version:

Anne Aguilera, Marie-Hélène Massot, Laurent Proulhac. Exploring the Relationship Between Work and Travel Behavior on Weekdays: Analysis of Paris Region Travel Survey over 20 Years. Transportation Research Record: Journal of the Transportation Research Board, 2009, pp.69-77. <10.3141/2135-09>. <halshs-00560500>

**HAL Id: halshs-00560500**

**<https://halshs.archives-ouvertes.fr/halshs-00560500>**

Submitted on 28 Jan 2011

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

**EXPLORING THE RELATIONSHIP BETWEEN WORK AND TRAVEL  
BEHAVIOR ON WEEKDAYS  
AN ANALYSIS OF THE PARIS REGION TRAVEL SURVEY OVER 20 YEARS**

Anne Aguiléra (corresponding author)  
Université Paris Est-LVMT-INRETS  
19, rue Nobel  
77455 Marne la Vallée  
Tel : +33-1-64-15-21-02  
Fax : +33-1-64-15-21-40  
E-mail : [aguilera@inrets.fr](mailto:aguilera@inrets.fr)

Marie-Hélène Massot  
Université Paris Est-LVMT-INRETS  
19, rue Nobel  
77455 Marne la Vallée  
Tel : +33-1-64-15-21-16  
Fax : +33-1-64-15-21-40  
E-mail : [massot@inrets.fr](mailto:massot@inrets.fr)

Laurent Proulhac  
Université Paris Est-LVMT-ENPC  
19, rue Nobel  
77455 Marne la Vallée  
Tel : +33-1-64-15-21-25  
Fax : +33-1-64-15-21-40  
E-mail : [laurent.proulhac@enpc.fr](mailto:laurent.proulhac@enpc.fr)

Paper prepared for the TRB 2009  
Paper # 09-0303

Re-submitted on: 4 June 2009  
Word Count: 7,995 (main text) + 4 (tables)\*250= 8,995 words

**Abstract**

This paper questions the relationship between work and weekdays travel behavior of workers. Not only commuting trips are taken into account but also business trips. Data come from the 1983 and 2001 Travel Survey of the Paris Region. Results show significant differences between working days, during which work trips dominate, and non-working days during which non-work trips are by far more numerous and also more diversified. Moreover travel behavior is different on workdays if the worker has made business trips or not. In addition our research shows how differences in travel behavior by gender and by professional status are highlighted by taking into account business trips and by separating working and non-working days. Finally, we highlight the main changes over the 1983-2001 period.

**Keywords:** travel behavior, commuting trips, business trips, non work trips, working days, non working days, Paris Region.

## 1. INTRODUCTION

Many studies have explored the relationships between work patterns, time-use and travel behaviour (1, 2, 3). Some have concentrated on the working population alone. For instance D. Levinson and A. Kumar have highlighted that workers have encountered a significant diminishing of non-work time per day in Washington, DC between 1968 and 1988 (4). A lot of studies have in addition revealed considerable differences between male and female workers concerning space-time constraints and thus travel behavior (5, 6). Other studies have compared workers and non-workers use of time and/or travel behavior (7).

This paper explores specifically the relationships between work and travel behavior of workers living and working in the Paris Region at two dates, 1983 and 2001. Our study concerns only weekdays because data concerning week-end travel behavior are not available for the whole region in the 1983 survey contrary to 2001. We investigate two directions. The first concerns the nature of work-related travels. Commuting trips, i.e. trips to regular workplace are in general the single category which is taken into account in literature. However work is performed in more diversified places than in the past (8): consequently regular workplace can not anymore be considered as the unique destination of work-related trips. Hence business trips, defined here as work-related travels to non regular workplace ( for instance in order to visit a client, to participate to a conference, etc.), have been considered in this paper as a relevant and also distinct category. The second direction explores the relationships between work and travel behavior for all purposes. The aim is to evaluate whether work patterns and in particular work trips, which are mainly constrained, affect non-work trips patterns. We then differentiate and compare travel characteristics of workers on working and on non-working days. The two questions addressed here are treated both at a general level and also by questioning differences by gender and by professional status.

The paper is organized as follows. In the second section we review literature devoted to the relationship between work and travel behavior of workers. The third section details motivation and methodology of this research and describes the data we used. The fourth section highlights the structuring aspect of work for daily mobility both on working and on non-working days and highlights differences and complementarities between the two. The fifth section concentrates on the parameters which influence travel behavior on working days and especially the role of business trips. The sixth section of the paper presents the main changes between 1983 and 2001. The concluding section summarizes the main results and indicates some directions for future research.

## 2. WORK AND TRAVEL BEHAVIOR: A BRIEF REVIEW OF LITERATURE

Since many decades an important body of research has highlighted the multiplicity of factors that influence individual travel behavior. Space-time constraints related to work, especially work duration and workplace location, are of major importance. On the one hand they are determining in explaining differences in travel behavior between workers and non-workers. On the other hand space-time constraints related to work contribute to explain differences among workers.

### 2.1 Differences between workers and the rest of the adult population

If the average number of weekday trips is about the same for non-workers and for workers, distance and time traveled are significantly higher for the latter. For instance the 2001 US National Household Travel Survey indicates that workers travel about 12 miles more each day than non-workers (9).

Work patterns and especially the fact that workplace is for the majority of individuals located outside home (and often outside the municipality of residence) mostly explains this finding. Home-to-work trip duration is thus about 30 minutes in France (10) like in the US (4). Non-work trips are largely determined by geography and schedules of work and more precisely of journeys between place of home and workplace. Indeed the destination of a great number of non-work trips, especially for those which are regular in location and frequency (9), is situated near workplace or near home or along the way between the two (11, 12). In the US in 2001 54% of commuters stop for a non-work purpose during their home-to-work trip. In average they thus spend about 100 minutes in travel of which 45 are in work tours (9). Trips made by non-workers are rather internal to the municipality of residence or directed to its surroundings: hence they are quite shorter both in distance and in duration.

