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# Analysing the potential for modal shift based on the logic of modal choice

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**Abstract:** This article explores how the logic underlying modal practices tends to modulate the population's responsiveness to improvements in global transport supply. Based on a quantitative survey conducted in 2018–2019 among the working population of the cantons of Bern, Geneva and Vaud, it presents the construction of eight types, each of which corresponds to a specific combination of action logic and allows segmentation of travel behaviour. The exploration of the links between this typology and three metropolitan areas shows that the weight of the types within the active population is associated with the quality of the transport offered, especially at the workplace, and that the use of the different means of transport for commuting within the types stays consistent with the opinions of the respondents, as confirmed by an ordinal regression. All the results presented in this article show that a modal shift objective in daily mobility requires a strategy that is segmented by these types.

are based on a much wider range of reasons, which have tended to diversify over the two last decades (Jindra 2014; Lufkin et al. 2018; SPREAD 2012). In particular, with the development of remote communication technologies, travel time has ceased to be an interstitial gap with a duration that should be minimised, provided that conditions of comfort allow time to be used. These same technologies have also contributed to the development of new modes of transport, such as carsharing, carpooling and Uber taxis, which allow users to limit the cost of their journeys.

Following these observations, and given the diversity of the population's attitudes towards means of transport, this article explores how the logic underlying modal practices is likely to modulate the population's reactivity to various improvements of the transport supply and thus constitutes an instrument for the strategic management of modal shift policies.

## 2 State of the art

### 1 Introduction

The objectives set by the Paris Agreement regarding the decarbonisation of mobility require a policy of modal shift from cars to public transport and active modes of transport (cycling, walking). In this context, the modal shift is now the stated objective of a large majority of urban and transport policies in Switzerland. This ambitious objective implies significant investments and, therefore, goes hand in hand with major political challenges. All policies and measures in this area thus require a detailed understanding of demand, its evolution and its sensitivity to changes in transport supply. Without a good understanding of these elements, a certain number of investments and measures may not be very effective – or may even be counterproductive – in relation to a modal shift objective.

With regard to the use of means of transport in everyday life, recent studies have agreed that the comparison of travel times and prices is not the only factor explaining the use of means of transport. Indeed, modal practices

With the growing awareness of the nuisances associated with automobile traffic, the modal shift from motorised individual transport (MIT) to means of transport that generate fewer negative externalities such as public transportation (PT) is an objective of urban transport policies throughout Europe (Banister 2005; Flamm 2004). For more than 20 years, urban policies have attempted to achieve this type of objective in many European cities by acting on land-use planning and transport supply (Apel, Pharoah 1995). This has led to proactive spatial planning policies aimed at reducing urban sprawl, concentrating urban growth near railway stations and in areas that are well connected by public transport. In Switzerland, this has been the case through the federal government's agglomeration policy, which invites city centres and adjacent municipalities to work together to implement urban-transport coordination projects in order to obtain a share of federal funding for major urban projects. Significant investments have been made in providing public transport, including tram networks, metro systems and regional rail services such as the

S-Bahn. However, these policies have generally been hampered by behavioural inertia and resistance to change among motorists (Canzler, Knie 1998; Fouille 2010; Buhler 2012; Buhler, Lesteven 2017).

De Witte et al. (2013) highlighted four types of factors influencing mode choice for daily mobility, including spatial environment, travel characteristics, travellers' socio-demographic characteristics and socio-psychological factors. The study revealed that, among the determining factors, car availability, income, age, household characteristics, and density are often found to be significant in the literature that authors reviewed for their study. However, income effects tend to fade away in the wealthiest countries as most households own at least one car (Lipps, Kunert 2005). This means that other sociodemographic characteristics may be more relevant to explain the modal choices. As an example, the effects of car use seem to be differentiated by gender, since men are more likely to use a car than women, or age, as older people over 60 are more likely to travel by public transport for long-distance commuting (Ko, Lee, Byun 2019) or even walk or bike (Buhler 2011). However, the oldest as well as the youngest people make fewer and shorter trips compared to employed males (Giuliano, Dargay 2006).

Nevertheless, socio-economic attributes appear to be insufficient to make complete predictions about travel behaviour. Consequently, studies are increasingly incorporating latent variables representing attitudes, perceptions and preferences into choice models (Rieser-Schüssler, Axhausen 2012; Atasoy et al. 2013). For approximately the last 20 years, the use of socio-psychological approaches has made it possible to observe behaviour in detail through social representations, which introduce elements relating to perceptions and attitudes to explain certain forms of dissociation between opinions and actual behaviour (Gärling et al. 1998; Van Acker et al. 2010; Wang, Chen 2012; Ma et al. 2015). A close examination of the literature indicates that the difficulty in bringing about transfers from car use to other means of transport in daily life also depends on two orders of factors (Brög 1993; Scheiner 2010): people's mobility skills (in particular, their access to networks and their knowledge of transport offerings) and the attitudes and experiences they have developed towards different means of transport (Canzler, Knie 1998; Ettema et al. 2012; De Vos et al. 2015; Higgins et al. 2018; Rérat 2019). A large body of social sci-

ence research has shown that the mobility skills that determine the use of transport in everyday life are not reducible to the minimisation of travel time and price comparison (Dupuy 1975; Fichelet 1979; Duhemet et al. 1995; Kaufmann 2003; Jain, Lyons 2008; Metz 2008). Factors relating to value systems and habits play a central role in these practices, as do the perceptions of possible alternatives.

