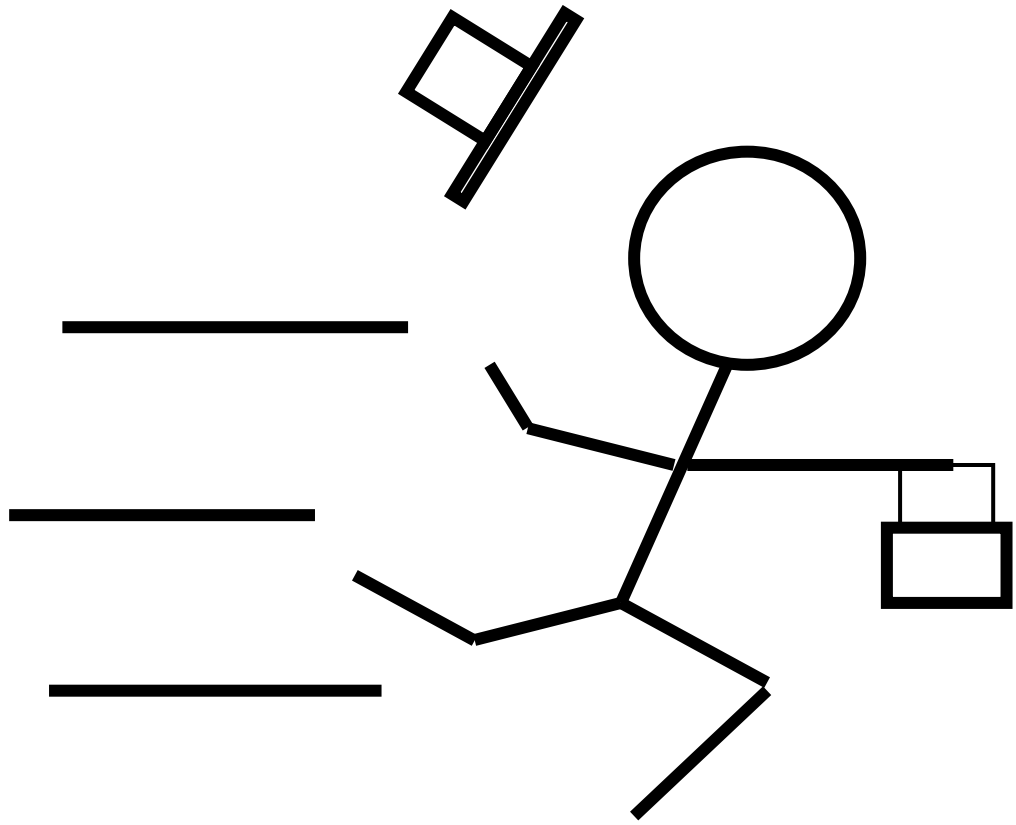

The Daily Duration of Transportation: An Econometric and Sociological Approach

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Abstract

This paper combines both quantitative and qualitative methods to provide supplemental information and results that clarify the reasons that individuals devote ample time to travel.

Through a quantitative analysis of travel-time budgets (TTB) in seven cities (Zurich, Bern, Geneva, Rennes, Lyon, Strasbourg, and Grenoble), the research initially establishes the relationship between the amount of daily travel time allocated and socio-demographic characteristics of individuals and households. The application of a duration model method additionally highlights the influence of diverse types of activities at the destination on TTB. Our analysis confirms that the overall TTB of individuals has increased over roughly the past ten years, with Swiss cities possessing higher travel times than French ones. In many cities, around 20% of our samples also devote excessive amounts of time to travel. The duration model therefore indicates an atypical individual behavior not explained by the covariates of the model. Conversely, other dimensions could certainly explain the choices or obligations that influence these high TTB.

Accordingly, in-depth interviews are given to individuals that travel during the week for longer than 2 hours a day. Their profiles provide several explanations to the reasons behind their choice (or obligation) to spend major amounts of time in daily travel. Consequently, the allocation of travel time of a person is not solely determined by the activities at a destination, but also by individual aspects. Additionally, travel time is perceived as time when other activities can be performed simultaneously (ex. working on the train, listening to music, etc.).

Keywords

Travel-time budgets, model duration, perceptions of travel time, societal influences

1. Introduction

Transportation time is perceived as a mobility indicator, yet certain attempt to quantify while others research its qualitative elements. Nonetheless, both undertake questions on the measurement, the universality, and the perception of time. Consequently, the analysis of transportation time appears to provide an opportunity to reunite multiple disciplines. This is notably one of the aspects discussed at the conference "Mobilities and Temporalities" in 2004 from the workgroup "Spatial Mobility and Societal Fluidity" of the AISLF.

Montulet (2005) illustrates how issues of congestion and individual/social time, including its acceleration, can be articulated through the use of transportation time, showing that one issue strongly correlates with the other. He also evocates the large complexity of mobility and temporality relationships that "proposes, illustrating a primary approach, to resort to the conjugation between social time, the organization of transportation modes, and temporal attitudes"[1]. Measuring transportation time is indeed necessary, for example, for the articulation of monetary costs, in order to better understand mobility behavior or improve our comprehension of urban dynamics. At the same time, certain challenges and limits often appear within quantitative operations, which could be complimented by qualitative dimensions.

From an economic perspective of transportation, the study of transportation time constitutes a vital tool for the comprehension of mobility behavior with its relationship to a trip's finality, or the activities at the destination. This provides our initial point that demonstrates a greater issue regarding the creation of daily agendas, which appears all more complex in the current context of "deregulating" social and individual time. Our mobility analysis first concentrates on transportation time and individual characteristics, then progresses to related dimensions, such as activities performed at a destination, residential location, and possible reallocation of transportation time.