In addition workers are more motorized in average than the rest of the adult population. Hence they thus travel more frequently by car. Indeed car is often the most relevant mode to reach workplace especially when it is located in remote subcenters (13). Another reason for frequent car use is because the home-to-work trip is the occasion to make non-work stops that could not have been made easily by using public transport. Consequently the share of kilometers traveled daily (especially by car) by workers is by far more important than what they represent in the overall population. For instance in the Paris Region on a given weekday workers represent less than the half of the adult population (45%) but 63% of overall kilometers traveled during the day. Hence policies promoting a better matching between employment and residence location are of great importance to reduce travel demand and particularly car use within metropolitan areas (14).

## **2.2 Differences among workers**

### *2.2.1 Gender*

Women have been proved to encounter higher levels of day-time fixity constraints than men (15). This is a consequence of gendered division of labor within households which implies greater implication of women in domestic and family tasks (6, 16, 17). Hence women live closer to their workplace. The fact that women have greater household responsibilities is also obviously not independent from the choice to work part-time: M.P. Kwan (15) has thus noted among the population of female workers a positive relationship between the level of fixity constraints and the likelihood to work part-time .

As a result, travel behavior is quite different between female and male workers. In average women make shorter work trips than men but more non-work trips (18), especially child chauffeuring, household-serving travels (19) and also shopping trips (20).

### *2.2.2 Income and professional status*

Income and professional status are both positively correlated with motorization and with greater opportunities to choose a residence relatively independently from workplace location. Indeed in average distance to workplace is greater for high-income workers (21).

Moreover the influence of income on work-related travel behavior concerns not only commuting trips. On the one hand high-income workers are more likely to make business trips: for instance in the US one fourth of all business travels is made by individuals who earn at least \$100,000 annually according to the 2001-2002 National Household Travel Survey. By contrast low-income business travelers are rare (22). Indeed a large share of business trips is associated with face to face meetings with customers or business partners: they thus concern rather managers and executives than other categories (3, 23).

In addition professional status and level of qualification (rather than income alone) influences time-use and especially the balance between in-home and out-of-home non-work activities, both discretionary and obligatory. However the relationships are neither direct nor simple. For instance one can expect the most graduates to have greater access and also greater use of ICT in order to reduce the number of less-desirable trips, especially on weekdays, by using the Internet (thanks to on-line shopping for instance). But people can also be more likely to make more discretionary activities out-of-home (and then more leisure trips) than the rest of the working population insofar as a number of out-of-home activities, like sport or cinema, are onerous. The latter hypothesis is supported by the findings of A.R. Kuppam and R.M. Pendyala (24) who have underlined that workers from higher income households were more likely to make out-of-home recreational activities.

### *2.2.3 Work duration*

Daily time spent to reach the workplace is a growing function of work duration although a threshold exists: beyond certain amount of working hours commuting time tends to decline (25). Hence work duration and commute length are positively correlated. In addition work duration determines to a certain extent the amount of daily time available for non-work activities and then non-work trips, both obligatory and discretionary (26): consequently work duration has an inverse effect on the number of non-work trips (11, 27).

## **3. MOTIVATION OF RESEARCH AND DATA DESCRIPTION**

### **3.1 Motivation**

#### *3.1.1 Work-related trips: a distinction between regular and non regular workplace*

The place of business travels in work-related trips has to be measured and better understood especially at the metropolitan scale, where they are part of local ‘buzz’ which is regularly regarded as a key-element in business relationships (28). However business concerns not only face to face interactions but trips are also produced by delivery of goods and services to clients.

The large majority of studies takes only commuting trips into account and business trips have been largely ignored. Sometimes data do not allow to take them into account like for instance Census Data which only indicate place of residence and regular place of work. But in many studies using travel data business travels are deliberately ignored or incorporated into work-related trips. One reason is that business trips represent only a small fraction of overall daily travel: less than 3% in the US in 1995 compared to about 9% for travels to regular place of work (29). However for workers alone business trips account necessarily for a larger share of daily trips.

One major question addressed in this paper concerns the share of workers who make at least one business trip on a given weekday. Our objective is to propose a typology of workers depending on the nature of their work-related travels. We propose thus to distinguish and to analyze travel behavior of three categories of workers: the ‘commuters’ who, on a given weekday, travel only to regular place of work, the ‘nomads’ who make only business trips, and the ones who make both types of trips.

#### *3.1.2 A distinction between working and non-working days*

A certain number of time-use studies have already highlighted the interest to distinguish between working and non-working days in order to explain time-allocation between in-home

and out-of-home activities (30). But to our knowledge such useful distinction has not been applied to travel data. It has only been suggested by A. Agarwal (31) that weekend and non-working weekdays could be used to fulfill activities that workers could not make during working days due to time and geographical constraints related to work.

In most studies working individuals are regarded as a single category. In other words no distinction is made whether they have worked or not during the day or the period of time considered. However some of them have not worked because they have a part-time job, because they were on holidays, etc. Hence they did not make any work trip.

In this paper the distinction between workers whether they have worked or not during the day considered is thus regarded as doubly relevant. On the one hand constraints related to work and especially work trips have direct and specific implications on travel behavior on working days. On the other hand this however does not mean that work patterns have no effect on travel behavior during non-working days: on the contrary we assume that a certain amount of non-work trips are 'deferred' to non-working days during which time-use is less constrained. Thus the comparison of travel behavior and especially of non-work trips between working and non-working days is assumed to contribute to highlight the relationship between work and travel behavior of workers.

