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Measuring the willingness-to-pay of air-rail intermodal passengers

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Abstract

This paper measures the willingness-to-pay of passengers for air-rail intermodal products. Several studies have been conducted in Europe to identify ways of improvement for a wider use of air-rail intermodal products. Different solutions have been considered including luggage through-handling, coordination of timetables, and compensation for delay, but the question of their price was not addressed. Using a conjoint analysis, we measure the willingness to pay of intermodal passengers for different versions of intermodal services. We find differences in the reservation prices of passengers according to several socio-demographic characteristics and infer some managerial implications.

Key Words: Willingness-to-pay, modal switch, intermodal transport, air-rail travel, combined tickets

1. Introduction

Air-rail intermodal agreements are playing an increasing role in transportation systems. Historically, these agreements emerged in Europe, essentially in Germany, Switzerland and France, but now extend to Asian countries. Until recently, the phenomenon has remained limited. For instance, according to the Direction Générale de l'Aviation Civile (2009), only 5% of passengers at Paris-CDG airport arrived by high-speed train (HST), although based on figures for Paris, French intermodal traffic increased by more than 300% between 1999 and 2011 while the air traffic increased by less than 50% during the same period (Direction Générale de l'Aviation Civile, 2011).

Air-rail intermodal strategies are, however far less developed in France than in countries such as Germany. A study by the French Civil Aviation Authority (Direction Générale de l'Aviation Civile, 2011) found that 5% of Paris-CDG airport traffic involves intermodal

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passengers using rail, but that the share falls to 0.5% when considering passengers using integrated/combined air-rail tickets.

Here we assess a range of policies that have been suggested for increasing the use of combined air-rail tickets, notably luggage through-handling, coordination of timetables, and guarantees for delay by assessing their monetary values for passengers. To be more precise, we want to measure their willingness to pay using on a conjoint-analysis. To do so, we first provide some theoretical insights concerning our objectives. We then detail our methodology justifying the use of a choice-based conjoint analysis to assess their willingness to pay. Finally, we present the results of our survey and give some interpretations.

2. Theoretical framework

The use of multiple modes of transport to make a trip gives airlines the opportunity to increase the destinations they serve around the world, by enhancing their "commercial presence" in many regional cities (Terpstra and Lijesen, 2011). By providing capacity from secondary cities to airport hubs, surface modes can increase airlines' traffic to their major market. Intermodal agreements with railways, for example, also allow regional passengers to book a rail/plane ticket from their city to the destination of their choice. Cathay Pacific and Qatar Airways have for instance made those kinds of agreements with Société Nationale des Chemins de Fer français (SNCF), the French state rail company. Lufthansa and Deutsche Bahn have also come together to form an intermodal strategy (Grimme, 2007) that replaces some unprofitable short-haul flights with a rail trip (Chiambaretto and Decker, 2012).

When an airline decides to cooperate with a rail operator, it creates the opportunity to transfer passengers from air travel to short rail trips, thus increasing the load factor of trains. Such transfers may improve the profitability on some rail routes, or more likely allow more costs to be recovered (European Commission DG Comp, 2007). Intermodal strategies may also increase the Europes HST's profiles by given passengers the opportunity to use this mode (Givoni, 2006).

Intermodal products are generally not attractive enough to attract significant numbers of passengers, however, in part because of their complexity. Several ways of possibly over coming this have been muted by the railways (Société Nationale des Chemins de Fer français, 2011), airports (Aéroports de Paris, 2011) and others have identified in these including the possibility of luggage through-handling, better coordination of timetables between airlines and train operators, and guarantees in case of delay. The issue is how valuable these features would be to potential users of air/rail systems.

Many different revealed and stated methods are available to measure the willingness-to-pay of consumers. These include (Miller and al, 2011):

- Open-ended question with the participant asked to declare the price he/she would pay for the product.
- The Becker, DeGroot and Marschak method involving the participant in a lottery to buy the product when the price picked is lower than the answer given by the respondent.
- Choice-based conjoint analysis where the willingness-to-pay is calculated from a choice of products with different attributes
- Incentive choice-based conjoint analysis where the participant of a lottery has to buy a product when the price picked is lower than the answer given by the respondent in the choice-based conjoint analysis method.
- REAL involves a dichotomy survey whereby the respondent chooses to buy a product or not.

