Business travel decisions and high-speed train: an ordered logit approach

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Abstract

The building of a new infrastructure is always a good opportunity to see how firms' behaviour changes in reaction to an accessibility improvement. Indeed, nowadays, doing business means face the increasing interconnection and globalization of our world. In this context, business travel has become a quite common and diffused practice, which generates billions of dollars in revenues and has impact on GDP and employment. In the economic literature, a lot was done on the high-speed trains' (HST) impacts. In particular, if we look at the impact on business travel, some studies have found that HST increase the number of face-to-face contacts between the cities connected. However, nothing was found in the literature on measurement of this growth and on the characteristics of the involved firms.

Therefore, the purpose of this research is to study the impact on business travel of the new high-speed railway line, called Alptransit, which will link Lugano with Zurich (Switzerland) in less than two hours. In order to investigate this issue, an on-line survey was conducted with firms located in Ticino.

An ordered logit model is applied, in which the dependent variable is represented by the self-assessed probability to travel more to Zurich for business reasons, thanks to Alptransit.

This probability is analyzed distinguishing by employees' categories: CEO and upper management, administrative staff, sales personnel and specialists. This specification is motivated by the fact that not all workers travel: professional status and hierarchical position are significant factors that influence the business travel characteristics.

In the econometric analysis, we control for the current spatial distribution of firm's productive relations, firm's spatial organizational structure, firm's spatial structure of current business travels, current transport mode used for business travel and firm's characteristics (sector, age and size). Those independent variables are selected on the bases of the past economic literature about this issue and on the correlation with the dependent variable.

Moreover, in order to capture more heterogeneity in the sample, we extend the framework of ordered models, allowing some parameters to be random distributed (mixed ordered logit).

Keywords

High-speed train - Business travel - Ordered logit - Firms' behaviour

1. Introduction

The building of a new infrastructure is always a good opportunity to see how firms' behavior changes in reaction to an accessibility improvement. In particular, this paper wants to study the impact on business travel of the new high-speed railway line project, called Alptransit, which will link Lugano with Zurich (Switzerland) in less than two hours.

Nowadays doing business means, after all, face the increasing interconnection and globalization of our world. In this context, business travel has become a quite common and diffused practice (UNWTO, 2012; Aguilera, 2008), which generates billions of dollars in revenues and has impact on GDP and employment (WTTC, 2014). By business travel, we mean a work-related travel to an irregular place of work (Aguilera, 2008).

In the economic literature, a lot was done on the high-speed trains' (HST) impacts; for example, thanks to HST isolated markets were better integrated, monopolistic positions were reduced and competition and productivity increased (Blum et al., 1997).

If we look at the impact on business travel, some studies have found that HST increases the number of face-to-face contacts between the cities connected (Blum et al., 1997; Willingers et al., 2007). However, nothing was found in the literature on measurement of this growth and on the characteristics of the involved firms. This paper wants to investigate this issue, using new micro data from Ticino (the Swiss Canton that includes Lugano) firms for the Swiss Alptransit project.

Why we can imagine that HST could have an impact on business travel? By shortening travel time, HST improves city's accessibility (Gutiérrez, 2001) and in particular, according to the definition of inbound/outbound accessibility (Törnqvist, 1984), it increases the face-to-face contacts opportunities during a one-day trip. In this sense, firms could decide to travel more frequently to Zurich/Lugano or to go and come back in half a day rather than in a full day.

The paper is organized as follows: the next section summarize the economic literature on the variables used in the empirical model. The third section is dedicated to the explanation of the data and econometric model used for the analysis. The fourth part highlights the preliminary results of our study. Finally, some conclusions and future research ideas are presented.

2. Literature review

In this section of the paper, we want to focus on the main variables used in the model, starting from the dependent variable: the probability that, thanks to Alptransit, business travel from Ticino to Zurich will increase.

In the literature, accessibility is considered as one of the fundamental factor for firms, in this sense HST makes easier the possibility of face-to-face contacts with other firms, customers, suppliers, partners and workforce (Blum et al., 1997).