Alternatively, the sociological perspective of transportation time attempts to understand the individual reasons, both intentional and inadvertent, that influence a person to assimilate a grand portion of time to mobility. This section particularly targets persons possessing high travel-time budgets (TTB) to identify their opinions on their respective travel time and the influential factors that condition their perceptions and choices. In this perspective, individuals not only organize their travel time according to the activities at a destination, but also to certain supplemental aspects. These are not related to the trip itself, but rather the individual

[1] p. 13 from Montulet B., (2005).

and their past mobility history, culture, convictions, etc. Research has previously evoked how an individual formulates their unique mobility through experiences and cognitive allocation of transportation (Kaufmann and Flamm, 2006). Choices are therefore not made purely on the satisfaction of a specific need, but take into consideration attitudes and personal attributes (Redmond and Mokhtarian, 2001).

This double approach attempts to go beyond the usual conceptions of transportation time, especially from certain economists that strictly relate mobility to monetary costs. The management of the temporal resource implies complex behavior, since transportation time is the center of numerous interactions between individual and social choices. This unique role of transportation time integrates the individual within a space filled with opportunities in multiple urban contexts. Consequently, managing mobility progressively appears to not be simply reduced to monetary or temporal costs, independent from other dimensions.

The objective of this article is to explore mobility that implies an atypical organization of the temporal resource. A sociological and econometric analysis is therefore proposed to comprehend the influential factors that cause certain individuals to accept their particularly high TTB. The quantitative approach is based on mobility studies of seven Swiss and French agglomerations, while the qualitative section uses interviews of individuals working or residing the Leman basin that possess high TTB.

After a general presentation of mobility and urban contexts of the chosen agglomerations (section 1), the article will present the implemented sociological and econometric methodologies (section 2). Section 3 will then present the results that aim to consolidate the findings of the two methodologies. Finally, the last section (section 4) will restate the complementarities in terms of results and methods, in order to highlight potential contributions identified between the two disciplinary fields.

2. Urban contexts and mobility disparities

2.1 Section 1 – Urban contexts and differentiated mobility

The following is based on mobility studies conducted in France and Switzerland[2], with our respective study concentrating on seven agglomerations: Bern (1994 and 2000), Geneva (1994 and 2000), Grenoble (1992 and 2001), Lyon (1985 and 1995), Rennes (1991 and 2000), Strasbourg (1988 and 1997), and Zurich (1994 and 2000). Large-scale studies are regularly

[2] Specifically, the studies are the *Enquêtes-Ménages-Déplacements* in France and the *Microrecensement* in Switzerland.

performed, allowing the study of two consecutive dates and possible transformations in mobility practices for each city. The data available for each city offers several advantages, such as the contemporaneity of the studied periods and the convergence of objectives and study methodologies. Consequently, the databases constitute an adapted tool to study mobility at both aggregated and disaggregated levels (see table A-1 in the appendix).

As expected, certain adjustments are necessary for our respective study on urban mobility. A methodology comparing different databases induces and comprises of several limitations and inaccuracies. The treatment and homogenization of information necessitates the choice of certain constraints, yet the information used here principally remains at a comparable level of traditional mobility analyses.

The observed mobility analyses of various urban contexts permit an identification of certain conditions that differentiate mobility forms. The choice of the cities was performed while taking into account availability constraints and the following criteria:

- The form and dispersion of the suburbanization process
- The level of development for the network of heavy public transportation modes
- The urban and transportation policies that target the organization of city center accessibility

The transportation systems and policies of the Swiss agglomerations are principally oriented towards public transportation and walking. Contrarily, in the French cities, transportation policies, such as automobile restriction and parking limitations in city centers, have only recently appeared compared to Swiss city policies (see table A-2 in the appendix).

Table 1 illustrates the means of TTB and the number of displacements per individual in each agglomeration. The study of the means reveals that the TTB per individual in French cities, around 70 minutes, is less than the estimated 80 minutes in Swiss ones.

However, the analyses of the TTB distribution for each city (table A-3 in the appendix), shown through the results of the duration models, illustrate the asymmetric distribution of TTB. Consequently, there exists an abnormality within the mean estimation, resulting in an overestimation of the TTB mean for all cities.

In cases of asymmetric distributions, the median also represents this tendency, regardless of its responsiveness to rounding. The TTB median is 60 minutes for French cities and 65 minutes for Swiss ones. Since the median is less sensitive to extreme values of the distribution, the separation of TTB between the two countries is reduced. The distribution

quartiles indicate that the large separation between the average Swiss and French TTB is partially due to the overrepresentation of the population characterized by particularly high TTB in Swiss cities. Moreover, an observable effect on agglomeration size is apparent by comparing the TTB levels of Rennes with Zurich or Lyon. The relative proximity of TTB medians strongly reduces the separation of TTB between these agglomerations. With the exception of Rennes and its lower median at 50-55 minutes, *the majority of individuals in all the agglomerations do not have a TTB that exceeds 60-70 minutes*. Finally, the TTB median difference between the two dates for each city is around 5 minutes. Accordingly, the TTB is characterized between the two dates by an increase in both Swiss and French cities.

