

## **New variables for detecting transport disadvantages. The role of social capital.**

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### **ABSTRACT**

This paper explores the potential role of social capital variables on the transport mode choice. Traditionally travel behavior model included social capital as empowerment factor (i.e. social capital as substitute of financial capital) or as social network influence on travel choice. Only recently constraints of social capital are considered as factors influencing travel behavior (Swanen et al, 2015, Di Ciommo & Martens, 2015). This article will show both aspects of empowerments and constraints of social capital in a dynamic way stressing two dynamic aspects of social capital: the building up social capital and use of social capital. Both aspects are related with the value of time: when you are doing something for others ( i.e. Voluntary actions, pick up all family members, etc) you are loosing your time, and your mode choice will be oriented to saving time, therefore a private mode will be chosen, while when you are using your social capital benefit (somebody else is helping you), you will easily choose the less flexible and more time consuming public transport.

After defining social capital notion in both aspects of empowerments and constraints, a set of social capital variables is defined. Then two of these variables are tested through a smartphone short panel survey, where 100 individuals living or working in one surrounding southern area of Madrid have participated in entering their travel data for an entire working week. The estimated mixed-logit model that incorporated two “social capital variables: participation in voluntary activities and receiving help for various tasks (i.e. child care) show how people who have less social capital, but that are trying to build it up choose more private than public modes: building social capital stock has a cost in term of time that push people to use more flexible transport mode (i.e. private car), while people who have already a stock of social capital and can use it (i.e. helped people) receive time from others and are more relaxed in choosing a less flexible mode of transport such as public transport. Results confirm that when a new metro station is opened, the shift towards metro is higher in the case of people “helped” and lower for those participating in some voluntary activities. From a policy point of view, it will be relevant to know if people leaving a specific area are more voluntary or helped oriented, for forecasting the future policies.

## 1. INTRODUCTION & BACKGROUND

Traditionally, few research works in travel behavior have included social capital variables in modeling, and when it happens, they include them such as empowerment factors (i.e. social capital substitutes or reinforces the individual financial capital). In other terms, social capital when you are a low income person increases your mobility or accessibility advantages, and lowers social disadvantage. Only recently some articles has presented the constraint aspects of social capital related with the need of resources for constructing or reinforcing and maintaining individual social capital.

This article will show both aspects of social capital in a dynamic way. First of all it will present a theoretical framework of social capital empowerments and constraints characteristics. Then, it develops a travel behavior model where both dynamic aspects of social capital (i.e. building up social capital and use of social capital) are integrated such as variables and estimated in their effects on transport modal choice.

Both aspects are related with the value of time: when people are doing something for the others (i.e. *Voluntary* actions, pick-up family members, etc.) they are using their time, and their mode choice will be oriented to saving time, therefore a private mode will be chosen, while when people are using their social capital benefit (i.e. somebody else is *helping* them), they will easily choose the less flexible and more time consuming transport mode.

Theoretically speaking, social capital variables indicate the social embedding of people in their own contexts (Granovetter, 1985; 2005). Actually, individuals could use social capital network integration for defining their own behavioural strategy (Granovetter, 1994). Putnam (1993) found that there is a strong correlation between civic engagement (i.e. voluntary) and government and local urban services' quality across Italian regions. Glaeser et al. (2002) highlights the spatial factor of social capital, therefore how its influence decreases with physical distance. In other words, social capital network is related to spatial proximity. Swanen et al. (2014) shows that internet and social networks media haven't a substitute effect on spatial distance and it doesn't increase individual social capital stock in this way. In other words, if people have not the opportunity to move for visiting members of their social network, they will progressively lose their social relationship. Their social capital stock will decrease: transport poverty as well could have strong effect on the social capital stock, in the opposite side than forecasted by Putnam above. Swanen et al. (2014) show that when you don't have regular access to transport you will lose social capital stock. The maintenance of social network needs spatial proximity. In this sense social capital generate more local trips (i.e. voluntary activities are locally based). Therefore, if the local community is social capital oriented, potential public policies to be implemented (including transport initiatives) may differ (Thièbault, 2003).

