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Travel time variability and airport accessibility

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ABSTRACT

We analyze the cost of access travel time variability for air travelers. Reliable access to airports is important since the cost of missing a flight is likely to be high. First, the determinants of the preferred arrival times at airports are analyzed. Second, the willingness to pay (WTP) for reductions in access travel time, early and late arrival time at the airport, and the probability to miss a flight are estimated, using a stated choice experiment. The results indicate that the WTPs are relatively high. Third, a model is developed to calculate the cost of variable travel times for representative air travelers going by car, taking into account travel time cost, scheduling cost and the cost of missing a flight using empirical travel time data. In this model, the value of reliability for air travelers is derived taking "anticipating departure time choice" into account, meaning that travelers determine their departure time from home optimally. Results of the numerical exercise show that the cost of access travel time variability for business travelers are between 0% and 30% of total access travel cost, and for non-business travelers between 0% and 25%. These numbers depend strongly on the time of the day.

1. Introduction

The accessibility of airports has been researched since several decades as it is an interesting topic for researchers, governments, airlines and airports. The work of Skinner (1976) and Harvey (1986) showed that the accessibility of airports in terms of travel time is of vital importance for the choice of an airport by air travelers. Increasing the accessibility of an airport can therefore be one of the possible strategic actions of airports to improve their market position.

As discussed by Kouwenhoven (2008), airport choice models can use generalized access cost as an accessibility indicator. In that case, all monetary cost for going to the airport such as parking cost and airport specific taxes are taken into account, while non-monetary cost such as travel time can be multiplied by the willingness to pay (WTP) values and then added to other monetary cost. Usually, such WTP values are estimated using stated choice experiments.

The WTP for a reduction in airport access travel time, or the value of access time (*VOAT*), has been frequently estimated in the literature. It has been found that the *VOAT* is considerably higher than the value of time for commuters. For example, Furuichi and Koppelman (1993) use RP data and find a value of 70 $/h for business travelers and 41 $/h for leisure travelers, although they add that there may be possible collinearity between travel time and travel cost so that the estimations may be biased. Pels et al. (2003) find even higher values of 118 $/h for non-business and 174 $/h for business travelers. Hess et al. (2007) find similar values as Furuichi and Koppelman for business and non-business travelers using data from a stated preference study. Furthermore, Hess and Polak (2005) suggest that a possible reason for the high estimates of the *VOAT* could be

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that travelers see increasing travel times as an increase in risk to miss their flight. Hess and Polak (2005, 2006), Dresner (2006) and Ishii et al. (2009) also show that there is significant heterogeneity in the *VOAT*.

The main contribution of this paper is that we include the cost of airport access travel time variability, using a scheduling model. Earlier models take into account schedule delay at the destination (Lijesen, 2006; Hess et al., 2007), but ignore access travel time variability. The only study that incorporates the effects of access travel time variability that we are aware of is a revealed preference study by Tam et al. (2008). They estimate the disutility of a safety margin that travelers apply when traveling to the airport. The safety margin in their study is defined as the difference between the preferred arrival time and the expected arrival time, and can be interpreted as the buffer that travelers take into account to cope with access travel time variability. They find that both business and non-business travelers are willing to pay money to decrease the safety margin by amounts between 1 and 1.3 times the WTP for reductions in travel time. We extend the paper of Tam et al. (2008) by explicitly explaining the determinants of the safety margin, using a scheduling model. In transport economics, the scheduling model has been frequently estimated for commuters (for overviews of empirical research see for example: Bates et al., 2001; Brownstone and Small, 2005; Tseng, 2008; Li et al., 2010). It is an intuitive model, where travelers make a trade-off between monetary costs, travel time costs and the expected cost of being early and/or late when determining the optimal departure time from home. In this paper, the WTP values for reductions in access travel time, schedule delay early, schedule delay late, and the probability to miss a flight, are estimated using stated choice data.

After that, a model is developed, to analyze the cost of access travel time variability for car travelers using empirical travel time distributions and taking into account "anticipating departure time choice", meaning that in order to cope with access travel time variability, travelers may depart earlier from home. This final step is needed to connect the estimated WTP values to real travel time data. The resulting generalized cost can be implemented in accessibility models that analyze airport choice behavior of travelers (see, for example, Kouwenhoven, 2008).

The main motivation to develop a separate model for air travelers is that the variability of travel time is important, because the cost of missing a flight is expected to be high. Therefore, air travelers can be expected to apply large buffers, to be sure that they are on time. Using our departure time choice model it is possible to test the hypothesis of Hess and Polak (2005, 2006) that the high VOAT is the result of an increase in risk of missing a flight, because the risk to miss a flight is now included explicitly in the model and in the stated preference survey.

The setup of the paper is as follows. In Section 2 the scheduling model for air travelers is introduced. This model differs from the standard models used for commuters, in that air travelers have a large cost penalty if they arrive at the airport later than their final check-in time. Section 3 analyzes the determinants of the preferred arrival time at the airport. In Section 4 binary mixed logit models are estimated to derive the WTP values for reductions in travel time and travel time variability, using data from a stated choice experiment. In Section 5 a model is developed to derive the generalized access cost for car travelers taking into account access travel time and access travel time variability. Section 5 establishes the connection between the estimated WTPs and the observed travel time data and also models the behavioral response of travelers to access travel time variability. We use a real world travel time dataset to apply the model, and show how to calculate the cost of access travel time variability. Section 6 concludes and discusses the results.

2. The scheduling model for air travelers

2.1. The basic model

The scheduling model of Noland and Small (1995) has been widely accepted as a standard tool of analyzing the effects of travel time variability. Their model was based on earlier work of Vickrey (1969) and Small (1982). The central idea is that travelers make a trade-off between being earlier or later than their preferred arrival time (t_{pat}). In this paper, the model is extended to account for the specific concerns of air travelers. Notably, the departure time from home (t_h) chosen by air travelers is expected to strongly depend on the probability of missing a flight, and the associated expected cost. Fig. 1 illustrates the assumed structure of the air traveler's scheduling cost as a function of arrival time.

The x-axis of Fig. 1 indicates the time of day, and the y-axis indicates the scheduling cost. Suppose an air traveler has a certain flight departure time with a corresponding final check-in time (*FIT*). We assume that when a traveler is later than this final check-in time, he will certainly miss his flight, whereas he will catch it certainly otherwise. The cost of missing the flight is likely to be high, and this is the reason why travelers may apply substantial buffers when going to the airport. Given the fact that travelers perform other activities at the airport such as shopping, $t_{pat} < FIT$ is the optimized arrival time at the airport. Arrivals that are different from t_{pat} result in higher travel costs. The way the function is drawn suggests that there is a distinctly positive probability of catching the flight for any arrival time at the airport before *FIT*; but of course θ could approximate 0 without loss of generality. The kinked function of Fig. 1 may be taken as an approximation for a smooth function that has a steep segment near *FIT* in reality.

When leaving from home, an air traveler first estimates what the in-airport service time and variability will be, and how much time he wants to spend on airport activities. The airport service time is defined as the time for checking in, going through the passport control and security, walking to the gate and boarding the plane. Based on this subjective belief the traveler determines his preferred arrival time t_{pat}. Longer perceived in-airport service times will therefore result in an earlier t_{pat} (for a given scheduled flight departure time). The t_{pat} used in this paper is defined as the time a traveler wants to arrive at