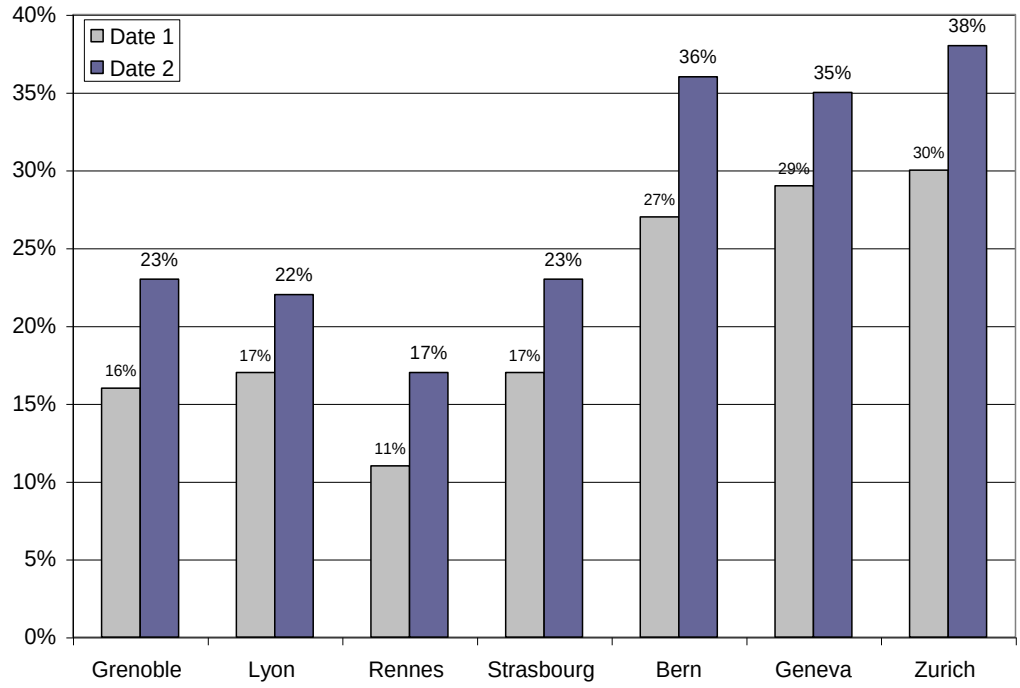
Table 1: Mean and median of travel time budgets and number of daily trips

French cities				
	TTB		N	
City	Mean	Median	Mean	Median
Grenoble 1992	67.20	55	4.26	4
Grenoble 2001	78.92	65	4.72	4
Lyon 1985	67.79	60	4.04	4
Lyon 1995	78.44	65	4.26	4
Rennes 1991	57.44	50	4.04	4
Rennes 2000	70.91	55	4.25	4
Strasbourg 1988	69.94	60	4.67	4
Strasbourg 1997	78.90	65	4.96	4
Swiss cities				
	TTB		N	
City	Mean	Median	Mean	Median
Bern 1994	74.13	60	3.78	4
Bern 2000	85.41	69	4.05	4
Geneva 1994	83.41	60	3.96	4
Geneva 2000	84.06	65	4.22	4
Zurich 1994	82.11	65	3.75	4
Zurich 2000	87.35	70	3.96	4

Source: *Enquêtes-Ménages-Déplacements* and the *Microrecensement*

For each city, the increase in average TTB is notably the result of an increase in persons with particularly high travel times of over 100 minutes. Figure 1 shows the increase of the number of people with over 100 minutes of daily travel time between the two observable dates.

Figure 1: Percentage of persons with TTB over 100 minutes



Source: *Enquêtes-Ménages-Déplacements* and the *Microrecensement*

As the results of the duration models show, these individuals with extremely high daily travel times, or "intense commuters", do not necessarily distinguish themselves from the rest of the population by classic socio-economic characteristics or their mobility attributes.

Therefore, the objective of implementing two methodologies is to first clarify this phenomenon with the use of statistical data, then the use of sociological means, in order to illustrate the attributes of these intense commuters. The application of an econometric model on all the chosen cities allows the proposal of conclusions relative to intense commuters and their atypical organization of the temporal resource allocated to transportation. Conversely, in-depth interviews propose unique explanations regarding the behavior of intense commuters. They not only validate sociologically certain econometric results, but also exemplify certain limits of the quantitative approach.

3. Methodologies[3]

Two different methodologies were incorporated to understand the behavior of intense commuters. The disaggregated analysis of displacement durations integrates the econometric tool of duration models, while the sociological aspect utilizes in-depth interviews.

3.1 The duration model applied to travel-time budgets

The duration model aims to produce an analysis of daily transportation durations. Models such as these are frequently used to analyze activity durations, but their application strictly refers to non-transportation activities. Two types of results are expected from its implementation:

1. The demonstration of influential variables through the use of personal and household socio-economic characteristics, residential location, and certain attributes on activity and mobility programs. This should clearly illustrate the relationships between TBB and certain variables.

2. The identification and description of the temporal dynamic that partially dictates the organizational processes of daily travel time. This temporal dynamic is analyzed through the variation of apparent effects as the TTB gradually increases. As in the analysis of activity durations, a temporal dynamic specific to daily travel time can be identified. Its description will indicate the rhythm and possible cycles that characterize daily travel time through the course of the day.

3.2 In-depth interviews of intense commuters

The qualitative research targets individuals with high TBB, in order to understand the perceptions and experiences of travel time. A general TBB of 100 minutes was set to establish persons that were considered intense commuters. Certain additional criteria were imposed in the selection process:

- The individual works or lives in the Leman basin.
- The individual works or goes to school at least three times during the week.

[3] Refer to the appendix for more precise information on the two methodologies.

- The sample respects a heterogeneity that reflects the regional population. This does not only consider socio-demographic aspects, but also transportation modes used.