Miller and al find that the willingness-to-pay estimate is closer to reality when the participant has no choice but to pay. However,, the choice-based conjoint analysis is more efficient when the products have greater substitutability, face more competition and contain more attributes.

3. Methodology

The choice of variables and terms maybe are important because the choice of criteria defines our ability to analyse the way buyers make their decisions. Following Orme (2010), the criteria must cover all existing possibilities, be independent and exclusive and have a balanced number of terms for each of the variables. Thus variables and terms were defined based on Direction Générale de l'Aviation Civile (2011) and Aéroports de Paris (2011). To make our stated preference forms easier to fill in, we use a narative to introduce the text:

"Imagine you are leaving from a French regional city (for example Lille) flying to a large city in Asia, such as New Delhi or Hong Kong. Several intermodal possibilities are suggested to you. Given the airline a number of rail product are available to complement it. We are going to show you several possibilities by pair. Each time you will be asked to tell us which one of a pair you prefer. The average price of an intermodal return ticket for these destinations is about €620."

The variables and terms used are outlined in the Table 1

Table 1. Variables and terms for the choice-based conjoint analysis

Variables	Terms
Price	€575
	€600
	€625
	€650
	€675
Check-in/luggage withdrawal	At the airline desk
	At Paris-CDG train station
	At Lille (regional city) train station
Guarantee in case of delay	With
	Without
Connecting time	1h30
	2h30
	3h30
Services in the train	Meal included
	Meal not included

The terms are defined as

- *Price*: Prices were chosen based on a trip to Asia (for example Lille-Mumbai), booked two months in advance (Lille-Paris by HST and Paris-Mumbai by long haul air). The average price being €620.
- *Check-in/luggage deposit*: Usually, the luggage check-in is done at the airline desk. We add two additional cases, a check-in at Paris-CDG train station (to avoid luggage movement between terminals at the airport), or a check-in at the Lille (regional city) train station to benefit from a luggage through-handling.
- *Guarantee in case of delay*: The guarantee allows passengers to be on the next flight in case of a train delay (and vice versa). This guarantee already exists for combined tickets (*tgvair*) and is often used to justify the extra-cost of combined tickets compared to tickets sold separately.
- *Connecting time*: At Paris-CDG airport, the average connecting time of intermodal passengers is around 3h30. We wanted to assess whether a shorter connecting time would be appreciated.
- *Services in the train*: This refers to the provision of a free meal on a train akin to that available on aircraft.

To make the form more respondent friendly, the survey offered only two choices at a time, with each different variables appears with different terms. For rigor the survey conformed with

- Balance in terms of frequency (each ticket appears the same number of times)
- Orthogonality (each term is associated with another term the same number of times)
- Balance in terms of position (each term appears the same number of times)

To generate tickets, choices and surveys meeting these criteria, we used the software XLSTAT. This software generated 12 tickets and 13 steps, each step corresponding to a choice between two tickets. It ensures that the number of choices is sufficient. By generating consumer choice using a random function, we can calculate the partial utilities.

Concerning sample size, we follow the standard basic textbook rule (Orme, 2010):

$$(n \times t \times a)/c > 500$$

where; *n* is the minimal size of the sample to probe; *t* is the number of choices to make; *a* is the number of tickets appearing in each choice ; and *c* is the maximum number of terms for a variable. In our case, t is 13, a is 2, and c is 5. To get a representative sample, the survey was administered to freshly arrived passengers at CDG airport HSR station who were waiting for their train and 172 questionnaires were collected, which exceeds the 97 required for statistical validity.