Coleman adopts an individual approach where social capital could substitute financial capital and positively influence social inclusion (Coleman 1988). Putnam (1993) highlights the strong correlation between civic engagement (i.e. voluntary) and government and local urban services' quality. In other words when people are social capital oriented they will receive better services. Following both approaches, a local community is social capital oriented when its members build up the social capital stock. In this way, social capital could decrease the role of socio-economic disadvantages. Adopting the Putnam's approach for local community analysis, urban services poverty (i.e. transport poverty) happens when people have not enough worked for building up their own local social capital. There is a kind of individual responsibility in the construction of social capital stock or network.

Bourdieu (2003), from a sociological approach highlighted that the stock of social capital is directly related with the socio-economic background of people: an the highest socio-economic

status provides people of an higher stock of social capital. Therefore the individual social capital stock is just a deterministic result of individual socio-economic embedness. In other words, there is a cumulative effect between social and economic factors: high income people will be easily social capital endowed. Social capital is a factor of increasing social disadvantages, including in transport domain when you are a low-income person.

Within the social capital context, this article defines the influence of social capital on transport choice, and try to focus on detecting its advantage or disadvantage in terms of individual mobility.

## **2. SOCIAL CAPITAL VARIABLES AND TRAVEL BEHAVIOR MODEL**

Making a point about social network and travel behavior, we find that following the egocentric approach of social network, people use to go to visit their friends or pick up other members of their family, but we really don't know if people are going for maintaining or for building or for using their social network. Therefore a forward step is needed for being aware when people need to take the more flexible and time-saving transport mode. Otherwise without knowing the motivation of the visit we could not well understand why some social trips is done by private car and other by public transport. And this could have some consequence in terms of modal shift to more sustainable transport modes (i.e. Public transport, bike and walking).

The first step for detecting the role of social capital on transport mode choice is to define a set of social capital variables. Socially speaking, the characteristics of social capital variables related with transport mode use are regrouped between empowerments and constraints. Empowerments represent the status of being part of a milieu where a specific travel choice (i.e. bicycle) is very prized (Graham et al. 2010). Social constraints are related to a cultural community against the use of a specific transport mode (i.e. bicycle for women in Musulman community). Economically speaking, social capital variables are related to two dynamic phases: the building up process of the stock of social capital, and the use of this social capital. Both phases deal with time availability: the social capital building process is a time consuming activities, while the use of social capital stock is a time liberating activity.

Following this classification of social capital variables, in this paper we focus on the economically speaking aspects and we define two specific variables already texted through a Smartphone panel survey in Madrid:

1. Social embedding of people in their own contexts (helped, i.e. time liberating);
2. Voluntary engagement in local community (Voluntary, i.e. time consuming)

Following the discrete choice modelling trend of treating inter-dependence of choices, we incorporate two social capital variables directly into a Mixed Logit (ML) model (Train, 2009), the choice of these two variables are related with two different dimensions of social capital: a passive one (receiving help) and an active one (to carry out voluntary activities). Both variables influence travel behaviour in a different way: the first one liberates some additional time for travel, while the second one generates new social trips and creates an additional time constrained subgroup (Farber and Paez, 2009). Voluntary people are constituting their social capital stock and this activity has a cost in terms of time that is directly related with travel behavior. Voluntary activity generates social trips generally defined as visiting someone. Sharmeen and Timmermans (2013), using a multimodal logit model of mode choice, show that

for social trips half of the respondents in a Dutch survey sample used slow private modes, while 39% used car and only 11% used public transport. Both social capital variables are economically correlated: high income people are more helped and social embedded, while lower income people are voluntary and oriented to build their own social capital stock. Both behavioral variables are related with time use, and directly influence the choice of transport modes.

The rest of the paper is organized as follows. A description of the panel Smartphone survey is reported in the next section, while the third section presents two different models estimated including the social capital variables role in travel mode choice. A synthesis of the estimation results including a discussion of the key variables for understanding transport mode choice is presented in section four. Finally, section five offers our conclusions about the role of “social capital” variables in explaining modal shift.