### 3.2 Data

In France the most recent National Travel Survey is now nearly 15 years old. For this reason we have chosen to use local data from the Travel Survey of the Paris Region, which is by far the biggest Region of France with 11 million inhabitants (about 16% of French population) and 5 million jobs (20% of national employment). The latest Travel survey has been conducted in 2001. Moreover it has also been conducted in 1983 with the same methodology: at the two dates a representative sample of the Paris Region inhabitants has been surveyed by face to face interviews with the same interview guide. Hence it is possible to analyze a 20-years period of travel behavior within the Region.

The Travel Survey of the Paris Region is made periodically by the DREIF (Direction Departementale de l'Équipement Île de France) which depends upon the French Ministry of Transportation. In 2001 the sample came from the 1999 Census of the French population and in 1983 from the 1982 Census. The sampling frame was identical. About 23,656 persons have been surveyed in 2001 (representing 9.7 millions inhabitants) and 23,601 in 1983 (representing 8.8 millions inhabitants). Among them nearly the half were workers both in 2001 and in 1983.

The data we used describe the all of the trips on a single weekday for each individual of the sample. A trip is defined as a one-purpose travel from one origin to one destination. Each trip can be characterized by usual indicators like length, duration and mode. One limitation is that extra-regional trips are mentioned but not described in the survey. Hence only individuals who have traveled inside the Region have been taken into account in this study. Nevertheless they represent 98% of workers living in the Region in 2001. Besides travel data the survey collects information about individual characteristics like gender, professional status, work duration (part-time or full-time).

A major interest of this survey is that it distinguishes work trips according to whether the destination concerns regular workplace (commuting trips) or not (business trips). In addition non-work activities are detailed: it is thus possible to distinguish what is related to discretionary activities (leisure) or to more obligatory activities (like daily or weekly shopping). In addition return at home has been considered as a distinct purpose.

In the following travel behavior on working days is considered as travel behavior of the workers (working outside home) who have declared at least one work trip during the day

considered (n=8944 individuals in 2001). Individuals who have declared to work always at home have all been excluded because it was not possible to determine whether they had really worked or not when they had declared no work trip. Travel behavior of workers on working days has been compared with travel behavior of workers who had declared no work trips (n=1387 individuals in 2001): we have thus made the assumption that the comparison was meaningful *i.e.* that travel behavior of those who had not worked was indeed representative of how those who have worked traveled on non-working days.

#### **4. DIFFERENCES AND COMPLEMENTARITIES BETWEEN WORKING AND NON-WORKING DAYS**

##### **4.1 ‘Rationalization’ of non-work trips between working and non-working days**

Whether he works or not a worker has not the same travel behavior at all. On a non-working day, if the average number of trips (3.6) are about the same than on a working day (3.8), travel distance and travel time are about the half and very similar to those of non-workers. Thus on a non-working day trips made by a worker are mainly internal to the municipality of residence or directed to its surroundings.

On a working day more than a third (39%) of trips made by a worker are directly directed to a workplace (regular or not) like about the half of travel distance and travel time. By comparison only 24% of trips concern a non-work related destination (home excluded). In addition data confirm previous studies which indicate that non-work trips are characterized by shorter length both in terms of distance and time compared to work trips. On a working day the geography and duration of non-work activities are obviously limited by space-time constraints related to obligatory activities and especially to work. Hence some non-work trips are made at a short distance from the workplace, especially during a pause (32). The number of non-work trips is thus significantly reduced on working days (0.93) compared to non-working days (2.16). This finding, which is moreover true whatever the professional status, suggests that a part of non-work trips are deferred to non-working days.

The detailed analysis of non-work trips purpose reinforces the ‘rationalization hypothesis’: during working days non-work travels are more frequently devoted to obligatory activities, especially daily shopping and chauffeuring. On non-working days non-work travels concern rather discretionary activities (like leisure or visit to the family or to friends) or obligatory activities that can be (or must be) planed. In addition they often concern shops or services that are located close to the place of residence and that are closed when workers return home after work. Hence it seems that non-work trips, in terms of number, length and duration, are used by individuals as a variable of adjustment: they are to some extent ‘rationalized’ between working and non-working days according to whether they concern obligatory or less obligatory non-work activities.

##### **4.2 Another look at travel differences by gender**

At first sight differences between male and female workers living in the Paris Region are reduced. On working days male and female workers make indeed the same number of trips (3.8) but women travel less kilometers (22.3 km but 30.7 km for men). The latter result has already been interpreted as a consequence of smaller home-to-regular workplace distance for women. More interesting is the fact that on non-working days women make more trips (3.7) than men (3.5). Distance traveled is still lower but the difference is by far narrower (only 2 km) than on working days.

An analysis by trip purpose both on working and on non-working days highlights new elements about gender differences. Thus although men and women make the same number of



trips on working days women make actually less work trips (1.36 for women and 1.57 for men) and inversely more non-work trips (1.05 for women but only 0.83 for men) which is consistent with other studies like the one of P. Gordon, A. Kumar and H. Richardson (16) in the US. Moreover in the Paris Region women make more non-work trips than men on non-working days: they make in average 2.20 non-work trips on non-working days and men only 2.11. Thus greater household responsibility obviously lead to more trips for working women both on working and non-working days. However women somehow ‘compensate’ by making less work trips and also shorter work trips in distance by living closer to usual workplace: they travel in average 9.8 km per day for work purpose compared to 15.1 km for men.