The reception potential of these practices in the territory – and especially the set of factors – refers to what George Amar (1993) calls urban adhesion; that is, the adequacy of transport modes with respect to the spaces crossed. Thus, the form and diversity of the built environment are central in accounting for the use of different transport modes (Cervero, Duncan 2003; Handy et al. 2005; Kaufmann 2008). The literature on car dependency reflects this problem (Newman, Kenworthy 1989; Dupuy 1999; Ewing, Cervero 2010; Buehler et al. 2017; Li et al. 2017), pointing out that universes of coherence make territories dependent on the automobile system and lead to the intensive use of the car as a driver (Buhler 2012; Vincent-Geslin, Kaufmann 2012).

This position leads us to consider the use of means of transport as the activation of people's dispositions to use it in a given supply context. Dispositions to use reflect more or less positive attitudes towards different modes of travel, which are measured and analysed, in particular, through the image that people have of the different modes of transport. The context of supply is understood through the concept of affordances (Gibson 1979; Wilhoit 2017). According to Gibson, urban context and transport offerings constitute as many holds for people, offering various possibilities of action in the urban environment. Thus, the use of a means of transport, that is, the use that is actually made of it, results from the match between the qualities offered by a means of transport and the population's willingness to use it.

Taking Max Weber's (1922) three logics of action as a starting point, the willingness to use can be conceptualised in the form of three principles that can be combined based on the potential for reception that these logics encounter in the territory.

Instrumental logic implies that users choose their modes of transport according to objectified values of time and money. It is the efficiency of the car in terms of marginal cost – but, above all, of speed – which is the mechanism behind its preferential use. According to this rationale, cars are the means of transport that

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allow complex programmes of activities to be conducted in the shortest time and at the lowest cost. The second logic of action does not refer to the comparison of alternatives based on their respective performances but on value systems. The predominant use of the car would then result from a ‘differential desire’ to use the private car compared to other means of transport. Car use would a priori be preferred to that of public transport because of the intrinsic characteristics of the mobility offered by it. Driving one’s own car and moving around in the private space of the car’s cabin encourage individualisation and individuation and make the car a powerful symbol of freedom. The third logic of action relates to habits and routines. Having to make choices implies effort to seek information about the alternatives available and effort of comparative experimentation. It can, therefore, be rational to make a choice because the automatism of habits is a comfort. This logic refers directly to lifestyle. It follows that the use of one means of transport cannot be substituted for another without calling into question certain aspects of social integration. This anchoring of modal habits in lifestyle would then be a major obstacle to change in modal practices.

### 3 Data collection and methods

Our study is based on data from the 2018 modal choice survey (Kaufmann et al. 2019), produced at the request of several public partners in the cantons of Bern, Geneva and Vaud (see acknowledgements) in order to collect updated data to identify the potential for modal shift among the working population, which can be compared with those collected in two similar surveys conducted in 1994 and 2011 (Kaufmann 1998; Munafo et al. 2012). The questionnaire investigates factors that influence mobility behaviours such as: 1) the equipment (in

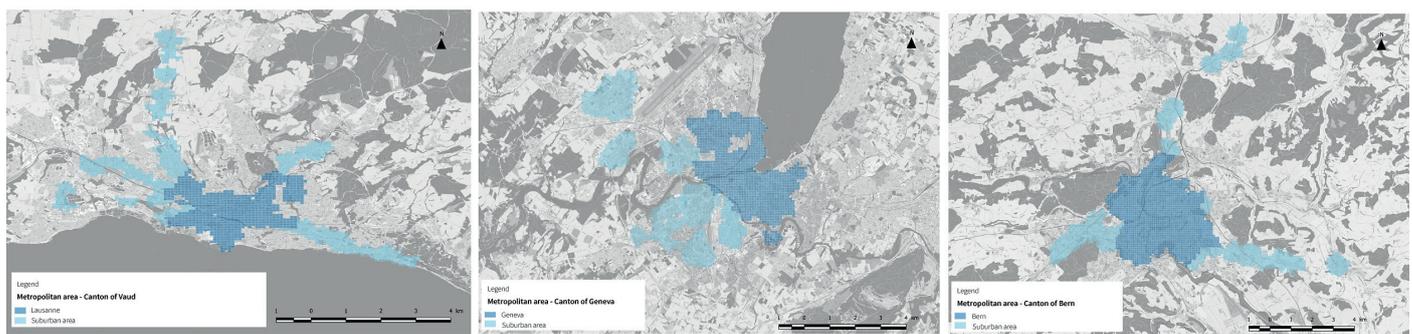
subscriptions, vehicles and connected tools); 2) the habits of use of the different means of transportation and their evolution over time; 3) the image and opinion about their quality; 4) the use of travel time.