### **3. RESEARCH METHODOLOGY AND SURVEY DEVELOPMENT**

An exploratory survey, a sample of 1,174 individuals was selected among people leaving in suburbs of Madrid nearby new metro stations. The survey included useful information such as trip characteristics (i.e. itinerary and travel purpose, relevant information about times and costs of trips (i.e. including type of public transport ticket used) and users’ socio-economic attributes (gender and car ownership) to explain the characteristics of the sample (Cherchi and Ortúzar, 2002; Comendador et al., 2012).

An important result of the exploratory survey was that people used the new metro stations mainly for work trips with log-odds of choosing metro over car equal to 1.24 (significant at the 95% level), while trips with other purposes including social ones, are more car oriented. We used this result to build the panel survey, and think about new variables able to explain this difference in the modal choice. Therefore at this stage following the relevance of social capital aspects in the national population survey of Australia, Canada and United States such as other social-economic variables income, education two additional social capital variables were defined for this panel transport survey to check its relationship with the use of public transport: we should separate transport from social disadvantages. Therefore we were looking for social capital variables dealing with transport and social status such as voluntary and helped that are two indicators of social integration and socio-economic status. Actually, statistically speaking helped people are higher income surveyed people, while voluntary people are lower income surveyed people. This first result seems to point out that the social capital stock that seems to characterize helped people is a cumulative variable with financial capital, while voluntary people who are trying to construct their own social capital are investing on that and deal with a lower income level.

The first phase of the conducted survey was a face-to-face interview aimed at registering personal data about the respondent (it covered a wide variety of socio-economic variables). This interview was also used to explain the content and objectives of the survey and to ask two main questions about the social capital influences of residents and workers in the catchment area. In particular we asked:

- if they received some help for child-care or housekeeping (Helped dummy variable) and

- if they participated in non-compulsory meetings or activities (Voluntary dummy variable).

In the second phase, we provided respondents with a smartphone and asked them to register their trips during five days. Weekends were not included because we focused on daily trips.

There is an underrepresentation of men, because workers were mainly selected at the health care sector; participants were recruited during two previous informative meetings (on survey organization and its objectives) at the local Health Centre. There is also an over-representation of people between 24 and 45 years of age, the average revenue is quite high (65% of the sample earns more than € 2,000/month, while the average income of the MMA is € 1650/month) and households have four members on average. On the other hand, there is a significant share of people with a driving license and having daily car availability, and a low percentage of participants with a PT monthly travel pass. The distribution of the number of trips shows an expected peak around 10 to 14 trips per week but mode shares are 62.2% for car, 18.4% for walking, almost the same for PT (18.5%) and 0.9 are multimodal trips.

#### 4. THE BASE MODEL

The modelling stage started with the estimation of a basic Multinomial Logit (MNL) model where the representative utility  $V_{iq}$  of each alternative  $i$  was considered a function of the observable level-of-services (LOS) characteristics ( $X_{kiq}$ ) of the alternative, choice situation (trip purpose, for example) and decision-maker  $q$  (income, age, usual place of residence, gender, social capital variables); the set of parameters ( $\beta$ ) to be estimated included a full set of alternative specific constants (ASC). As usual, individual utility  $U_{iq}$  was assumed to incorporate an additive error term  $\varepsilon_{iq}$  following an identical and independent Type I Extreme value distribution (Ortúzar and Willumsen, 2011, chapter 7):

$$U_{iq} = V_{iq} + \varepsilon_{iq} \quad (1)$$

In this case, the choice probability for each alternative  $i$  is defined as:

$$P_{iq} = \text{Prob}(\varepsilon_{jq} \leq \varepsilon_{iq} + V_{iq} - V_{jq}, \quad \forall j \neq i) = \frac{\exp(\lambda V_{iq})}{\sum_j \exp(\lambda V_{jq})} \quad (2)$$

where the scale parameter  $\lambda$  is not identifiable (so we end up estimating coefficients multiplied by it) and  $V_{iq}$  is typically a linear function in the coefficients  $\beta$ , but not necessarily in the attributes. In fact, in our formulation it includes several interactions among the LOS attributes and decision makers' characteristics that allow accounting for systematic heterogeneity in individual preferences (Ortúzar and Willumsen, 2011, page 279). (For a deep description of the model, see Di Ciommo et al. 2014).