To work part-time (a situation which concerns almost only women) seems to be another way for women to face household responsibilities and associated amount of non-work trips. Data show thus a positive correlation between part-time job and the number of non-work trips especially on working days: women who work part-time make 1.64 trips and women who work full-time 1.34 trips. This could mean that women with part-time job are more than the others in charge of domestic and family tasks. But this could also be a consequence of more availability of time for women with part-time job... However even when they work full-time women make significantly more non-work trips than men on working days.

## **5. EXPLAINING TRAVEL BEHAVIOR ON WORKING DAYS**

### **5.1 Workplace: regular, not regular or both. What implications for travel behavior?**

One of the questions addressed in this paper concerns the importance and influence of business travels in the composition of work travel. Data from the Paris Region indicate that in 2001 trips directed to regular workplace are dominating by far: they account indeed for 80% of total number of work travels on weekdays. Moreover the share is about the same in terms of distance and time.

Indeed only a minority of Paris inhabitants is concerned by intra-metropolitan business trips: on a given weekday only 17% of them have made at least one business travel. Consequently the vast majority of the workers (83%) belongs (on a given weekday) to the classical ‘commuters’ category. This latter result is not really surprising: indeed business trips are for mainly long-distance trips which exceed 100 km (see for instance the results of 2001 the US National Household Travel Survey) and have not been taken into account in this research. In addition among workers who have made at least one business trips during the day a majority (59%, referred as ‘intermediate category’ of workers) have also make at least one trip to regular workplace. Thus only a minority can be classified as ‘nomads’: they represent 7% of the Paris inhabitants on a given weekday and their work trips are composed only of business trips during the day considered.

For our purpose the interesting fact is that the two categories of ‘non-commuters’ (the nomads and the intermediate category of workers) have significantly different travel behavior compared to the commuters (Table 1). Moreover the nomads and the intermediate category of workers travel quite differently. Business trips are indeed associated with more trips during the day, more kilometers and more travel time. It is moreover more pronounced for the intermediate category which is by far the one with the highest scores.

(Table 1)

Work trips differentiate the three categories of workers more than non-work trips. Nomads make thus in average 1.3 more work trips than the commuters and the intermediate

category almost three more work trips than the commuters! Indeed workers belonging to the intermediate category make on a working day as many as trips directed to regular workplace than business travels. Distance and time traveled are also about the same for trips to the usual workplace and for business trips. In particular the origin of half of business trips is regular workplace and inversely 40% of travels to regular workplace come from a non regular workplace (which is as many as from the place of residence). It suggests that regular workplace remains a strategic place for workers. In addition, the fact that average distance traveled for each business trip is small suggests that non regular workplaces (and especially clients' office) are mainly located close to the firm's location. This is coherent with the fact that location decision of firms which are sensitive to face to face contacts with clients, like are business services, are dependent from the geography of market area (33).

Moreover Table 1 indicates that commuters do not benefit from lower travel distance and time to make more non-work trips on working days. On the contrary the number of non-work trips is a little bit higher for the ones who have made also business trips. However the difference is small. Non-commuters make more leisure trips which is surprising because of time constraints due to an important number of work trips during the day. These so-called leisure trips are actually trips to restaurant at lunch time: they are thus probably related to the fact that workers are frequently outside regular workplace at lunch because of business trips. Hence these so-called leisure travels are related to work patterns. Moreover workers who have made at least one business trip during the day have also made a little bit more shopping trips and also more personal trips perhaps because of more fragmented working-time due to business trips and especially more available time during the opening hours of shops and services. Thus for some workers business trips seem to be in conjunction with more flexible time-use.

## **5.2 Confirmed influence of distance from home to regular workplace**

Because work trips are in majority trips to regular workplace we have investigated how distance between home and regular place of work contributed to explain travel behavior of workers. Results indicate that on the one hand distance between home and usual workplace is positively correlated to overall distance and time traveled during a working day: the main reason is that work trips (and symmetrically return at home trips) are significantly longer, whereas non-work trips are less sensitive in terms of distance and duration. Non-work trips are short independently of the home-to-work distance. They are however significantly less numerous when regular workplace is situated far from home: only 0.65 non-work trips are made in average when home-to-workplace distance exceeds 20 kilometres but 1.03 when distance is inferior to 5 kilometres. In addition the number of work trips and return at home trips are less numerous when workplace is very distant from the place of residence: in particular because workers are less likely to eat at home during lunch time.

## **5.3 Differences by professional status**

Table 2 confirms that travel behavior is quite different according to professional status. On working days the category of craftsmen, tradesmen and firms' managers makes significantly more trips than other categories because of more work trips to regular workplace and also more business trips (Table 2). 33% of them have made at least one business trip which is about twice more than the average. Because the category is very heterogeneous it is difficult to give an explanation. However one can assume that business trips are necessary on the one hand to find and convince clients and on the other hand to fulfill the task. Moreover work trips of this category of workers are shorter in distance and in time because they live closer to

workplace and also because market area is obviously limited in order to reduce work trips. Indeed traffic congestion is important in many parts of the Paris Region.

Workmen and executives are also more frequently concerned by business trips than the other categories but the meaning and the role of these work trips for current activity are obviously very different. For the executives business trips are probably related to the need for face-to-face contacts and the 'buzz' hypothesis (28) while for workmen business trips have obviously another meaning. A Travel Survey is however not adapted to understand precisely the objectives of business trips and other data would be necessary, in particular interviews of workers. Moreover long-distance trips have to be taken into account for a complete understanding of business trips.