Table 3: Presentation of interviewees

Name[4]	**Age**	**Profession**	**Principal transportation modes**	**Zone and type of residence**	**Household situation**	**BTT**	**Distance home-work (in km)**[5]	**Specific attributes**
John	30	Doctoral assistant	Train, tram	Downtown-Apartment	In couple	150-170	75	
Paul	38	Employee in a rental car agency	Car	Countryside-Apartment	In couple	180-195	55	French resident working in Switzerland
Sarah	26	Hair dresser	Bus	Countryside-Residence	With parents and brother	120-130	13	African origin, very slow transportation speed
Cindy	26	Administrative assistant	Train, bus, bicycle	Downtown-Apartment	In couple	150-160	65	Bicycle use
Robert	46	Doctor	Car	Countryside-House	Married with three kids	135-195	95	Long distance
Anne	34	Ex pharmacist	Car	Countryside-Villa	In couple	100-125	65	Ancient commuter
Rachel	50	Secretary	Train, metro, car	Countryside-Villa	Married	100-160	40	Multi-modal
Wanda	29	Doctoral assistant	Train, bus	Countryside-Apartment	With mother	210-270	65	African origin, very slow transportation speed
George	29	Designer	Train, bus	Downtown-Apartment	Single	220-265	105	
Thomas	36	Editor	Train, car	Countryside-House	Married with two kids	160-215	75	Multi-modal
Caroline	35	Employee in a cafeteria	Car	Countryside-House	In couple	85-115	65	Carpooling

[4] The names have been changed to keep the interviewees anonymous.

[5] We used the Michelin web site www.michelin.fr to calculate the distance by car between the two referred communes. The numbers themselves are not necessarily reliable for statistical calculations (ex. speed), considering that the exact address was never requested. However, the kilometers provide a way to compare relatively distance between interviewees.

4. Comparative results

Two types of results are shown through the use of the two different methodologies:

A. An atypical organization of transportation times

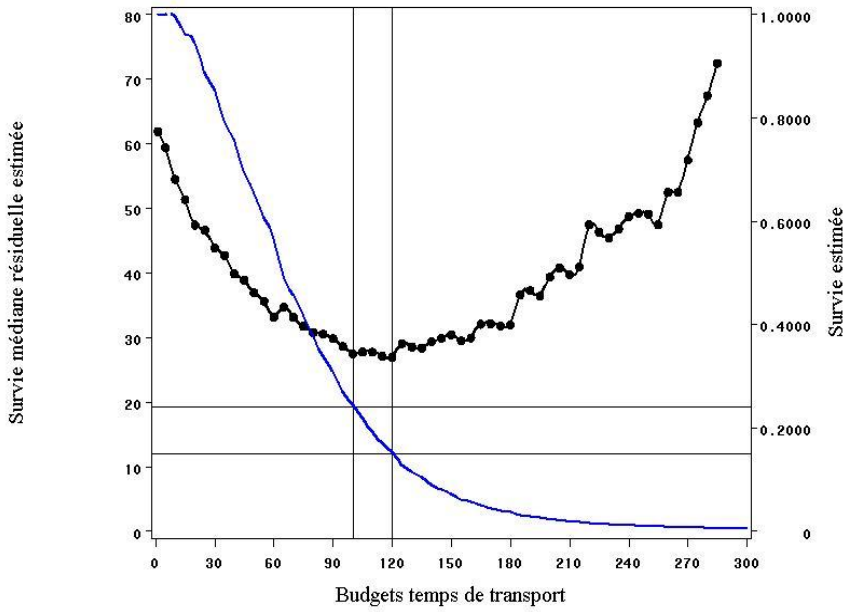
The first result from the duration models of intense commuters is made by the non-parametric estimation of TTB distributions. The form of the estimated hazard function is non-monotone and similar for each city[6]. The conditional probability of the time passed of an interruption in transportation time allocation first increases until 120 minutes, then decreases after 120 minutes.

The interpretation of this non-monotone property of the estimated hazard function becomes relevant when considering the estimated residual survival median (figure 2), or the transportation time remaining or residual according to the time already devoted to mobility. The non-monotone, estimated hazard derives from a residual transportation time that first decreases, then increases. Therefore, according to the estimated hazard for Lyon 1995, during the process of transportation time allocation, an individual that has already passed 30 minutes of transportation time has "on average" a remaining transportation time of around 45 minutes. Accordingly, a person with 60 minutes of transportation time generally still has 30 minutes remaining.

In an intuitive sense, an individual has a remaining transportation time that decreases from the beginning of the temporal process, which appears coherent with the hypothesis of the behavioral reduction of transportation time (from lassitude or saturation of preferences). However, once greater than 100 minutes, the hazard trend is opposite and the remaining time increases. In other words, individuals tend to devote greater supplemental time to transportation after 100 minutes. The resistance to allocate greater time for travel appears to reduce after 100 minutes. Accordingly, the estimated hazard and residual survival median level suggests a transition in travel time allocation behavior for a population group with a TTB of around 100 minutes.

[6] Joly et al. (2006) explain this result of the hazard curve, confirmed by the interval curves with a 95% confidence indicator.

Figure 2: Travel time budgets of the estimated residual median in minutes



Source: EMD Lyon 1995

The non-monotone nature could be the result of the non-integration of an important explicative dimension. Conversely, the parametric analysis of the model, presented in the following section, was constructed to introduce individual and household characteristics while testing the different hazard forms. The performed tests that integrated individual attributes validated the non-monotone nature of the hazard (table 3). Therefore, this could not derive from an unobserved heterogeneity or non-described elements in the data.

This hazard form contradicts the simplistic economic vision that the reduction of transportation time, with monetary costs, would be an optimization condition of mobility. In contrast, the econometric result illustrates a mechanism less direct. Other dimensions appear to be integrated, which does not represent time allocation behavior by means of travel time reduction. The change of the estimated hazard form indicates the existence of two phases in the allocation process of travel time. Intuitively, the increasing conditional probability to interrupt the process refers to the behavioral reduction of the temporal use of mobility. The change in the tendency would indicate an irregularity in the mechanism, almost as though certain individuals cannot, or choose not to reduce their travel times after a certain level. Those with TTB above 100 minutes may be faced with situations and constraints that do not allow them to easily reduce their travel time, or quite simply their behavior cannot be represented by a simplification of temporal use.