Along with our joint analysis, socio-demographic information was collected regarding, sex, age, purpose of the trip (leisure or professional), number of flights during the last twelve months (less or more than twice) and user or not of "tgvair" (combined ticket). The analysis focuses on each socio-demographic to infer their willingness to pay. Before doing this conjoint analysis, one must verify that the sample is representative. We thus compared the socio-demographic characteristics of our travellers to the sample studied by the Direction Générale de l'Aviation Civile (2011). We have 72% leisure passengers, compared to 71% in the DGAC's study, and 38% on short and medium-haul flights compared to 41%; thus we can reasonably hypothesize that our sample is representative of the population of intermodal passengers.

The partial utilities found for each term are set to a chosen constant. One of the consequences is that we cannot compare the utilities of different variables' terms but only the relative preference of terms from the same variable. To do this, we convert the relative utilities of two terms of the same variable into a monetary equivalent; a conversion cannot be done every time. Prices utilities do not necessarily decrease when the price increases because of statistical noise in the data collection when the terms of

prices are close to each other. We thus use a linear regression to evaluate the coefficient of utility per monetary unit.

Another element is the evaluation of a variable in the decision process. We can evaluate the importance of any variable, for example the connecting time, by dividing the maximum difference of partial utility of the variable by the sum of maximum differences of partial utilities for every variable.

4. Results

The partial utilities, associated to each variable and term, are seen in Table 2 using a multinomial logit. We also see the partial utilities for the different groups, according to their socio-demographic characteristics. In addition to the partial utilities, this table also indicates the importance of the criteria in the decision process[1]. Based on the partial utilities, we can estimate the price that passengers are willing-to-pay for each service of the intermodal bundle. Thus, for a given category, we consider the relationship between the partial utilities according to the different prices with estimation of the partial utilities done relative to a chosen constant. Consequently, when a utility for a price is negative, it is only because the constant set by the software is too low and setting a new constant, all the partial utilities would become positive.

To calculate the value of a unit of utility in monetary terms, we match the partial utility values with the prices and the regress this to obtain the effect of a €1 increase in terms of utility. For example, for the entire sample, we compute a linear regression. with the slope here of -0.0359, showing that a €1 increase of the ticket price lower the partial utility by 0.0359;i.e. a unit of utility costs €1/0.0359. By performing this operation for each subcategory, we obtain Table 3.

We find that the most important criterion for passengers is the price (45%), followed by the luggage handling (25%), with the guarantee in case of delay the least priority (3%).

- *Luggage handling:* Respondents are willing to pay €32 for the baggage handling in Lille, which seems to be consistent with our expectations for this additional service. However, they reject rather strongly the luggage check-in at the Paris-CDG train station. Several interpretations are possible for this rejection. First, we can think that respondents did not fully understand the interest of getting rid of their luggage at Paris-CDG train station (even though it avoids the handling of their bags from the station to the terminal of the airline). A second explanation could be that choosing to

[1] Wald tests for all estimates, aggregate and by subcategory, reject the null hypothesis that all coefficients are equal to zero.

give a piece of luggage to an airline is a benefit-risk trade-off (Shaw, 2011). If a passenger drops his luggage at Paris-CDG train station, the advantage perceived seems to be too low compared to additional risks in terms of loss of his bag. This explanation also applies to Lille train station, but in this case, the benefits associated to these services seem significantly higher than the additional risk, so passengers will be ready to pay extra-money for this solution.

Table 2. Partial utilities by overall sample by age (top) and by purpose of the trip by number of flights (bottom)

				Age	
			Overall	18-49	50 and more
Partial utilities	Price	€575	0.895***	1.045***	0.627*
		€600	2.179***	2.389***	1.770***
		€625	-0.833***	-0.859***	-0.841***
		€650	0.523***	0.504***	0.560**
		€675	-2.764***	-3.079***	-2.116***
	Check-in/Luggage	At the airline desk	0.172**	0.259**	-0.034
	Withdrawal	At Lille (regional city) train station	1.296***	1.226***	1.481***
		At Paris-CDG train station	-1.468***	-1.485***	-1.447***
	Guarantee in case of delay	With	0.202***	0.180**	0.279***
		Without	-0.202***	-0.180**	-0.279***
	Connecting time	1h30	0.083	0.278**	-0.342***
		2h30	-0.808***	-0.926***	-0.547***
		3h30	0.725***	0.649***	0.889***
	Service in the train	Meal included	0.714***	0.815***	0.495***
		Meal not included	-0.714***	-0.8153***	-0.495***
Importance		Price	44.64	46.56	39.67
		Check-in/Luggage withdrawal	24.96	23.08	29.88
		Guarantee in case of delay	3.65	3.06	5.69
		Connecting time	13.85	13.41	14.65
		Service in the train	12.90	13.89	10.11