Among the available data from the survey (also including several cities and periurban sectors in the three cantons), this article focuses on the metropolitan areas surveyed (Geneva, Lausanne, and Bern as a reference for the benchmark), each consisting of the central city with suburban municipalities (Figure 1).

The data were collected in the autumn of 2018 (Geneva and Lausanne) and the summer of 2019 (Bern). The data collection protocol was based on a telephone survey (RBS landline method with a CATI treatment) conducted by a polling company with a randomly selected sample (among quota and survey sectors defined with the partners), which was representative of the target population in terms of sex, age and geographical location. All individuals in the target population met the following two criteria: “Be active (full or part-time)” and “Live within 500 m walking distance of a public transport stop (or 800 m from a railway station) with a relatively good service (main public transport network)”.

According to the survey institute and common standards (AAPOR 2015), our response rate is close to 30%, (with no prior recruitment, incentives nor information letters). The number of pages or questions, the complexity of the questions posed, and the saliency of the survey are also determinants. Schmidt and Axhausen (2019) reviewed these determinants and proposed an objective way of rating the response burden with a scoring approach. With 48 questions, eight transitions, and answering actions of multiple types (from simple yes/no actions to more complex tables to complete), the response burden estimate reaches a score of 404.5 points for the *choix modal 2018* questionnaire. This

Fig. 1: Metropolitan areas (Geneva, Lausanne and Bern) and sectors for surveying.



score is average compared to the 65 reported surveys employed in the operationalisation of the response rate estimate (ibid.: 7). The average completion time for our questionnaire was approximately 30 minutes.

Finally, the 2598 workers studied in this article (601 in Lausanne; 1739 in Geneva; 258 in Bern) were distributed as follows within the sample (Table 1)<sup>1</sup>.

In terms of methods, the first step in the analysis of this dataset for this study consisted in developing a typology of the logics of action that makes it possible to link dispositions with regard to means of transportation. The typology enables accounting for the combination of the three logics of action that may be involved in mobility behaviour: the instrumental logic of action, broken down into functional, sensitive or social orientation; the preferences for use and the environmental values attributed to the various means of transport (by integrating

active modes); and the anchoring of mono- or multi-modal habits in daily life<sup>2</sup>.

In order to identify the willingness of the respondents to use the different means of transport, they were asked in the survey to spontaneously name three adjectives to describe the car, public transport and the bicycle. This corpus of adjectives made it possible to create several variables: (1) positive or negative attitude variables with regard to the various modes of transport (one per mode – for the car, public transport and the bicycle), (2) an identification variable for the registers of action contained in the corpus of adjectives, i.e. the search for efficiency, the search for sensorial comfort and the search for sobriety. The variables thus created were used to construct the typology.

Methodologically, the construction of the typology is based on the results of a discriminant cluster analysis. It is an update of the typology of logics of action developed in the 1990s, which was based on a cluster analysis of the variables associated with the three parameters presented above (for a scheme of its construction see Kaufmann 1998; Munafo et al. 2015 or Kaufmann et al. 2019: 93). Eight types, each corresponding to a specific disposition towards the use of different means of transport, were thus obtained (see section results Table 4 for a description of the types).

The last step of this work was to test the influence of the dispositions underlying modal practices on the frequency of MIT use for home-work trips. To assess the factors that may influence modal practices, these dispositions identified in the typology were tested in conjunction with control variables related to public transport accessibility, metropolitan area of residence and other socio-demographic control variables (Table 2). Two variables related to the

Variables	Modalities	Frequencies
Sex	Male	43%
	Female	57%
Age	35 and under	12%
	36 to 49	35%
	50 and over	54%
Education	Secondary school or less	47%
	Higher education	53%
Household composition	With children	56%
	Without children	44%

Tab. 1: Structure of the working sample by sex, age, education and household composition, in % of respondents.

Tab. 2: Variables included in the ordinal logistic regression model.