The acquired non-monotone hazard refers to the economic notion of generalized cost. This illustrates that the economic objective of an individual is to not reduce each cost, but rather reduce their integral sum. This concept integrates the possibility to reduce one cost to the detriment of another.

Personal factors could partially explain this phenomenon in the mobility behavior of intense commuters. An individual constructs their unique mobility plan with the factors related to the trip (ex. financial costs, speed, duration) and complementary specific elements, such as environmental protection, personal space, past history, etc. (Flamm, 2003). Accordingly, in the analysis of intense commuters, subjective elements that are not associated with the trip must be taken into account.

The analysis of the in-depth interviews suggests that other dimensions, in addition to monetary or temporal constraints, could influence the allocation of travel time. Generally, each individual creates arbitration between travel time and a combination of additional elements (residential location, modal choice, etc.). Intense commuters distinguish themselves in their time allocation behavior, due to the lack of optimizing the temporal resource.

However, the difficulty is to test explicative dimensions of these atypical time allocation behaviors. The second series of results compares quantitative and qualitative results, in order to deduct similarities or divergences of interpretation.

B. The influence of socio-economic characteristics, mobility indicators, and activity program attributes

The second result of the duration models is an estimation of the effects of explicative variables from the three following dimensions: individual and household socio-economic attributes, mobility attributes, and activity programs. Due to space constraints, only the estimated models with the national samples are presented. The customary distribution forms have been tested[7]. The distributions that produce the best adjustment are the logistic-log and generalized-gamma distributions (table 3). The logistic-log distribution is presented here for an easier interpretation.

[7] The Exponential, Weibull, Normal-Log, Logistic-Log, and Generalized-Gamma have been confirmed and tested. Only Exponential, Weibull, Normal-Log, and Generalized-Gamma were formally testable, because of their encasement.

Table 3: Probabilities and ratio tests of probabilities of *a priori* distributions

Distribution	***Log probability***	
	Swiss Sample	*French Sample*
Weibull	-9587,08	-54824,51
Normal Log	-9310,61	-51999,94
Generalized Gamma	-9269,36	-51858,53
LogLogistic	-9164,85	-51648,07

Model 1 vs Model 2	***Test Statistic***	
	Swiss Sample	*French Sample*
Weibull vs GG	635,44 ***	5931,96 ***
Log N vs GG	82,5 ***	282,82 ***

Table 4 indicates the effects of explicative variables on TTB. The estimated coefficients are interpreted after an exponential transformation, such as the travel time quotient of individuals characterized by the variable and the travel time of other individuals. For example, the associated coefficient of the professional activity variable is 0.114. The variable is therefore significant at over 99%, which has a positive effect on TTB. More precisely, a worker has an average TTB that is estimated at 12% greater than a person unemployed ($e^{0,114} = 1,12$). From the econometric model, the different influential elements in travel time allocation are discussed simultaneously with the results from the sociological analysis.

Table 4: Parametric log-logistic models for the two national samples

	French sample		*Swiss sample*	
Variables	**Exp β**		**Exp β**	
Constant	43,250	***	49,452	***
Travel time budget	1,000	***	1,000	***
Shopping time budget	1,002	***	1,001	***
Leisure time budget	1,001	***	1,001	***
Male	1,097	***	0,940	
Active	1,121	***	0,993	
Center	1,046	***	0,925	***
Suburban	1,009		0,933	***
Monday	0,911	***	0,888	***
Tuesday	0,962	***	0,954	*
Wednesday	0,943	***	0,893	***
Couples without children	1,016		0,973	
Couples with 1 child	0,936	*	1,111	
Couples 2 children	0,927	**	1,120	
Couples 3 or more children	0,986		1,026	
Single male without children	0,865	***	1,218	**
Single male with one child	0,985		1,183	*
Single female without children	0,934	*	1,074	
Single female with one child	0,968		1,055	
Age < 19	1,014		1,726	***
18 < Age < 35	1,292	***	1,181	***
34 < Age < 50	1,172	***	1,176	***
49 < Age < 65	1,112	***	1,161	***
Driver's license	1,061	***	1,019	
High revenue	0,985			
Low revenue	0,977			
No motorized transportation	1,052		1,022	
1 private vehicle	1,045		0,952	
2 PV	1,054		0,962	
3 PV	1,065		1,027	
Bern 94			0,793	***
Bern 00			0,967	
Geneva 00			0,953	*
Geneva 94			0,842	***
Zurich 94			0,858	***
Grenoble 01	0,997			
Grenoble 92	0,872	***		
Lyon 85	0,924	***		
Lyon 95	1,051	***		
Rennes 00	0,867	***		
Rennes 91	0,796	***		
Strasbourg 88	0,919	***		
Dependant coefficient				
Log Probability				

These different elements in transport time allocation, from the econometric model, are discussed at once with the results from the sociological analysis.

4.1 Weekly regularity

By retaining the hypothesis that TTB are partially influenced by the activities at a destination, the multiplicity of these activities, according to the day during the week, would increase or decrease the travel time. Essentially, the two methodologies show the differences of TTB in relation to the day of the week, which forms certain regularity in the long term and creates a weekly cycle.

During the week, many of the interviewees have an increase in their TTB once or twice a week, due to activities outside the workplace. Frequently, these activities are premeditated and performed on precise days. For example, John increases his TTB by 20 minutes two times per week for soccer practice. After 50 minutes of travel by train, Thomas drives 40-50 minutes once a week for band rehearsal. Anne also adds 10 minutes of travel to drop off and pick up her laundry two times a week.