(Table 2)

#### **5.4 Differences by gender**

Previous analysis has shown that women were more likely to live close to workplace than men. Such residential choice is all the more relevant given the fact that women's work trips are principally trips to regular workplace. In average on a given weekday 12% of working women living in the Paris Region have made at least one business trip although men were 22%. In particular only 7% of women have made work trips both to usual workplace and to non regular workplace while this share is 14% for men. The difference is moreover true whatever the professional status. Hence women not only live closer to regular workplace. They in addition seem to choose jobs characterized by a lower frequency of (at least intra-metropolitan) business trips. It is consistent with the US National Household Travel Survey which shows that men account for 77% of business trips in the US.

#### **5.5 Multivariate analysis**

On working days the average distance traveled and the average number of daily trips vary according to gender, professional status, distance from home to regular workplace and nature of workplace location (regular or not). In order to better understand the influence of each parameter and to question the effect of some others, we have made some linear regressions by using the GLM procedure in SAS. In this paper we only present the most significant models.

The parameters we have considered are on one hand gender, professional status, working time (full or part-time) distance to regular workplace, and number of business trips, and on the other hand some other socio-demographic and economic variables that may influence travel behavior. To explain distance traveled we have considered homeplace location because the literature suggests that distance to the city center is positively correlated with the number of daily kilometers traveled, especially for work trips, insofar as jobs have remained concentrated within and around the city centre in France. The Paris Region has been divided into three parts: the city center (the municipality of Paris), the first ring and the second ring. The number of children under ten years of age has also been taken into account to explain both number of trips and distance traveled insofar as the presence of young children is assumed to be associated with more space-time constraints. We have also incorporated in all models the transport mode (car, public transport or non-motorized modes) from home to workplace: indeed car is supposed to be more flexible and allow more trips per day than public transport. In addition, people who are using a non-motorized mode probably cover a smaller distance than the others. Age has not been considered because it was not significant.

The first set of models explains the number of trips on working days. Three models have been made (Table 3): the first considers all trips, the second only work trips and the third only non-work trips. In these models professional status has not been considered because it was not significant. The results confirm the influence of gender in explaining average number of daily trips and average number of non-work trips (but not average number of work trips which is similar to previous result): on working days female workers make more trips and more precisely more non work trips than men all else being equal. Distance to workplace is also significant and is negatively correlated to the number of trips and of work trips. Non-work trips are not affected by this parameter which is also in accordance with previous analysis. As expected, the fact of making business trips is positively correlated with the number of daily trips, for both work and non-work purposes. In addition, working part-time is positively correlated with the total number of trips and of non-work trips but, as expected, is negatively correlated with the number of work trips. Homeplace location explains only the total number of trips and the number of non-work trips: more precisely living in the municipality of Paris is positively correlated with the number of non-work trips because of the concentration of shops, services, restaurants, etc. But there is no significant link with the number of work trips. In addition, workers who have children under ten years of age make more trips. In fact, they make less work trips but more non-work trips (child-chauffeur, etc.). However the third model concerning non-work trips is not very satisfying ( $R^2$  is low) and further research should improve it by taking into account additional parameters.

The second set of models is composed of two models which consider successively all trips and work trips (Table 4). The model explaining non-work trips is not presented because it was not significant. Professional status has been considered because it was significant for the two models. As expected, average distance traveled on working days is positively correlated with distance from homeplace to workplace, and the existence of business trips increases the daily distance traveled. In addition, the use of public transport to go to work positively affects the average distance traveled: this is not a surprise because the public transport network is very extended and due to important congestion on the road network it is preferable to avoid car use when covering long distances, especially at peak hours. Inversely the people who go to work by non-motorized modes travel logically less kilometers than the others. The place of residence is also not neutral and confirms previous finding: living in the city center or in the first ring is negatively correlated with the total number of daily kilometers because of high density and mixed land-use. Distance traveled per day is higher for executive and intermediate professionals, all things considered, which may be related to higher revenues. Distance traveled for work trips also increases with distance to workplace, the existence of business trips and the use of public transport (and again decreases with the use of non-motorized modes). Again, it is higher for executive and intermediate professionals. As expected gender and the fact of working part-time are both significant, all things considered, and have a negative sign. However the presence of children less than ten years of age is not significant. Finally average daily distance for work purposes is negatively affected by a residential location in the city center or in the first ring, where the majority of jobs are concentrated: people who live in the city center or in the first ring have indeed smaller home-to-work distance (13).

(Table 3)

(Table 4)

## 6. MAIN CHANGES OVER 20 YEARS

Three main evolutions are discussed in this section. Firstly travel differences between working and non-working days have reinforced over the period. Secondly the number of work trips has diminished. Thirdly gender divisions have reinforced.

### 6.1 Intensification of travel differences between working and non-working days

Compared to 1983 inhabitants of Paris Region make in average in 2001 about the same number of daily trips. However they travel more distance (+17%). Daily travel time has also increased (+5%) but it increased less than distance because of a growing use of car.

Evolutions have differed significantly between workers and non-workers. Contrary to the latter, the average number of daily trips made by workers has decreased (-5%). Hence difference concerning the number of daily trips has narrowed between the two categories. Over the same period difference concerning the average travel distance has also narrowed because of a higher growth rate for non-workers. However average distance remains still significantly reduced for workers compared to workers as we have seen before.

Concerning workers alone the number of trips has diminished on working days (-9%) although it has increased quite a lot on non-working days (+34%). In particular personal trips (in particular chauffeuring), leisure trips (in particular dinner out) and return at home trips have all increased.