In addition of the classical attributes of cost and time, three individual-specific variables were included as dummies that did not vary across alternatives: Gender, which takes the value of one for females; car ownership (CO) which takes the value of one for households with one or more

cars, and Purpose which takes the value of one if the trip was to work. Finally, our model included the two dummies (Voluntary and Helped) related with the social integration level of the decision-maker; these are two observable characteristics, in the sense that they explain a specific situation for each decision-maker. The first is a time consuming variable and the second a time saving variable; thus, both may influence travel behaviour, but probably in a different way.

## 5. MODEL ESTIMATION RESULTS AND CONCLUSIONS

Individuals were considered to have a choice among the three modes of travel: car, public transport and walking. Our study attempted to find out whether better models could be obtained when using social capital variables such as Voluntary and Helped. Table 1 reports the results of two ML models with different specifications, with and without the social interaction effects, to test the effects of their inclusion. The ML models were estimated using an own code (available on request from the authors) written within the R statistics package (Croissant, 2011).

	ML 1		ML2	
	Estimates	t-test	Estimates	t-test
Total Travel Time	-0.036	(-4.9)	-0.044	(-4.7)
Personal Travel Cost	-0.441	(-6.1)	-0.397	(-6.6)
Systematic heterogeneity in Travel time				
Female	-0.283	(-8.4)	-0.301	(-8.6)
Car ownership	-0.004	(-7.2)	-0.004	(-6.0)
Work	-0.003	(-1.9)	-0.003	(-1.6)
Voluntary	---		-0.006	(-5.3)
Helped	---		-0.011	(-9.3)
Attributes specific for Public Transport				
ASC	0.980	(17.0)	0.502	(12.5)
St. Dev. (panel effect)	1.465	(9.1)	0.897	(8.8)
Female	2.017	(3.3)	1.475	(3.1)
Car ownership	-3.932	(-7.1)	-5.680	(-8.0)
Work	-0.770	(-1.5)	-0.822	(-2.0)
Voluntary	---		-1.700	(-1.7)
Helped	---		1.391	(2.8)
Attributes specific for Walking				
ASC	1.240	(16.9)	1.092	(17.8)
St. Dev. (panel effect)	0.043	(6.1)	0.057	(6.0)
Female	-1.346	(-4.1)	-1.141	(-3.6)
Car ownership	-5.263	(-5.0)	-5.778	(-6.3)
Work	-1.438	(-1.9)	-1.502	(-2.5)
Voluntary	---		-3.016	(-4.5)
Helped	---		1.924	(5.8)
Log-likelihood	-433.91		-390.44	

**Table 1 - Model estimation results (N = 974 observations)**

As can be seen, all coefficients are significantly different from zero and have the expected sign. A log-likelihood ratio test on ML1 and ML2 confirms that for this particular case study, the latter has indeed higher explanatory power. Furthermore, with the inclusion of Voluntary and Helped almost all parameters increase their statistical significance except for Time and Gender. The marginal utility of total travel time seems to be influenced by both social capital terms. This is expected, as a person doing more activities has less time and should reveal a higher value of time. On the other hand, people receiving help (e.g. in childcare) probably needs it and would not have enough time, otherwise, to deal with all their activities (interestingly, although they have relatively higher incomes they tend to choose PT and walk more often, spending more time); this helps explaining why their values of time are even higher than those who do voluntary activities, and therefore, they generally decide to not participate in voluntary activities (Putman, 2000). This result confirmed that helped people are cumulating both financial and social capital endowments, while voluntary people that are lower income and lower social capital endowed decide to invest their time in constructing their own not yet consolidated social capital through their participation to voluntary activities. The socioeconomic attributes also improve the statistical quality of model ML2, especially car ownership (CO) and the Work variable related with the Walk mode. In summary, these results confirm that observed behaviour is not only ruled by the typical LOS attributes, but also by a strong social influence component.

The results of model ML2 imply that the introduction of Voluntary reduces the probability of choosing Walk and PT, and has a non-linear influence on the utility function. This result could be explained by the effect of activities on mode choice: if somebody participates more in voluntary activities, s/he consumes more time than otherwise and may take more account of LOS variables (and in peripheral boroughs, such as the case study examined in this paper, this favours the car mode). In turn, Helped increases the probability of choosing Walk and PT (as when having some help for house and childcare, a person saves some time that can be used for travelling by foot or by public transport). In both models the Work dummy, related to the PT mode, seems less important for the same reasons as above: the direct relationship between different activities (and Voluntary or Helped are two of them).