In addition, the notion of opportunity transportation cost is perceived within the interviews. The intense commuters often see their "free time" for other activities clearly reduced. The constraint of "increased scarcity" with time consequently modifies certain mobility aspects. The first effect relates to the difficulty of returning back home when supplemental and occasional activities are planned. These supplemental trips are therefore frequently linked with regular ones to gain time for activities. This also influences the choice of transportation modes. For example, instead of habitually taking the train to go to work, Rachel changes transportation modes and travels by car when she has other activities planned at Lausanne after work, often for plays and musicals.

Another observation is shown through the influence of planning one's mobility for other days of the week. John and Thomas, for example, must leave work early to attend their soccer and band meetings. They then must recuperate the hours lost by working more on the other days of the week. In this case, secondary activities can even influence TTB for the entire week.

These daily variations are observed in numerous quantitative studies[8]. The daily cycle of a TTB model commonly shows an increase from Monday to Friday. In general, the analyses of TTB in the seven agglomerations also produce this same daily cycle.

[8] Van der Hoorn (1979), Zahavi and Talvitie (1980), Prendregast and Williams (1981), Kumar and Levinson (1995), Quetelard (1998)

4.2 Urban and individual contexts

Two types of contextual dimensions have been identified that can have an influence on mobility practices and TTB. First, the urban context constitutes a framework where daily activities are performed. Individual contexts then play a role in mobility behavior, via the combination of personal, household, and professional spheres.

Generally, the effects of urban spaces produce ambiguous results among the studied cities. Size and density factors are sometimes contradictory. Joly (2005) presents a rapid overview of literature of these effects of the urban context. Most often, an inconsistency between two urban systems appears between spread-out and dispersed cities, depending on transportation systems that favor automobile use, and concentrated ones that possess a greater equilibrium among transportation modes. These correspond to two principal profiles, with French cities commonly characterized by higher TTB in the city center, while lower TTB levels in Swiss cities.

The qualitative interviews clearly confirm this behavioral change, consistent with urban contexts and lifestyle, with both dimensions being influential. Compared with the three interviewees from the city center, individuals residing in the country are noticeably more stable and oriented towards family life. They also often live with several other people. According to their testimony, they sacrifice a part of their daily time for the advantages of the countryside, not only for themselves, but also for the other people in the household (ex. green and secure areas for children). Arbitration exists between several dimensions, such as mobility costs (temporal and monetary), residential location and land price, access to property ownership (Orfeuil and Polacchini, 1999), lifestyle changes (Cao and Mokhtarian, 2005), and even personal situations of each member of the household (Flamm, 2004).

Contrarily, the three interviewees of the city center prefer the lifestyle of those in the countryside, yet subsidiary factors restrain them to downtown areas. For example, George desires to live in the countryside, but he does not have enough money to buy a car. John and Cindy believe that their lives are too unstable for the moment, since their professional position is temporary and precarious. In the future, these individuals could presumably look for a certain lifestyle (ex. life in the countryside, car, family, etc.) after stabilization in their professional careers, without necessarily attempting to reduce their travel time.

The results presented in table 4 partially illustrate these lifestyle effects, but they are generally very difficult to quantify. Age, the number of children, household structure, or zone of residential location are indicators used to assess lifestyle cycles and modes. Frequently, these attributes of travel time are different according to the level of responsibility of the members of the household, professional status, or the type of residence.

However, cultural influences are difficult to measure quantitatively, yet emerge in the interviews. Two interviewees noted that their decision to stay at their current residential location was based on family reasons, resulting in a weak accessibility to public transportation and a high TTB compared to the distance covered. Both are 30-year old women, dependant of their parents, and are strongly engaged in daily family affairs. When asked about the reasons for their acceptance of a high TTB, they believe that their choice is greatly influenced by their African culture that promotes daily interaction with family members. Consequently, traditional indicators to indicate lifestyle, such as age or professional position, have a difficult time to grasp the mobility behavior of individuals strongly influenced by cultural or familial aspects at greater scales.

4.3 The allocation of travel time

Travel time is not solely used to physically move from an origin to a destination. Activities can also be performed during the trip. Several questions were asked in the interviews to first identify the activities during these trips, then understand the perceptions and experiences of the trip through the use of these activities.

Generally, public transportation users have a greater variety of activities than automobilists. All interviewees using public transportation read, work, sleep, socialize with others, or listen to music. Contrarily, automobilists are limited to listening to music or talking on the phone. In most cases, the interviewees believe that they partially take advantage of the travel time by simultaneously performing other activities.

However, according to all those interviewed, travel time is nevertheless considered to be time "lost". To a degree, activities help to compensate for the lack of free time, but all interviewees recognize that they could do more activities and be more efficient if they were not traveling at the same time. For example, certain interviewees have problems working in the train, due to crowds or the short travel time. Others are too tired for their return trip and are only productive in the morning. For automobilists interviewed, the concentration needed for highway travel prohibits them from completely taking advantage of the travel time.

Frequently, this incomplete compensation for travel time is nonetheless valorized in a different manner when an individual uses the travel time to escape from pressure or stressful situations. For instance, Caroline listens to the news or music on the radio when she drives and the activities only partially aid in compensating for lost time. However, instead of activities, her passion for driving makes the commuter trips pleasurable. Robert, on the contrary, takes advantage of his travel time differently. He listens to CDs disliked by his family in his car. The CDs improve his musical knowledge, which creates a personal space outside social obligations. Lastly, Thomas takes advantage of his time in the train to be away

from his children. According to the interviewee, his children are young and require a lot of attention. The travel time on the train allows him to relax without the worries of familial responsibilities. In all these examples, the trip not only represents physical travel, but also a change in mental state.