In this study, the probability that face-to-face contacts will increase after Alptransit is analysed distinguishing by employees' categories: CEO and upper management, administrative staff, sales personnel and specialists. This specification helps in identifying the probable meeting purpose, for example visiting clients, branches, government department or attending courses,

fairs, conferences and conventions, opening or closing new units, projects, R&D, etc. (Beaverstock et al., 2009; Swarbrooke et al., 2001).
Looking at the explanatory variables that are included in the model, they are selected based on the literature and on the correlations analysis with the dependent variable, and we can divide them into five main categories:

- The current spatial distribution of firm's productive relations. As the literature suggests, the relations with clients and suppliers are one of the main cause of face-to-face contacts (Aguilera, 2008; Beaverstock, 2009).
- The firm's spatial organizational structure, in terms of subsidies, branches and headquarters. In this context, business travel is essential to tie together spatially distributed subsidies (Willingers, 2003).
- The firm's spatial structure of current business travels. The destination of current business trips obviously influences the future use of Alptransit: we can imagine that firms that nowadays travel to Zurich will take more advantage from HST than those that have not any kind of business relations with that city.
- Firm's characteristics: sector, age and size. Some studies underline the importance of sector in the perception of accessibility importance. In particular, the empirical evidence shows that tertiary sector, like services and R&D, needs face-to-face contacts for the success of its activities (Blum et al., 1997). While firm's size is determinative for the accessibility perception (Willingers, 2003), we have not found any evidence that support the hypothesis that firm's age (start-up or not) significantly influence travel behavior.
- Characteristics of current travels to Zurich: firms that nowadays travel to Zurich with train will probably use more Alptransit, indeed travel behavior is based on habits (Aarts H. et al., 1998, Aarts H. et al. 2000). Moreover, we control for current overnight stay in Zurich after a business meeting: those firms, thanks to the reduced travel time, could substitute the overnight stay with more one-day trips. We decide to include also a variable that indicate the distance in kilometers from the nearest Alptransit station (Lugano or Bellinzona) to take into account another measure of accessibility.

After this presentation of the main variables that are included in the econometric model, in the following section we describe the data and method used.

3. Data and methods

The data for the present research are collected with an online survey, in the period between April 2014 and February 2015. The questionnaire was built following recent examples in the literature, and it principally aimed at mapping firms' business relations. It was explicitly addressed to CEO and upper management of 6235 firms located in Ticino, whose contacts were in the Bureau Van Dijk database. 778 questionnaires were entirely filled in, with a response rate of 12.5%, which is quite in line with the results in the literature. From that sample, we exclude firms with zero employees (which are mainly foreign branches with only legal residence in Ticino), since they are not interesting for the purposes of our analysis.
Therefore, 696 firms are considered in the model.

Table 1 shows some descriptive statistics regarding our sample: 72.4% of firms in the sample operate in the tertiary sector; they are mainly mature firms (74.1%) and sole proprietorships (78.4%). Moreover, about 71% of them are micro firms (with less than 10 workers). Those sample characteristics, which seem quite unbalanced, actually reflect Ticino economic structure that is manly composed by micro, independent firms, which operate in services. Nevertheless, we decided to introduce random parameters, in order to capture the unobserved heterogeneity hidden in the sample, and in particular exactly in firm's micro dimension and in sector.