A breakdown in the analysis of Helped and Voluntary user types (Table 2) seems to confirm that the former freely choose to take PT as they have, on average, more cars and higher income; Voluntary users, on the other hand, have less access to cars and a relatively lower income, but freely decide not to use the new metro lines. However, the estimation of systematic heterogeneity in travel time for both social capital variables highlights the same negative sign for both types of users (i.e. they perceive negatively the time restriction). So, in this case the integration of social capital variables adds something to the neoclassical explanation of the effect of income on the value of time, which is an interesting result: car choice is not completely associated with a higher level of income. In fact, Voluntary users carry out more activities liberating some time by using the car intensively; their social embedding profile makes them more socially active people. Helped users, who are characterized by an higher social status embedding, are able to obtain help because of their higher income and high social network but decide to use their cars less as they have more time since they benefit from the time of others.

In fact, time per trip for “helped” people is on average 34 min, while time per trip for “voluntary” people is 27.6 min. Di Ciommo and Lucas (2014) show that time ratios between public transport and car are quite high (i.e.1.62 in average) in the suburbs of the Madrid Metropolitan area. People involved in voluntary activities need to liberate time for their social

trips. Therefore, as shown by Sharmeen and Timmermans (2013), these trips are more likely done by private modes (i.e. car, bike and walk) than by public transport. In general, for social trips people choose private modes that present additional degrees of “perceived” freedom with respect to PT (Jakobsson, 2000). People characterized by both variables Helped and Voluntary seem to combine mode choice criteria: they still prefer the car but less than just Voluntary people, and increase their PT use. Finally they definitely increase their walking distance even more than just Helped people. This result seems to point out to the conclusion that some social trips are done more easily by walking than using car (see Table 2).

Socio-economic Characteristics	Helped = 'yes'	Voluntary = 'yes'	Helped & Voluntary = 'yes'
Female	66.7	71.9	68.8
Age	43.2	43.0	43.0
Household size	3.2	2.8	2.8
Monthly income (euros)	2766.7	2468.7	2678.3
Driving license	92.3	90.1	92.1
One or more cars	84.4	78.1	80.5
% Monthly travel pass	15.5	21.2	17.5
<b>Weekly travel Characteristics</b>			
Tours	6.2	6.0	6.2
Time per trip	34.0	27.6	29.9
Trips by car	9.8	11.3	10.1
Trips by PT	4.7	4.5	4.5
Walking trips	5.9	5.6	6.0
Trips to work	14.1	15.2	14.6
Non-working trips	6.3	6.2	6.0
Car time (min)	207.3	286.3	265.5
PT time (min)	264.3	177.3	190.8
Walk time (min)	222.4	126.7	140.7
Car distance (km)	8.2	9.0	8.7
PT distance (km)	3.8	2.7	3.0
Walking distance (km)	2.4	2.3	2.5

**Table 2 - Helped and Voluntary user types**

The first conclusion is related with the analysis of transport disadvantage through the lens of social capital. The model results highlight that lower income people are more oriented to engage themselves in social capital activities, but that this engagement makes them less public transport and soft modes oriented, in other words less sustainable, while people with an already consolidated social capital are more sustainable modes oriented. This consequence has a deep consequence in terms of policies: when policy-makers are oriented to develop a more sustainable transport system and increase a soft choice mode share, they should act on time availability of people and reduce travel-time for social travel trips. Actually, social disadvantage created by social capital variables contribute to a lower use of sustainable transport modes.

The second relevant conclusion of this exploratory research shows that social capital as individual resource reinforces socio-economic variables and time availability instead of acting such as a substituting variable.



Thirdly, a new research domain could be developed in defining social capital variables and detecting by them transport disadvantage. In other words, social exclusion and transport disadvantage could be linked through the lens of social capital. The drivers for defining key variables for modeling transport disadvantages deal with time constraints, income constraints, and social and physical constraints.

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