Dependent variable			
Frequency of motorised individual transport (MIT) use for commuting			
Independent variables			
Socio-demographic	Accessibility to Public Transport (PT) on the way to and from work	Residential and professional context	Individual dispositions for the use of modes
<ul style="list-style-type: none"> <li>• Sex</li> <li>• Age</li> <li>• Education</li> <li>• Household composition</li> </ul>	<ul style="list-style-type: none"> <li>• Distance to work</li> <li>• Number of public transport connections (commuting)</li> <li>• Quality of public transport at home (ARE accessibility index)</li> <li>• Quality of public transport at work (ARE accessibility index)</li> </ul>	<ul style="list-style-type: none"> <li>• Residential affiliation to one of the 3 metropolitan areas surveyed</li> <li>• Number of working days per week outside of the home (i.e.. # of commuting days per week)</li> </ul>	<ul style="list-style-type: none"> <li>• Typology of the logics of action underlying modal practices</li> </ul>

PT service quality at the place of residence and at the workplace (established by the ARE<sup>3</sup>) were used. To qualify the PT quality between place of residence and place of work, we considered the influence of the distance between these two locations as well as the number of connections between the different public transport lines or modes. Socio-demographic variables included sex, age, education and presence of children in the household. The consideration for metropolitan area covers a diversity of potential factors depending on the urban local context (such as density and land use, but also regional and linguistic cultures which could potentially influence the attitudes towards professional and mode-choice habits). We also included the number of days of commuting per week and per working person to take into account the schedule associated with the job of our respondents (part-time jobs, teleworking, etc). Our model doesn't take directly into account some variables discussed in section 2 of this article (*State of the art*) such as MIT availability, income or mobility competencies, under the assumption that, in our sample, working people benefit from a minimum level of income, education and competencies which allow them to easily obtain and use a vehicle if necessary for commuting.

The method used for the modelling was an ordinal logistic regression that compared the probability of choice between several ordered modalities of the variable to be explained (McFadden 1975). This method is based on the postulates of transparency of the environment, that is, the knowledge by individuals of all avail-

able alternatives as well as the rationality of their choices. This approach has historically been based on journey-related characteristics – cost, comfort, connection, etc. – to which differences related to socio-demographic characteristics – age, education, household composition, etc. – are then added (Souche 2010). The characteristics of the places used are also considered, namely the origin and destination of trips.

## 4 Results

Starting from the first descriptive results on the modal practices of the respondents, we present the results of the analytical typology of modal choice logics. Finally, we analyse the association of the typology, among other variables, on the MIT use for commuting with our interpretation of the ordinal regression.

### 4.1 Equipment, practices and modal habits of respondents

The analysis of the average number of trip-days (per week and per respondent) highlights the comparative intensity of transport mode use. Work-related trips appear to be less frequent than non-work-related trips, accounting for less than 30% of total trips (Figure 2).

The results confirm the choice of Bern as a reference, where public transport and cycling are used more than in Geneva and Lausanne, where MIT trips remain predominant, even though Bern has the highest total number of trip-days. A detailed study of modes shows

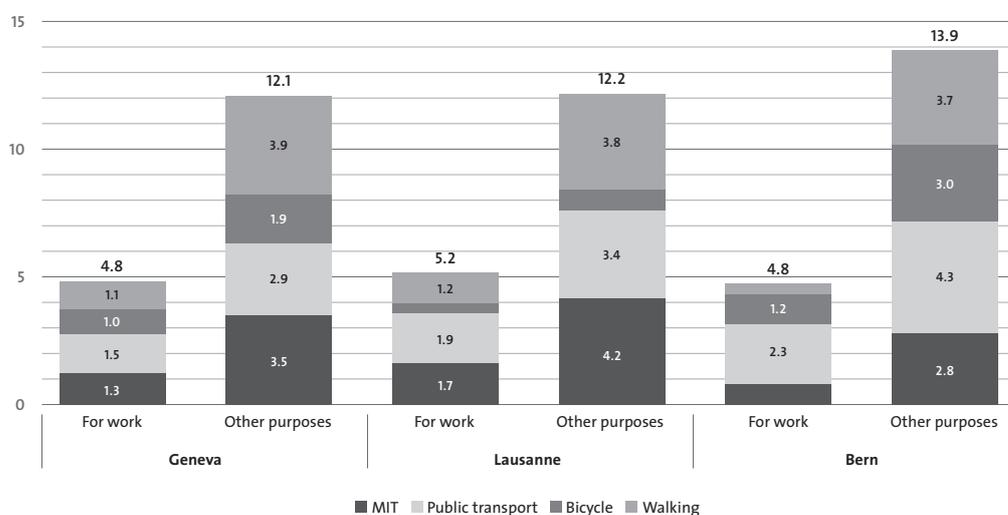


Fig. 2: Average weekly frequency of mode use by purpose and residential context (metropolitan areas), in trip-days (for calculation method: Kaufmann et al. 2020).

that the MIT category primarily corresponds to working people who drive their car, while public transport is more oriented towards urban public transport than trains, particularly in Geneva (22% of trip-days). Regarding bicycles, electric models are still marginal, including in Lausanne, where the declivity already explains the low use of conventional bicycles. Generally speaking, the differences in modal share between the three conurbations can be explained by the accessibility of the different means of transport (i.e., MIT, PT, active modes, etc.). This is particularly true for the car in Bern, where a large proportion of jobs are located in the city centre and near railway stations, and where parking facilities are limited within the city and the agglomeration railway network is highly developed.