Hence workers make in 2001 about the same number of daily trips on weekdays whether they work or not: this number was however 1.5 times lower on non-working days 20 years ago. Over the same period the average distance traveled has increased quite more on non-working days (+48%) than on working days (+15%). On non-working days the travel average distance traveled has increased mainly because of a growth in the number of trips while on working days each individual makes fewer trips but each trip is longer in terms of distance.

On working days both the number of work trips (-10%) and of non-work trips (-3%) have diminished. Hence non-work trips have increased a lot on non-working days and decreased on working days. To a certain extent these evolutions seems to be correlated. More precisely it seems that travel behavior and thus time-use has 'specialized' between working and non-working days. Non-working days have thus absorbed overall growth of non-work trips of workers while non-work trips have decreased on working days. This suggests that constraints related to work (like work duration and distance traveled) make the realization of non-work trips more difficult on working days. This result is moreover independent from the professional status.

### 6.2 The diminishing in the number of work trips on working days

Over the study period the average number of work trips has diminished by 10% on working days. The first explanation is the decrease in the number and share of workers who have declared at least one business trip (from 83% to 81%) and who are those for which the number of work trips is the highest (see above). Actually the number of nomads has grown (+26%) whereas the number of workers from the intermediate category has decreased (-16%). This finding suggests a better rationalization in terms of workplace location: in an increasing way work seems to be done entirely at usual workplace or entirely outside. The second explanation concerns the diminishing in the number of work trips for the commuters (-7%), for the nomads (-2%) and for the intermediate category (-8%) for whom both the number of trips to regular workplace (-9%) and business trips (-6%) have diminished. This evolution is obviously related to the growth of travel distance both to regular and non regular workplaces

for all three categories of workers in a context of suburbanization of home and employment and also of greater use of car. Thus, daily travel time for work related purposes has not changed since 1983.

### **6.3 The affirmation of gender differences**

Over 20 years the variation in the average number of daily trips between male and female has cancelled on working days while it has a little increased on non-working days. Women make in 2001 1.07 trips more than men on non-working days whereas the difference was 1.02 in 1983. Indeed the growth rate of non-work trips has been higher for women than for men. On working days men made 1.02 trips more in 1983 whereas there is no more difference in 2001 because women have less diminished their average number of work trips than men. Indeed on working days women have three times less reduced the average number of work trips than men and twice more diminished the average number of non-work trips which in addition were already superior than those of men in 1983 (1.10 against 0.86).

Moreover over the study period the average distance traveled on working days by women has increased twice more than men. Probably this finding is related to growing difficulties to locate close to both workplaces for dual-earner households but also to the growing motorization of women which allows them to live further (in terms of distance) to workplace.

In addition on non-working days women make 36% more trips compared to 1983 and men 30% more. For both categories the number of non-work trips and return at home has grown in about the same proportion. Hence whereas the difference in the number of non-work trips between men and women was slight in 1983 (less than 0.3 trips per day) it is more pronounced in 2001. Thus travel behavior on non-working days is rather more gendered than 20 years before.

## **7. CONCLUSION**

This paper has explored some of the relationships between work patterns and travel behavior of workers. Our results show that on working days trips to the regular workplace are dominating in 2001 like in 1983. However over the study period the growing number of nomads and of commuters and the diminishing in the number of workers who have made both categories of work trips on a given working day suggests a tendency toward a sort of specialization of workplace location (between regular and non regular workplace). However the reasons and means of such specialization can not be understood only with travel data.

In addition we have investigated differences between working and non-working days. The findings indicate that non-work trips are reduced and frequently limited to obligatory trips on working days. Hence a number of non-work trips are deferred to non-working days. Moreover the difference is more marked in 2001 than in 1983. Non-work trips have thus significantly grown on non-working days but diminished on working days. It seems that constraints related to work reduce in an increasing way the opportunity to make non-work trips on working days.

Gender is a crucial parameter which differentiates travel behavior among workers, which confirms other studies (34). Thus in accordance with the household responsibility hypothesis women make more non-work trips even on non-working days. The counterpart is that they live closer to regular workplace, work more frequently part-time and also seem to choose jobs for which business trips are less frequent.

Future work will improve regressions in order to analyze the potential influence of other parameters like household composition (for instance occupation of the spouse) or income. We will also explore the relationships between weekday and week-end activity-travel

behavior but not for the whole Region because data about week-end trips are available only for a sub-sample of the Region inhabitants in the 1983 Travel Survey. Finally we will try to improve our understanding of the relationship between work and travel behavior by questioning workers about the way they manage the need for business travels in everyday activity. Another important issue concerns the hypothesis under which women are more likely to choose jobs for which business travels are rare.

In addition, also because of data limitation, only intra-regional trips have been taken into account in this study whereas many business trips are extra-regional. The next National Travel Survey which data should be available by the end of 2009 will allow more complete investigation. It also will allow to compare Paris Region with other French Regions. It would also be of great interest to make a comparable analysis on travel data concerning not a single day but a longer period but no travel survey of this type is available in France contrary to other countries (35).