			Purpose of trips		**Number of flights in the last 12 months**	
			Leisure	Business	Less than two	Two or more
	Price	€575	0.907***	0.874***	0.769***	0.964***
		€600	2.297***	1.914***	1.908***	2.306***
		€625	-0.862***	-0.768***	-0.484**	-0.976***
		€650	0.506***	0.567***	0.288	0.617***
		€675	-2.848***	-2.586***	-2.481***	-2.911***
	Check-in/Luggage	At the airline desk	0.100	0.339**	-0.051	0.273**
	Withdrawal	At Lille (regional city) train	1.406***	1.054***	1.294***	1.307***
Partial utilities		At Paris-CDG train station	-1.506***	-1.394***	-1.243***	-1.581***
	Guarantee in case of delay	With	0.241***	0.114	0.332***	0.152**
		Without	-0.241***	-0.114	-0.332***	-0.152**
	Connecting time	1h30	0.068	0.116	-0.003	0.123
		2h30	-0.826***	-0.776***	-0.730***	-0.840***
		3h30	0.759***	0.659***	0.733***	0.717***
	Service in the train	Meal included	0.716***	0.706***	0.541***	0.795***
		Meal not included	-0.716***	-0.706***	-0.541***	-0.795***
		Price	44.52	44.90	43.31	45.14
		Check-in/Luggage withdrawal	25.20	24.42	25.03	24.99
Importance		Guarantee in case of delay	4.17	2.28	6.54	2.63
		Connecting time	13.72	14.32	14.44	13.47
		Service in the train	12.39	14.09	10.68	13.76

Notes: Significance level. * p< 0.10. ** p < 0.05. *** p < 0.01

- *Guarantee in case of delay*: The price is around €11 and it seems rather realistic even if it is within a low range. We note that such a service is perhaps not as attractive as what one might think and this could explain the low share of combined tickets "tgvair" in intermodality at Paris Airport (Direction Générale de l'Aviation Civile, 2009, 2011).

- *Connecting time:* The results here are counterintuitive; the intermediate connecting time (2h30) is the most rejected one (- €43). This "medium offer" does not seem to seduce any segment. Indeed, business and leisure passengers have very different preference times (Belobaba et al, 2009) with the former preferring shorter connecting times (1h30) and leisure passengers preferring longer transit time (3h30) to reduce the fear of missing the plane. Another possible interpretation could be more technical, and involves preferences of passengers not always being transitive. This is a problem that can be encountered when performing pairwise comparisons. We call A, B and C the connecting times 1h30, 2h30, and 3h30. When A and B are compared, the respondent does not know which offer he really prefers, because the difference is too small relevant: A and B are considered indifferent to the respondent. When B and C are compared, the same problem occurs: B and C are also indifferent. However, when A and C are compared, the respondent sees a clear difference and can clearly choose, leading to non-transitive results.

Table 3. Passengers' willingness to pay for additional intermodal services

		Global	**Age**		**Purpose**		**Number of flights**	
			18-49	50 and more	Leisure	Business	Less than 2	More than 2
	Slope (absolute value)	0.0359	0.04	0.026	0.037	0.033	0.037	0.032
Check-in/Luggage withdrawal	At the airline desk	Ref	Ref	Ref	Ref	Ref	Ref	Ref
	At Lille (regional city) train station	€31.32	€23.84	€56.53	€35.11	€21.62	€41.42	€27.39
	At Paris-CDG train station	€-45.67	€-43.03	€-52.76	€-43.18	€-52.41	€-36.68	€-49.10
Guarantee in case of delay	With	€11.26	€8.87	€20.82	€12.95	€6.91	€20.42	€8.06
	Without	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Connecting time	1h30	€-17.89	€-9.14	€-45.96	€-18.58	€-16.42	€-22.67	€-15.73
	2h30	€-42.71	€-38.85	€-53.60	€-42.61	€-43.39	€-45.04	€-41.25
	3h30	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Service in the train	Meal included	€39.77	€40.23	€36.96	€38.50	€42.69	€33.31	€42.13
	Meal not included	Ref	Ref	Ref	Ref	Ref	Ref	Ref