From the point of view of reducing polluting emissions, it is important to emphasise the predominant role of daily use (“every day or almost every day”) in car traffic: approximately 75% of car journeys (all motives) correspond to those of daily motorists who, nevertheless, represent less than 50% of the respondents.

Non-motorised households are over-represented in Bern (31%, compared with 18% in Geneva and 16% in Lausanne), while the most frequent situation in the three metropolises is of households with a car (Geneva and Lausanne 58%, Bern 45%). As the vehicle may be shared within the household or linked to a mobility service, around one-third of our respondents have a vehicle every day, and another third has one two or three times a week.

Parking remains a key variable in terms of car accessibility, which greatly determines the constraints linked to the use of this mode in an urban environment. Between 8% and 20% of workers employed in the central areas use reserved parking spots at their place of work; this

proportion exceeds 20% for workers coming to work in suburban areas, and reaches more than 30% in Geneva and Lausanne if non-reserved parking spots at the place of work are also considered. Working people have relatively safe parking.

As far as public transport season tickets are concerned, the territorial differences within our sample of working people are striking (Table 3). Bern stands out from the rest with a particularly high subscription rate: only 7% of Bern respondents do not have any of the subscriptions offered, compared to 29% in Lausanne and 38% in Geneva. As the average price of local subscriptions is slightly superior in Bern than in French-speaking cities<sup>4</sup>, we suspect that this prevalence of PT subscriptions in Bern is mainly due to the strong performance of public transportation, particularly for the trains, thanks to the central position of this city in Switzerland, which is much better than the location of Geneva, for example (where the Geneva-Lausanne railway is the only alternative to access the rest of the country by train). This hypothesis stands in line with the fact that the subscriptions in Bern are primarily due to a large proportion of SBB passes.

By providing car parking spaces at the workplace, often at advantageous rates, the employer participates directly in financing car use to go to work (depending on the sector, between 50% and 75% of workers going to work by car could be affected). For users who go to work by public transport and have a season ticket, the employer contributes in about a third of cases. Full coverage represents about 15% of the workers considered in the three metropolises, while partial coverage is more variable.

Generally speaking, connections are associated with the use of public transport: the more the number of connections increases, the more

	Public transport season ticket (Unireso-Mobilis-Libero) :	Prepaid public transport card	Train (SBB) General Abonnement	Train (SBB) half-fare card	Personal car-sharing subscription	Professional car-sharing subscription	Bike (Public Bike) subscription	No subscription (details: excluding prepaid card and half-fare card)
Geneva	38%	4%	5%	31%	4%	0%	1%	38% (57)
Lausanne	30%	8%	8%	46%	4%	2%	1%	29% (60)
Bern	28%	40%	25%	60%	14%	4%	6%	7% (39)

Tab. 3: Proportion of season ticket holders by residential context (metropolitan areas), in % of respondents.

the use of public transport decreases. Changing lines is often experienced as a constraint, with loss of average speed, interruptions in the use of travel time and more inconveniences.

Residents of Bern have a high proportion of two-wheelers (90% of respondents personally own at least one, compared to 68% in Geneva and 53% in Lausanne), particularly conventional bicycles (83%, 52% and 42%, respectively).

#### 4.2 *Typology of logics underlying modal practices*

The dispositions towards means of transport are synthesised in the analytical typology constructed from Max Weber's three logics of action (Munafò et al. 2015) based on the methodology presented in Section 3. These different variables combined enable identification of eight logics or types associated with a specific disposition towards the use of different means of transport (Table 4).

The distribution of the eight types identified in Geneva, Lausanne and Bern reveals several general trends (Table 5). On the one

hand, 'exclusive motorists' are marginal in the two French-speaking cities and have now completely disappeared in Bern. This seems counterintuitive in relation to the connotations of the adjectives cited to describe the modes of transport. Indeed, the image of the car is more negative in Lausanne (43%) and Geneva (35%) than in Bern (26%). In the typology, we find more MIT-predisposed people, especially in Lausanne (9%), while the 'comfort comparators' and 'environmentalist' reach a threshold for all the areas (around 10% and 7% of respondents, respectively).