## REFERENCES

1. Mokhtarian P.L., Defining Telecommuting. In *Transportation Research Record: Journal of the Transportation Research Board*, N°1305, Transportation Research Board of the National Academies, Washington, D.C., 1991, pp. 273-281.
2. Vilhelmson, B., and E. Thulin. Is regular work at fixed places fading away? The development of ICT-based and travel-based modes of work in Sweden. *Transportation*, Vol.33, 2001, pp. 1015-1029.
3. Aguiléra, A. Business Travel and Mobile Workers. *Transportation Research Part A*, Vol. 42, pp. 1109-1116.
4. Levinson, D., and A. Kumar. Activity, travel and the allocation of time. *Journal of The American Planning Association*, Vol.61, 1995, pp. 458-470.
5. Kwan, M.P. Gender, The Home-work Link and Space-time Patterns of Non-Employment Activities. *Economic Geography*, Vol. 75, 1999, pp. 370-394.
6. Turner T., and D. Niemeier D. Travel to work and household responsibility: new evidence. *Transportation*, Vol. 24, 1997, pp. 397-419.
7. Chenu A., and N. Herpin. Une pause dans la marche vers la civilisation des loisirs ?. *Économie et statistique*, N° 352-353, 2002, pp.15-37.
8. Crague, G. Le travail industriel hors les murs : Enquête sur les nouvelles figures de l'entreprise. *Réseaux*, 2005, N° 23, pp. 65-90.
9. McGuckin, N., and N. Srinivasan. The Journey-To-Work in the Context of Daily Travel. *Paper prepared for the Census Data for Transportation Planning Conference*, 2005, 42 p.
10. Baccaini, B., F. Sémécurbe, and G. Thomas G. Les déplacements domicile-travail amplifiés par la périurbanisation. *INSEE Première*, N° 1129, 2007, 4 p.
11. Bhat, C.R. Work travel mode choice and number of non-work commute stops. *Transportation Research Part B*, Vol. 31, 1997, pp. 41-54.
12. Hanson, S. The importance of the multi-purpose journey to work in urban travel behavior. *Transportation*, Vol. 9, 1980, pp. 229-248.
13. Aguiléra, A. Growth in Commuting Distances in French Polycentric Metropolitan Areas : Paris, Lyon and Marseille. *Urban Studies*, Vol. 42, 2005, pp. 1537-1547.
14. Korsu, E., and M.H. Massot. Achieving a Jobs-housing Balance in the Paris Region: the Potential of Reducing Car Traffic. Paper presented at the 45<sup>th</sup> Congress of the European Regional Science Association (ERSA), 2005, Amsterdam, 20 p.
15. Kwan, M.P. Gender differences in space-time constraints. *Area*, Vol. 32, 2000, pp.145-156.
16. Sermons, M.W., and F.S. Koppelman F.S. Representing the differences between female and male commute behavior in residential location choice models. *Journal of Transport Geography*, Vol. 9, 2001, pp. 101-110.
17. Sullivan, O. Time Waits for no (Wo)Man: An Investigation of the Gendered Experience of Domestic Time. *Sociology*, Vol. 31, 1997, pp. 221-239.
18. Gordon, P., A. Kumar, and H.W. Richardson. Gender Differences in Metropolitan Travel Behaviour. *Regional Studies*, Vol.23, 1989, pp. 499-510.
19. Mauch, M., and B.D. Taylor. Gender, race and travel behavior: Analysis of household-serving travel and commuting in San Francisco Bay Area. In *Transportation Research Record: Journal of the Transportation Research Board*, N°1607, Transportation Research Board of the National Academies, Washington, D.C., 1997, pp. 147-153.
20. Levinson, D.M. Space, money, life-stage, and the allocation of time. *Transportation*, Vol.26, 1999, pp. 141-171.



21. Aguiléra, A., S. Wenglenski S., and L. Proulhac. Jobs suburbanization and reverse commuting in the Paris area. Paper presented at the *World Conference on Transport Research*, Berkeley, 2007, 22p.
22. Mallett, W.J. Long-Distance Travel by Low-Income Households. *Transportation Research Circular, N° EC-026*, Personal Travel: The Long and Short of It, Conference Proceedings, pp. 169-177.
23. Arnfalk, P. and B. Kogg. Service transformation- managing a shift from business travel to virtual meetings. *Journal of Cleaner Production*, Vol.11, 2003, pp. 859-872.
24. Kuppam, A.R., and R.M. Pendyala. A structural equations analysis of commuters' activity and travel patterns. *Transportation*, Vol.28, 2001, pp. 33-54.
25. Schwanen, T., and M. Dijst. Travel-time ratios for visits to the workplace: the relationship between commuting time and work duration. *Transportation Research Part A*, Vol. 36, 2002, pp. 573-592.
26. Soo, J., D. Ettema D., and H.F.L. Ottens. Analysis of Travel Time in Multiple Purpose Trips given Home and Work Locations. *Paper presented at the TRB Annual Meeting*, Washington DC, 2008, 13p.
27. Kitamura, R., J. Robinson, and T. Golob. A Comparative Analysis of Time Use Data in the Netherlands and California. *Research Report n°UCD-ITS-RR-92-9*, Institute of Transportation Studies, University of California, Davis, 1992.
28. Storper, M., and A.J. Venables. Buzz: Face to Face Contact and the Urban Economy. *Journal of Economic Geography*, Vol. 4, 2004, pp. 351-370.
29. Nelson D. and J. Niles. Observations on the Causes of Nonwork Travel Growth. *Paper presented at the TRB Annual meeting*, Washington D.C., 2000, 18p.
30. Yamamoto, T., and R. Kitamura. An analysis of time-allocation to in-home and out-of-home discretionary activities across working days and non-working days. *Transportation*, Vol. 26, 1999, pp. 211-230.
31. Agarwal, A. A Comparison of Weekend and Weekday Travel Behavior Characteristics in Urban Areas. *Thesis for the degree of Master of Science in Civil Engineering*, University of South Florida, 2004.
32. De Coninck, F., and M.H. Massot. Les mobilités des actifs: les raisons du quotidien. *Colloque Approches qualitatives et quantitatives des mobilités : quelles complémentarités ?* Namur, 2007.
33. Aguiléra, A. Service Relationship, Market Area and the Intrametropolitan Location of Business Services. *The Service Industries Journal*, Vol.23, 2003, pp. 43-58.
34. Crane, R. Is there a Quiet revolution in Women's Travel? Revisiting the Gender Gap in Commuting. *Journal of the American Planning Association*, Vol.73, pp.298-316.
35. Spissu, E., A.R. Pinjari, C. Bhat, R.M. Pendyala, and K. Axhausen. An Analysis of Weekly Out-Of-Home Discretionary Activity Participation and Time-Use Behavior, Paper presented at the TRB Annual Meeting, Washington DC, 2008.