Note: Ref= Reference price based upon which of the others terms within the same variable is calculated

- *Meal:* The amount found in Table 3 (€39.77) represents two meals because it involves a return trip. The price that travellers are willing to pay for a meal on the train is therefore about €20; roughly in line with the current price of a meal in a HST.

These aggregate results are generally borne out if we disaggregate the data

Segmentation according to the age

- *Importance:* If the order of importance among the variables remains the same, it appears that older passengers attribute less importance to the price (39% against 46%) and more importance to the baggage handling (29% against 23%).
- *Utility/price:* The slope in absolute value is lower for travellers over 50, reflecting a lower price elasticity. This means that over-50 passengers are less price sensitive than the other ones, essentially due to their stronger purchasing power (Shaw, 2011).
- *Luggage handling:* Older passengers show a very strong preference for a luggage check-in at Lille train station. Several explanations could be mobilized such as the effort or additional stress caused by luggage handling for senior passengers.
- *Guarantee in case of delay:* Travellers over 50 are willing to pay almost the double of those under 50 for the guarantee. This reflects a greater fear of missing their plane in this segment.

Segmentation according to the purpose of the trip

- *Utility/price:* The slope coefficient shows that business passengers are slightly less sensitive to price changes, often because their firms refund them.
- *Baggage handling:* Business travellers are not willing to pay as much service baggage check at Lille train station as leisure travellers (€22 for business passengers compared to €35 for others). This can be interpreted in two ways: First, business passengers are accustomed to flying, and are able to easily their baggage within the current system. Second, business travellers tend to travel with smaller suitcases, so a baggage processing service is not of great interest for them.
- *Connecting time*: Because of their higher time values, business passengers will prefer shorter connecting times than leisure passengers.
- *Meal:* For a meal during a round trip, business passengers are ready to pay €42.69 against €38.50 there leisure counterparts either because an employer pays business expenses or because business people spend a lot of time traveling and are sensitive to this kind of service.

Segmentation according by the number of flights in the last 12 months

- *Baggage handling:* Frequent travellers are willing to pay €27 for luggage through-handling from the train station in Lille, against €41 for those who travel occasionally. Again, we can reasonably pose that a regular traveller is much more used to managing bags than a leisure passenger. In addition, one must note that frequent travellers are mostly business passengers who tend to carry smaller bags[2].
- *Guarantee in case of delay:* A significant difference in the price of the guarantee appears between regular travellers and occasional travellers. Frequent travellers tend to get exchangeable or refundable tickets and are characterized by a higher rate of no-show (Belobaba et al, 2009), which may partly explain their lack of interest in this service.
- *Connecting time:* Frequent travellers prefer a short transit time compared to other correspondents. This is consistent with intuition because they spend more time commuting, and are therefore more time-sensitive.

5. Conclusions

To understand how to improve the use of air-rail intermodal products, we have examined the willingness-to -pay of passengers for some intermodal service attributes. A conjoint analysis based on surveys collected at the Paris-CDG train station, is used to to determine values associated with these various services. From a theoretical point of view, the conjoint analysis considers the overall utility of a product as the sum of the partial utilities of its components. It turns out, however, that this assumption of independence is excessively strict and that some criteria may have values that fluctuate according to other variables. For example, some passengers clearly find a connecting time of 1h30 acceptable but only if there was a guarantee in case of delay. We also find distinct differences between the attitudes of business and leisure travellers regarding what they seek from intermodal air/rail services. However, one must keep in mind that this revenue approach of intermodal services has to be completed by an assessment of the costs of these projects before any implementation.

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[2]In the sample, 85% of frequent travellers are business passengers.

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