With regard to the differences in the logics of action based on the geographical context, the 'exclusive motorists', 'MIT-predisposed', 'efficiency comparators' and 'predisposed to individual modes' types are systematically over-represented in the suburban areas compared to the central cities. This seems logical since these types are favourable to the car, the use of which is more important in suburban municipalities, even if the adjectives used to describe the car in the two types of territory remain similar. For the 'predisposed to alternative modes' and 'ac-

Types of modal choice logic	Description
Exclusive motorists	They only use the car in their daily lives; their activity programmes are structured around the accessibility offered by this means of transport.
Predisposed to MIT	They have a strong preference for the use of cars and motorised two-wheelers for the freedom of space and time that these means of transport allow. These people are attached to the rapid and individual crossing of space.
Comparing efficiency	They are primarily responsive to comparisons of the efficiency of transport modes. They will therefore favour the fastest and most cost-effective means of transport.
Comparing comfort	They are, above all, reactive to comparisons of travel comfort. The search for comfort and ergonomics in travel time is motivated, in particular, by the desire to use travel time as free time or, on the contrary, as working time.
Predisposed to individual means of transportation	This group is characterised by an attachment to autonomous travel. As much as possible, these people avoid being confronted with the constraints of public transport systems (i.e. lines, schedules and shared travel).
Predisposed to sustainable means of transportation	They do not like driving and prefer to use other means of transport. It should be noted that their motivation for not using the car is not related to ecological considerations but rather to the stress of driving (traffic jams, accidents etc).
Predisposed to active means of transportation	They favour the use of active means of transport (bicycle, electric bicycle and walking) and avoid using motorised means of transport as much as possible in their daily life.
Environmentalists	They favour the use of environmentally-friendly means of transport in line with their convictions. Their image of the different modes of transport is marked by environmental considerations.

Tab. 4: Description of the eight modal choice logics in the typology used since 2018.

‘active’ types, the opposite trend is observed since urban centres are more suitable for the use of public transport and soft mobility. Overall, active modes have a particularly positive image in all the areas surveyed, even if this image remains associated with leisure use.

Concerning the distribution of the eight types based on socio-demographic characteristics, no significant difference appears in relation to the sex of the working people surveyed. The distribution of the typology by age category indicates an evolution of modal choice logics based on the life course. The weight of the ‘comfort comparators’ in the sample increases with age, while the youngest appreciate

independence and are more strongly represented among those ‘predisposed to individual modes’.

The distribution of types by education level indicates that the ‘environmentalist’ type is correlated with longer education, while respondents with upper-secondary education are under-represented among the ‘alternative mode inclined’. Those with an apprenticeship (or less) are numerous among the ‘efficiency comparators’.

This segmentation by logic of action allows an understanding of the levers, enabling a modal shift towards sustainable modes of transport: each type is characterised by a spe-

	Exclusive motorists	Predisposed to MIT	Comparing efficiency	Comparing comfort	Predisposed to individual means of transportation	Predisposed to sustainable means of transportation	Predisposed to active means of transportation	Environmentalists
Geneva	1%	5%	21%	13%	13%	26%	13%	8%
Lausanne	4%	9%	25%	12%	14%	21%	7%	6%
Bern	0%	2%	36%	10%	16%	22%	7%	8%

Tab. 5: Distribution by modal choice logic by residential context (metropolitan areas), in % of respondents.

	Exclusive motorists	Predisposed to MIT	Comparing efficiency	Comparing comfort	Predisposed to individual means of transportation	Predisposed to sustainable means of transportation	Predisposed to active means of transportation	Environmentalists	Mean
Geneva	12	7	5	5	7	3	4	3	4.8
Lausanne	11	8	6	6	7	4	5	5	5.9
Bern	-	8	4	3	6	2	2	2	3.7

Tab. 6: Average weekly frequency of use of individual motorised transport by modal choice logic by residential context (metropolitan areas), in trip-days.

	Exclusive motorists	Predisposed to MIT	Comparing efficiency	Comparing comfort	Predisposed to individual means of transportation	Predisposed to sustainable means of transportation	Predisposed to active means of transportation	Environmentalists	Total MIT traffic
Geneva	4%	8%	24%	13%	18%	18%	10%	5%	100%
Lausanne	8%	12%	26%	12%	18%	13%	6%	6%	100%
Bern	-	4%	41%	9%	27%	12%	3%	5%	100%

Tab. 7: Participation in overall MIT traffic by modal choice logic by residential context (metropolitan areas), in % of MIT trip-days.

cific sensitivity to measures in terms of multimodal transport supply and accessibility. If we look closely at the use of MIT through the prism of modal choice logics, we notice that the types favourable to MIT indeed make more intensive use of it<sup>5</sup>, and the opposite is true for the types unfavourable to MIT (Table 6). The ‘comparators’ show intermediate use.

However, the types that use MIT most for individual travel are not necessarily those that contribute most to car traffic. The intensity of use must be qualified based on the number of users of the type in question. It is, therefore, interesting to translate these proportions of users into shares of total car traffic to obtain a vision of the impact of each type (Table 7).