Table 1 - Sample descriptives

Category		Sample (n)	Sample (%)
Sector	Secondary	192	27.6%
	Tertiary	504	72.4%
Age	Startup	180	25.9%
	Mature	516	74.1%
Organizational structure	Sole proprietorship	546	78.4%
	Branch	80	11.5%
	Headquarter	70	10.1%
Dimension	Micro	495	71.1%
	Small	161	23.1%
	Medium-Large	40	5.8%

The model applied in our analysis is an ordered logit model, which is the more suitable econometric technique when there are dependent variables that are ranked on a scale. Moreover, this type of choice models allows analysing hypothetical situations: thanks to self-assessed probabilities, we could try to capture agent's behavior in a future situation.
Following the work presented in Greene and Hensher (2009), consider the latent variable y^* that in this specific case is how Alptransit will modify firms' business relations. This phenomenon can be described by the following latent regression model:

$$y_i^* = \beta' x_i + \mathcal{E}_i \quad (1)$$

and is observed in discrete form through a censoring mechanism. In particular, our latent variable is represented by a discrete and ordinal indicator y_i:

$$\begin{aligned} y_i &= 1 \quad \text{if} \quad \mu_0 < y_i^* < \mu_1 \\ y_i &= 2 \quad \text{if} \quad \mu_1 < y_i^* < \mu_2 \\ y_i &= 3 \quad \text{if} \quad \mu_2 < y_i^* < \mu_3 \\ y_i &= 4 \quad \text{if} \quad \mu_3 < y_i^* < \mu_4 \\ y_i &= 5 \quad \text{if} \quad \mu_4 < y_i^* < \mu_5 \end{aligned} \quad (2)$$

y_i is the self-assessed probability of increasing BT for each employees' category thanks to Alptransit, and is measured in our survey by the question: "How likely is that the following employees categories (CEO, sales personnel, administrative staff and specialists) will travel more to Zurich, thanks to Alptransit? 1 (Very unlikely), 5 (Very likely)".
The sample observations (firms) are labelled i = 1, ... , n; the vector x_i contains all our explanatory variables, which are assumed to be strictly exogenous of ε_i and are described in Table 2.

Table 2 - Explanatory variables

Variables	**Operationalization**
Suppliers in Zurich	How many suppliers firm has in Zurich
Suppliers in East Europe	How many suppliers firm has in East Europe
Clients in Ticino	How many clients firm has in Ticino
Clients in Zurich	How many clients firm has in Zurich
Clients in Italy	How many clients firm has in Italy
Clients in East Europe	How many clients firm has in East Europe
Services	Firm belongs to service sector (financial and insurance activities, real estate, administrative, scientific and professional activities)
Manufacture	Firm belongs to manufacture sector
Micro	Firm has less than 10 workers
Startup	Firm is a startup (less than 3 years)
Sole proprietorship	Firm is a sole proprietorship
Branch	Firm is a branch of a company group
Other plant in Zurich	Firm has another plant in Zurich
CEO current BT to Ticino	Current BT frequency of CEO in Ticino
CEO current BT to Zurich	Current BT frequency of CEO to Zurich
Admin. current BT to Ticino	Current BT frequency of administrative staff in Ticino
Admin. current BT to Zurich	Current BT frequency of administrative staff to Zurich
Admin. current BT to Milan	Current BT frequency of administrative staff to Milan
Comm. current BT to Ticino	Current BT frequency of sales personnel in Ticino
Comm. current BT to Zurich	Current BT frequency of sales personnel to Zurich
Comm. current BT to Italy	Current BT frequency of sales personnel to Italy
Other current BT to Ticino	Current BT frequency of specialists in Ticino
Other current BT to Zurich	Current BT frequency of specialists to Zurich
Other current BT to Milan	Current BT frequency of specialists to Milan
Current use of train to Zh	Current use of train to go to Zurich
Overnight stay in Zurich	Current overnight stay in Zurich after a business meeting
Distance	Distance in km from Alptransit station

The vector of unknown parameters β and the J+1 thresholds μ_j are the object of estimation and inference. Finally, we assume that the error term $\mathcal{E}_i$ is IID logistic distributed with mean 0, scale parameter 1 and cumulative distribution function $\Lambda(\mathcal{E}_i|x_i) = \Lambda(\mathcal{E}_i)$.
Given those assumptions, the probabilities associated to the observed outcomes are:

$$Prob[\, y_i = j \mid x_i] = Prob[\, \mu_{j-1} < y_i^* < \mu_j] = Prob[\mu_{j-1} < \beta' x_i + \mathcal{E}_i < \mu_j] =$$

$$= Prob\,[\, \mathcal{E}_i < \mu_j - \beta' x_i\,] - Prob\,[\mathcal{E}_i < \mu_{j-1} - \beta' x_i] = \Lambda[\, \mu_j - \beta' x_i] - \Lambda[\, \mu_{j-1} - \beta' x_i] \quad (3)$$

with j = 0, 1, … , J.