For the interviewees, the sentiment of lost time in travel is correlated to the execution of other activities during the trip and the quality of these activities. On the other hand, in the case of intense commuters, these activities do not appear to completely compensate for the lack of free time. This mechanism of "reallocating" travel time provides a supplemental dimension to the trip beyond simple physical movement. To understand the choices behind transportation, notably the choice in transportation modes, these behavioral notions must be taken into consideration. In this perspective, *the trip cannot be perceived as a simple function of monetary and temporal cost*. In effect, an individual can take advantage of travel time to do other activities, which is clearly an issue for intense commuters.

To restate the hypothesis of Mokhtarian and Salomon (2001), the utility of transportation can derive from three sources: the utility at the destination, the intrinsic utility of the trip, and the utility of the activities performed during the trip. The role of transportation is not simply attributed to an activity. The conception of travel time is not perceived merely as a cost (or a component of a generalized cost), but as interstitial time considered an activity in itself, a period of time devoted to execute another activity, and naturally the required time to reach a destination. Transportation is therefore an activity with an intermediary role between an obligated and discretionary activity.

4.4 Personal convictions

Individual convictions emerge as an important role in transportation behavior, notably in the choice of transportation mode. This is clearly illustrated in two individuals that are multi-modal. Rachel and Thomas first drive 10 to 15 minutes to a train station, then continue the rest of the trip by train.

According to the interviewees, the bad public transportation accessibility in their villages forces them to do part of the trip by car. Both enjoy the tranquility of the countryside and live in houses outside the city. However, their past transportation experiences were exclusively with public transportation to commute to work. Neither owned a car before buying their house, because their prior apartments were always located in areas with dense public transportation networks. They both consider the car "dangerous" and "bad for the environment", while public transportation represents a "calm" and "tranquil" atmosphere.

The part of the trip by car is perceived as an obligation for the two interviewees. They voluntarily sacrifice more of their spare time in their trip with the use of public transportation. Their reasons, however, are not uniquely related to a better quality of life in the countryside, but also other personal convictions and preferences. Therefore, in these instances, certain individual inclinations influence a person to use public transportation, regardless of a possible increase in temporal or monetary costs compared to the automobile.

5. Conclusion

Beyond the results or trends proposed by the interviews, the mobilization of the two methods illustrates the complementarities of both approaches and perceptions. Frequently, the weakness of one method is compensated by the dynamics of the other. The will to modulate and synthesize, with the supplemental contribution to explain in detail, are perfectly harmonizing and necessary for one another.

Our study attempts to demonstrate a mixed method, by mobilizing two tools that address the same subject. This work shows certain complementarities for mixed methods (Tucci, 2006):

1. The approach by using qualitative interviews aids to identify unobserved heterogeneities within data and proposes other variables to explain them.

2. The results of a mixed approach can contribute by explaining previously misunderstood statistical results.

3. Qualitative research can help discover problems in the definitions and measures of quantitative instruments.

4. The quantitative approach can be used to examine the extent of results from a qualitative study and provide support for their generalizations.

The disaggregated model identifies a certain number of influential factors in the durations of daily travel, such as individual and household socio-demographic characteristics, mobility attributes, and residential localizations. Conjointly, the estimation by the duration models illustrates the particularity found at an individual level with regards to transportation time management. Indeed, a significant part of our samples (around 20%) are characterized by high TTB, which paradoxically counters typical tendencies of increasing TTB. Despite the integration of certain explicative variables, the qualitative results compliment the quantitative study. The interviews provide a reminder that multiple dimensions interact and/or determine mobility behavior. Together, the two methods show that this specific population with high TTB may not wish, or have a harder capacity to

reduce their travel time, proving that other dimensions must be integrated in interpreting TTB besides temporal and monetary costs.

Therefore, by using a mixed method, this research on TTB demonstrates that one methodology is not necessarily independent from another. The mutual implementation of two methods permitted to surpass their respective limits by questioning and developing them together.

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7. Appendix

Table A 1: Comparable elements between the Enquêtes-Ménages Déplacements and the Microcensement		
	EMD	**Microrecensement**
Study	Local mobility (agglomeration)	National mobility (with larger samples in 10 cantons)
Methodology	Standard CERTU Interview at the household	Telephone interview (CATI)
Subject:	Household composition, mobility practices and opinions on general transportation policy or local themes	Household composition, mobility practices, exterior trips with one night passed, trips performed by plane and opinions on Swiss transportation policy
Size of the sample	Min 1,500 households	(1994): 16,570 households, including 18,020 referred individuals (2000): 27,918 households, including 29,407 referred individuals
Who?	All persons older than 5 years old in the residence	Referred individuals (6 years +) from households (2 pers. for households > 4 members over 6 years hold)
Which trips?	All trips performed the day before the study (a weekday)	All trips performed the day before or 2 days before the study (weekdays and weekends)
When?	One reference day over several months out of the year (October to May)	One reference day over the entire year
Where?	The perimeter of the study best represents the agglomeration (defined by principal client)	The entire country can be considered an origin or a destination of a trip

Table A-2: Organizational types of transportation networks (from the most recent studies)				
France	**Lyon**	**Grenoble**	**Rennes**	**Strasbourg**
Public transportation offer	Heavy network	Bus + Tram	Bus	Bus + Tram
Parking limitations	Weak enforcement	Weak enforcement	Weak enforcement	Weak enforcement, except in the hyper-center
Bicycle infrastructure	Little developed	Intermediate development	Little developed	Very developed
Managing access routes to the center	Instigator	Favorable to the automobile	Favorable to the automobile	Restrictive