#### *4.3 Ordinal regression analysis: the influence of disposition on MIT commuting habits*

To assess in the presence of control variables the association of the typology with the actual use of MIT, we ran an ordinal regression (link: logit) on 2230 individuals, where the dependent variable is the frequency of commuting days with motorised individual transport (MIT), as a function of socio-demographic characteristics, context and concurrent PT accessibility, associated with individual modal dispositions. This variable is coded with the five following levels: Never / One day per month or fewer / Two to four days per month / Two to three days per week / Four days per week or more.

The prediction model indicates goodness of fit to the observed data ( $p < .001$ ). The Nagelkerke R-squared (0.269) and the non-significant results of Deviance and Pearson chi-square tests also show that the model fits the data well (Petrucci 2009). The assumption has been satisfied because the test of parallel lines is not significant ( $p > .01$ ). We also checked the absence of multicollinearity and the low correlation between the variables.

Firstly, the results of this analysis seem globally consistent with the expected outputs. If we study the disposition to MIT use based on the logics of modal choice, our results confirm the significant impact of each type on MIT use, all other things being equal. Apart from exclusive motorists and those predisposed to MIT (as references), those predisposed to individual modes still have a higher probability of using MIT compared to other efficiency or comfort comparators. Individuals who are disposed to alternative, active or environmentally proactive modes consistently choose other modes of

transport over MIT. Nevertheless, we see that the environmentalists are not totally able to become independent of the use of MIT compared to the respondents predisposed to use active or alternative modes of transport. This fact could reflect a cognitive dissonance among the adjectives stated during the survey.

All other things being equal, the populations of Lausanne and Geneva, to a lesser extent, are more inclined to use MIT. This result is in line with figure 2, due to the fact the three Swiss cities considered here have had different development regarding public transportation and land use, and have different topographical and spatial configurations (Kaufmann, Sager 2006).

Regarding the number of commuting days, only a small number of commuting days per week (2 or fewer) have a significant influence on reducing MIT use, probably due to lifestyles associated with part-time jobs (low income compared to expenses for the use of a car, and a flexible schedule can encourage the use of PT services even with low coverage) while a distant workplace doesn’t significantly reduce MIT use. These results are interesting for teleworkers and their potential trade-off between frequency and distance for commuting (Ravalet, Rerat 2019). We can see that good or very good PT service coverage at the workplace significantly reduces the use of MIT for commuting, whereas only a very good level at home will have a significant but weaker impact on it. Furthermore, the number of connections in the journey by PT encourages the use of MIT as soon as there is one connection to be made. This result is probably reflecting the fact that commuters are sensitive to the optimisation of their daily trips, which are often during peak hours (even for flexitime workers: Wöhner 2022) and sometimes used as part of their working time.

Regarding sociodemographic variables, women seem to be less willing to use MIT (this result is in line with most research on this topic for regular trips in the daytime, see McCright, Xiao 2014) as well as people between 36 and 49 years old and younger workers even if the coefficient is not significant for this generation (which was more difficult to survey with landlines). Education seems not to be significant among our sample of working people, as we can assume that all respondents have a minimum level of education. Surprisingly, household size is not significant, again we can understand that commuting trips do not necessarily imply transportation of children, which can attenuate the expected effect of this variable (McCarthy et al. 2021).

The reference is the last modality of each factor		Odds ratio	Standard error	95% confidence interval	
* p < 0.05, ** p < 0.01, *** p < 0.001				Lower	Upper
Disposition	Environmentalists	0.184***	0.227	0.118	0.287
	Predisposed to active means of transportation	0.137***	0.215	0.090	0.208
	Predisposed to sustainable means of transportation	0.125***	0.188	0.087	0.181
	Predisposed to individual means of transportation	0.454***	0.197	0.309	0.668
	Comparing comfort	0.257***	0.199	0.174	0.380
	Comparing efficiency	0.235***	0.184	0.164	0.336
	Exclusive motorists / Predisposed to MIT	1			
Metropolitan area	Geneva	2.117***	0.172	1.511	2.966
	Lausanne	2.414***	0.183	1.687	3.453
	Bern	1			
# days outside for work	1 or fewer	0.355***	0.142	0.269	0.469
	2	0.648*	0.170	0.464	0.904
	3	0.778	0.137	0.595	1.017
	4	0.809	0.119	0.640	1.022
	5 or more	1			
PT service coverage at workplace	Very good (A-level)	0.309***	0.148	0.232	0.413
	Good (B-level)	0.449***	0.158	0.329	0.611
	Bad (C-level or less)	1			
PT service coverage at home	Very good (A-level)	0.677*	0.179	0.477	0.961
	Good (B-level)	0.828	0.184	0.578	1.187
	Bad (C-level or less)	1			
Home to work distance	(Continuous, unit: 10 km)	0.972	0.031	0.915	1.033
Home to work connections	0	0.235***	0.132	0.181	0.304
	1	0.392***	0.146	0.294	0.521
	2 or more	1			
Sex	Male	1.808***	0.093	1.506	2.171
	Female	1			
Age	35 and under	0.805	0.146	0.605	1.071
	36–49	0.744**	0.098	0.615	0.901
	50 and over	1			
Education	Apprenticeship or less	1.186	0.105	0.964	1.458
	Secondary	1.061	0.116	0.845	1.333
	University or equiv.	1		1.000	1.000
Household composition	No children	0.927	0.092	0.774	1.110
	With children	1			

Tab. 8: Ordinal logistic regression<sup>6</sup> analysis (dependent variable: ordinal frequency of MIT use for commuting).