**List of table titles**

- TABLE 1 Travel characteristics on a working day by category of worker
- TABLE 2 Travel characteristics by professional status and trip purpose in 2001 on working days
- TABLE 3 Average number of trips by worker on working days in 2001
- TABLE 4 Average distance traveled by worker on working days in 2001

**TABLE 1** Travel characteristics on a working day by category of worker

Travel characteristics	Commuters	Intermediate category	Nomads
Observations	7466	909	569
To regular workplace			
Number	1.22**	1.77**	-
Distance (km)	10.6**	13.6**	-
Time (mn)	39.2	52.1	-
Business trips			
Number	-	1.71**	1.63**
Distance (km)	-	13.2**	16.6**
Time (mn)	-	60.3**	62.7**
All work trips			
Number	1.22**	3.48**	1.63**
Distance (km)	10.6**	26.8**	16.6**
Time (mn)	39.2**	60.3**	62.7**
Return at home			
Number	1.36**	1.44**	1.59**
Distance (km)	10.3**	9.9**	13.8**
Time (mn)	40.8**	38.6**	55.6**
Non-work			
Number	0.91**	1.02**	1.09**
Distance (km)	3.5**	3.9**	4.9**
Time (mn)	16.1**	17.6**	20.6**
All trips			
Number	3.49**	5.94**	4.31**
Distance (km)	24.4**	40.6**	35.3**
Time (mn)	96.1**	168.6**	138.9**

\*\* p&lt; .01

**TABLE 2** Travel characteristics by professional status and trip purpose in 2001 on working days

	Craftsmen, tradesmen, managers	Executives and intellectual professions	Intermediate professions	Clerical workers	Workmen
Observations	258	2056	2485	2611	1338
To regular workplace					
Number	1.41**	1.20**	1.21**	1.19**	1.12**
Distance (km)	8.4**	11.0**	10.6**	9.0**	10.5**
Business trips					
Number	0.60**	0.33**	0.27**	0.16**	0.41**
Distance (km)	4.9**	2.9**	2.5**	0.9**	4.3**
All work trips					
Number	2.01**	1.53**	1.48**	1.35**	1.53**
Distance (km)	13.3**	13.9**	13.1**	9.9**	14.8**
Return at home					
Number	1.46	1.29	1.39	1.41	1.44
Distance (km)	9.2	10.9	10.9	9.1	1.8
Non-work					
Number	0.80	0.94	1.02	0.96	0.74
Distance (km)	2.9	3.7	3.9	3.6	3.4
All trips					
Number	4.27	3.77	3.89	3.72	3.72
Distance (km)	25.4	28.5	27.9	22.6	30.0

\*\* p&lt; .01

**TABLE 3 Average number of trips by worker on working days in 2001**

Independent variables	All trips		Work trips		Non-work trips	
	Coeff	t	Coeff	t	Coeff	t
Intercept	3.366**	76.28	1.280**	71.86	0.663**	24.58
Distance to regular workplace	-0.002**	-4.91	-0.001**	-4.14	-0.000	-2.23
Female (0,1)	0.274**	6.18	-0.014	-7.13	0.263**	9.71
Business trips (0,1)	1.847**	32.00	1.551**	66.56	0.150**	4.27
Part-time (0,1)	0.398**	4.80	-0.134**	-4.02	0.294**	5.81
City center (0,1)	0.184*	2.76	-0.017	-0.66	0.273**	6.70
First ring (0,1)	0.059	1.28	0.008	0.43	0.063	2.22
Children under 10 (0,1)	0.573**	12.40	-0.006	-0.36	0.471**	16.68
Public transport (0,1)	-0.656**	-13.73	-0.137**	-7.13	-0.301**	-10.34
Non-motorized mode (0,1)	0.180	2.46	0.099	3.36	-0.059	-1.34
Observations	8749		8749		8749	
R <sup>2</sup>	0.15		0.35		0.06	
F	3401.64		3446.68		558.66	
Pr>F	<.01		<.01		<.01	

\*p&lt;.05 \*\* p&lt; .01

**TABLE 4 Average distance traveled by worker on working days in 2001**

Independent variables	All trips		Work trips	
	Coeff	t	Coeff	t
Intercept	31.836**	48.32	14.189**	37.56
Distance to regular workplace	0.113**	16.76	0.056**	14.60
Female (0,1)	-6.219**	-12.03	-3.645**	-12.30
Business trips (0,1)	14.433**	22.33	12.618**	34.04
Part-time (0,1)	-2.739*	-2.96	-1.898*	-3.58
City center (0,1)	-19.609**	-25.88	-9.852**	-22.68
First ring (0,1)	-13.614**	-25.99	-6.578**	-21.90
Children under 10 (0,1)	1.544*	3.00	0.651	2.21
Public transport (0,1)	5.187**	9.66	3.124**	10.15
Non-motorized mode (0,1)	-10.899**	-13.31	-5.558**	-11.84
Observations	8749		8749	
R <sup>2</sup>	0.23		0.25	
F	1205.71		903.03	
Pr>F	<.01		<.01	

\*p<.05 \*\* p< .01