Switzerland	**Zurich**	**Bern**	**Geneva**
Public transportation offer	Heavy network	Heavy network	Bus + Tram
Parking limitations	Heavy enforcement	Heavy enforcement	Weak enforcement, except in the hyper-center
Bicycle infrastructure	Very developed	Very developed	Intermediate development
Managing access routes to the center	Restrictive	Restrictive	Favorable to the automobile
Source: Jemelin et al., 2006			

Table A-3: Indicators of TTB distributions

	BTT				
Ville	**Mean**	**CV**	**Q1**	**Median**	**Q3**
Grenoble 1992	67.20	78.32	35.00	55.00	85.00
Grenoble 2001	78.92	81.43	40.00	65.00	100.00
Lyon 1985	67.79	73.41	35.00	60.00	90.00
Lyon 1995	78.44	76.44	40.00	65.00	100.00
Rennes 1991	57.44	72.27	30.00	50.00	75.00
Rennes 2000	70.91	97.00	35.00	55.00	85.00
Strasbourg 1988	69.94	77.80	35.00	60.00	90.00
Strasbourg 1997	78.90	79.27	40.00	65.00	100.00
Bern 1994	74.13	90.27	31.00	60.00	94.00
Bern 2000	85.41	88.21	39.00	69.00	110.00
Geneva 1994	83.41	102.07	39.00	60.00	100.00
Geneva 2000	84.06	90.82	38.00	65.00	108.00
Zurich 1994	82.11	99.72	34.00	65.00	102.00
Zurich 2000	87.35	84.80	40.00	70.00	114.00

7.1 Duration models[9]

1. Particularities of duration data

The character of duration data[10] imposes a certain number of restrictions on the usable model types. The major problem of applying classic models to duration data is the normality hypothesis of duration distribution, which is rarely observable. The linear regression is therefore not vigorous when contradicting the normality hypothesis. In addition, the statistical inference properties of the estimators are not valid without the normality hypothesis of the residuals.

2. Modeling the conditional probability of interruption

[9] For supplemental notions of other estimation duration methods, refer to Kalbfleich and Prentice (1980), Allison (1995), Hosmer and Lemeshow (1999), or Lawless (2003).

[10] The first particularity of the duration data shows that they are positive variables. In addition, despite not being the focus of this study, they could be reproached and characterized by explicative variables that change over time.

Classic methods state beforehand the probability of an event. However, they treat equally events occurring before or after an observation period. Duration models concentrate on the modeling the conditional probability of interruption of a respective event. They therefore consider more complete information than classic models and provide unique information on the studied duration process. For example, linear regressions or logistics model the non-conditional probability of an event (the probability of an event, independently of the presented date of the event), while the duration model concentrates on its conditional probability.

Consequently, duration models introduce the temporal dynamic notion of a studied process. The probability of interruption can vary throughout the duration of the process. The analysis of the conditional probability of interruption is also explicit in providing information on the individual process of time management.

3. Characterizing the distribution of durations and the temporal dynamic

The objective is to model and study daily duration dedicated to transportation and the probability of interrupting this process during its execution. Classic models are founded on the probability of execution, an estimated event, obtaining a higher or lower TTB, and its survival attributes:

$$S(t) = \Pr[T > t] = 1 - F(t) = \int_t^{\infty} f(u) su$$

This corresponds to the probability that a process continues until date *t*.

The duration models estimate the probabilities of interruption after date *t*, knowing that the process continued until the respective date *t*. This conditional probability is noted *h(t)* and qualifies as a hazard function, defined as:

$$h(t) = \lim_{\Delta \to 0^+} \frac{P\left(t \le T < t + \Delta \,|\, T > t\right)}{\Delta}$$

4. Interpretation of the hazard and survival

The slope of the hazard function indicates variations of the slope and survival function. The variations of the hazard therefore correspond to modifications of the rhythm of the survival, the acceleration, or the deceleration of the process. The slope of the hazard curve *h* directly illustrates the variations of the descending rhythm of the survival function. The obtained log-logistic hazard shows a reversal of the slope. Consequently, this conditional probability increases over time, then decreases. The interruption is increasingly probable at the beginning of the process, then decreasingly probable for higher durations. The form of

the hazard function therefore has important implications on the representation of the temporal dynamic of the process (Hensher and Mannering, 1994).

5. The estimated residual survival median

A unique indicator of duration analysis is the median, preferred over the mean because of the reduced bias formed through possible dissymmetric distribution. The non-parametric estimation produced for the population at risk for each date shows that the supplemental survival time reaches 50% of individuals. This is the residual survival median at date *t*, showing the time of the remaining survival median for the population at risk for the date.

7.2 Qualitative interviews

We selected eleven people without using announcements to the general public (ex. local advertising). By asking various people known by the team, we successfully identified individuals that had high TTB. Listing and comparing certain socio-demographic criteria for each interviewee confirmed the diversity of the sample. Certain individuals also had unique attributes that enriched the results:

- Paul works in Geneva, but lives in France.
- Sarah and Wanda spend a lot of time using public transportation, without necessarily traveling long distances.
- Cindy regularly uses a bicycle for her trips during the week.
- Rachel and Thomas use both the car and public transportation for the same trip to get to work.
- Caroline carpools with a colleague

The interviews were either performed in person or via telephone. The interviews generally lasted between 45 and 60 minutes, with the questions focused on four phases: childhood, adolescence, after moving out of the parent's home, and the present. Several questions were asked on the perceptions and experiences of these trips, residential location, aspirations, other members of the household and their influences on the interviewee's mobility, the activities performed during the trip, and the regularity of these trips on a weekly or monthly basis.

The criteria of the city or countryside in residential location, positive or negative effects, and other subjective data all reflect the views of the interviewee.