## 5 Discussion and conclusion

The logic of action underlying modal practices, as measured by the typology based on adjectives for each mode and consistently associated with modal practices (e.g., car use for commuting as confirmed by the ordinal regression analysis), highlights opportunities and obstacles to a modal shift from cars to other means of transport. In light of the analyses presented, we should focus on two main types of factors: those related to the quality of PT accessibility, and those associated with the phenomena of cognitive dissonance (Masse et al. 2020). We observe this with the bicycle in Geneva, which has a good image but is used only marginally. Some contexts also seem to favour an ambiguous attitude towards cars, without having any effect on usage. This is the case in Bern, where positive opinions about cars are the highest, yet usage is the most virtuous. Thus, the symbolic dimension of the car (Rubens et al. 2011) seems to persist without altering the possibility of a fall in modal share, in this case, minimising the influence of values and preferences in favour of other instrumental logics. Conversely, we observe the opposite fact in Lausanne and Geneva, where negative opinions towards cars tend to suggest a lack of performant alternatives for commuting.

The dispositions highlighted by the typology reveal the potential for modal shift, particularly among individuals sensitive to the instrumental logic of time and money. This is the case for individuals willing to compare the efficiency of transport modes and those predisposed to individual transport, who are more involved in the global share of MIT use in the three metropolitan areas. Finally, the issue of connections seems to be a determining factor in the attractiveness of public transport, particularly for working people who compare the comfort provided during the whole trip. Indeed, the presence of a chain of journeys between the home and the workplace significantly favours a shift towards car use.

In view of these results, two types of strategies can be adopted to encourage modal shift. The first concerns the improvement of transport services, especially relating to the sensitivity of the service at the place of work for our sample of residents in urban areas. For example, in commercial and industrial areas where accessibility by public transport is often neglected, they are often located close to major roads, offering a real potential to improve travel conditions, which could lead to a signifi-

cant modal shift if an integrated approach was adopted by all the players concerned (including workers and employers).

The second strategy focuses on the influence of dispositions regarding modes of transport, based on the fact that environmentalists and efficiency comparators seem to be the most sensitive types to modal shift in the case of a variation in the quality of service at the workplace. As we suggest improving public transport in working areas, we also propose to focus on the benefits to exploit these topics in communication or pricing campaigns. The objective of such a proposal is to influence individuals' dispositions to shift from an insensitive form of disposition, to environmental or comparative efficiency sensitivities. What we mean here is that we can't push people to switch from exclusive motorists to environmentalists in one step. However, the intermediate status of comparators is an achievable milestone that can lead to progressive modal shifts thanks to the improvement of sustainable transport accessibility around work. With this aim, both the focus on improving PT accessibility and attracting through communication and pricing is necessary for such a paradigm to engage.

As future research directions, a longitudinal study following the same people going over several years<sup>7</sup> will bring us findings about what determinants influence shifting between predispositions in order to identify the process to support populations into evolving progressively from MIT use to more sustainable solutions. We are also interested in producing detailed results in order to understand the differences revealed by our results between German- and French-speaking respondents, for example, in a mutual urban context such as the bilingual city of Biel/Bienne, which is also available in our database.

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### Notes

- 1 The under-representation of respondents aged 35 and under (who use landlines less) was not adjusted for due to the sampling of sectors based on isochrones (6 min, i.e. about 500 m travelled) around public transport stops and the low impact on the results obtained for the active population.
- 2 For more details on the corpus of data used to construct the typology, see the working paper ‘Analyse des logiques de choix modal auprès de la population active du Grand Genève’ (Kaufmann et al. 2019).
- 3 Source: <https://www.are.admin.ch/are/fr/home/mobilite/bases-et-donnees/desserte-en-suisse.html>
- 4 According to this comparator: <https://www.combien-coute.net/abo-bus/suisse/>
- 5 The number of trip-days per week can exceed 7 as the MIT category results from the additional use of several means of transportation.
- 6 A value less than 1 means that the modality negatively influences the probability of strongly using MIT, while a value greater than 1 means that the modality positively influences the probability of strongly using MIT, compared to the modality of reference for each qualitative variable and all other things being equal. Modalities with confidence intervals that intersect the value 1 are not significant (threshold: 0.05).
- 7 Lake Geneva Sustainability Monitoring Panel (Ongoing research)

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