For identification purposes, we impose that $\mu_{j-1} < \mu_j$; $\mu_0 = -\infty$ and $\mu_5 = +\infty$.
The log-likelihood function, based on the previous implied probabilities, is:

$$\log L = \sum_{i=1}^{n} \sum_{j=0}^{J} m_{ij} \log\, [\Lambda\, (\mu_j - \beta' x_i) - \Lambda(\, \mu_{j-1} - \beta' x_i)] \quad (4)$$

where $m_{ij} = 1$ if $y_i = j$ and 0 otherwise.
Thanks to the maximum likelihood estimator (MLE), it is possible to estimate the (fixed) parameters β and μ.
However, past research has underlined the importance of including random parameters in the model, in order to capture the unobserved heterogeneity in the data. Following this strand of literature, we decide to introduce also random parameters in the models.
Following the procedure method in Greene and Hensher (2009) and the presentation in Sadri et al. (2013), we consider:

$$\beta_i = \beta + u_i \quad (5)$$

where β is the average effect, the common mean coefficient across all firms, and u_i is a randomly normal distributed term. Using simulated maximum likelihood estimation (see McFadden and Ruud, 1994; Train, 2001) with 5000 Halton draws, we obtain the preliminary results described in the next paragraph (we use Python Biogeme software). We choose to adopt Halton draws, instead of random draws, since the simulation procedure is faster with the first ones (Halton, 1970; Bhat, 2003).

4. Preliminary results

Preliminary results[1] of the four ordered models (one for each employees' category) show that there are some differences in the coefficients' significance for the variables related to geographical distribution of clients and suppliers. What clearly emerges is that higher the number of current clients in Zurich, higher the intention to travel more to Zurich with Alptransit

[1] Results table is under construction

(the coefficients are positive and significant for three out of four models). Therefore, Alptransit will consolidate the business relations between Ticino firms and the Swiss major economic pole, as expected. On the other hand, having many clients or suppliers in other locations not significantly influence the probability to travel more or, if significant, it negatively affects it.
Being a firm that belongs to service sector (financial and insurance activities, real estate, administrative, scientific and professional activities), so a high value activity, positively influences (if compared to other activities in tertiary sector) the intention to travel more with Alptransit only for CEO and for specialists.
On the other hand, the variable manufacture is significant for all the models and has negative sign; if compared with other activities in the secondary sector (principally construction) manufacture activities show a lower propensity towards increasing travels with Alptransit.
Another important result is that the more frequent current BT in Ticino or to Zurich for one employees' category, the higher the intention to travel more in the future for the same category. Therefore, Alptransit will consolidate the travel behavior of all those categories.
Looking at how current BT of one category influence the future BT of other categories, the more frequent CEO current BT to Zurich, the higher the probability of travelling more of administrative staff and sales personnel. In addition, the more frequent administrative staff current BT to Zurich, the higher the intention of increasing specialists' BT.
Alptransit will consolidate also the transport mode chosen to go to Zurich: the current use of train positively affects the probability of travelling more in the future for all employees' categories, if compared with those that currently use other transport modes.
The overnight stay variable is statistically significant only for the last two models and is positive: the fact that today, after a meeting, employees overnight in Zurich, positively impacts on the intention of increasing travels for sales personnel and specialists, if compared with those firms that currently not overnight.
So far, we have described the four ordered logit models with fixed parameters. However, we suspect that there is some unobserved heterogeneity in our sample, and we decide to estimate the same four models, but with random parameters, all normally distributed. We try different specifications of the random parameters models to understand where is actually hidden the heterogeneity. Here we present models' preliminary results, which turn out to be the best after statistical tests.
In order to compare the random parameters models with the fixed parameters ones, we use the likelihood ratio (LR) test, which can be calculated as follows:

$$LR = -2\,[LL(\beta_{random}) - LL(\beta_{fixed})] \quad (6)$$

Where $LL(\beta_{random})$ is the final log-likelihood of the random parameters ordered logit model, while $LL(\beta_{fixed})$ is the final log-likelihood of the fixed parameters model.
The likelihood ratio is distributed as a chi-square with degrees of freedom equal to the difference in the number of parameters between the two models. Table 3 shows the values of the tests for the four employees' categories models: we are able to reject the null hypothesis that random parameters are simultaneously equal to zero, only for the CEO and administrative staff models. Therefore, for those models, the random parameters approach is more appropriate than the fixed parameters approach.

Table 3 - Likelihood ratio test between fixed parameters and random parameters models

CEO models	
LR = -2 [LL (β rand) - LL (β fixed)]	18.594
Degrees of freedom	3
Critical chi-square value (0.95 level of confidence)	7.81
Administrative staff models	
LR = -2 [LL (β rand) - LL (β fixed)]	11.446
Degrees of freedom	3
Critical chi-square value (0.95 level of confidence)	7.81
Sales personnel models	
LR = -2 [LL (β rand) - LL (β fixed)]	3.192
Degrees of freedom	3
Critical chi-square value (0.95 level of confidence)	7.81
Specialists models	
LR = -2 [LL (β rand) - LL (β fixed)]	2.842
Degrees of freedom	2
Critical chi-square value (0.95 level of confidence)	5.99

Since for sales personnel and specialists models, the fixed parameters models are better than the random parameters ones, here we focus our attention only on the CEO and administrative staff models.

Looking at the CEO model[2], there are no great differences in signs and significance of coefficients. What is interesting is the important contribution of the random parameters: first, inside micro firms is hidden part of the unobserved heterogeneity in the sample (the standard deviation is significantly different from zero). Moreover, also for the variables CEO current BT to Ticino and to Zurich there is heterogeneity in the sample; this suggests that the effect on the self-assessed probability varies across observations: for some of them the effect may be positive, while for others it may be negative.

This is true also for the administrative staff model, but the variables in which we capture the heterogeneity are manufacture, CEO business travel to Ticino and overnight stay in Zurich, which have statistically significant standard deviation.

[2] Results table is under construction

5. Conclusions

The main goal of this paper is to understand how firms' business relations will change after the Alptransit railway project in Switzerland. In order to study this issue, we exploit discrete choice techniques and in particular, we apply an ordered logit model with random parameters.
We study this phenomenon by distinguishing the effect between employees' categories, since hierarchy plays an important role in managing face-to-face contacts inside firms, as suggested by business travel literature.
The inclusion of random parameters allows us to capture the unobserved heterogeneity in the sample and in particular, within micro firms, manufacture sector, firms that currently have contacts with Zurich and in Ticino, and those who overnight in Zurich after business meetings. Random parameters are the most suitable approach to look at CEO and administrative staff models, while for the other two employees' categories the fixed parameters ordered model is considered more appropriate. This element together with the differences in the coefficients' significance between the four models, support our idea of analysing separately employees' categories. However, for future research, we plan to build only one model that takes into account all those categories, to test their actual difference and the robustness of our results.
One of the main results of our analysis suggests that Alptransit will influence the behavior of firms with specific characteristics. Those findings provide some key insights on the likelihood of increasing business relations with HST and in particular, we can conclude that Alptransit will mainly consolidate business relations between Ticino and Zurich.
Future research should consider the double direction of accessibility concept: Zurich will be closer to Ticino, but also Ticino will be closer for Zurich firms. This viewpoint change could induce to study the impact of Alptransit on Zurich firms and in particular on their intention to increase business relations with Ticino.

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