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Model for Value Creating Process of Passenger Air Transport

Theses of Ph. D. dissertation

By

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1. ANTECEDENT AND ACTUALITY OF RESEARCH

Air transport is one of the most important industries in the world. Air transport plays a considerable role in the promotion of the modern society. In this regard it increases the market's size, on which the firms supply their activity, so the expenses of the research and development are repaid more quickly by the way of bigger sales potential.

The air transport industry supports the work and recreation of millions of people, and it supports the quality of life. Air transport contributes significantly to sustainable development through the promotion of international tourism. Tourism is capable of reducing poverty by its positive effects on economy and job creation. By increasing the amount of tourism taxes, revenues may increase and can insure the development and the saving of protected areas. Players of the air transport industry are significant tax-payers for local, regional and national budgets through airplane customers and through turnover taxes from handling services furthermore through consumption and immigration fees.

An outstanding aim of the European Union's transport policy [Biz11] is to increase the effectivity of the transport system and to contribute to sustainable development. This increasing of effectiveness can be realized through the completion of integrated, multimodal transport systems, in which it needs to identify the role of air transport. In virtue of this, one of the seeded aims of the dissertation is to define the role of air transport in the transport chains.

There are several international researches which are concerned with the workplace creating capability of air transport and its contribution to national gross domestic products [Med04], [Ata00a], [Oef09], but the value creating process of air transport for leisure and business travellers has not been elaborated in depth yet.

2. RESEARCH AIM OF THE DISSERTATION

In November 2004 I got acquainted with the detailed and valid dissertation of S. Medenbach [Med04], which handles primary air

transport's contribution to national GDP and workplace creation capability. The aim of my research is to analyze all the value creating processes and the negative effects of passenger air transport and to model the behavior of business and leisure air transport travellers.

The objective of the study is the analysis of micro- and macroeconomic functions of air transport. In macroeconomic regard I research the connection of air transport players, in micro economic regard I identify the value, which appears due to using air transport services furthermore the characterization of travel types.

In addition, the aim of this research is to analyze and to model the destination choice methods of travelers, furthermore to identify the choice factors and to uncover their relations.

Goal of my research was to work out following:

- Uncovering of related researches;
- Examination of available statistics;
- Creating a macroeconomic model for the air transport system;
- Analysis of travellers values due to air transport;
- modeling destination choice method of traveller;
- identification of choice factors and uncovering their relations.

3. RESEARCH METHODS

In compliance with my goals, I used a wide range of classic research methods in my dissertation. Among these I enhance structured text analyses elaborating practical experiences, methods of linear algebra and several used and adapted method for analyzing value creating, further statistical analysis.

Processed data in my dissertation came to know after impoundment of industry players, on that regard, that several international governmental and technical organizations regulate and control air transportation activities, and activities connecting air transportation. Beside regulating activities these organizations handle data collection from wide ranges of

air transport industry, which makes it possible to accomplish macroeconomic analysis as it is detailed in my research aims.

As mentioned above, during the research I identified and impoundment the players of air transportation and I constructed an effect-analyzer model for analysis of industry players contacts. During macroeconomic analysis I applied outcomes earlier studies and I developed their methods. On this basis I defined the function of the industry in the global environment and its impacts in national economy.

Passenger air transport influences customer behavior in several aspects, it forms their decisions. The analysis of complex coherences is possible only with models based on enough simplified system. In this dissertation I identify relevant factors in pre flight decision process and decision making characteristics. I modeled customer behavior with Logit models taken from neoclassical economy, which is often used for analysis user's decision.

Primary role of passenger air transport is contact possibility between far regions and the travel time shortage. Regarding this in the dissertation I identified travel types, appointed the expenditure of travel types by cost elements and I calculated the value for business and leisure travellers, which appear during travel time shortage. I investigated the factors for air transport choice; which can be dependent, partly independent and independent from travel distance. I analyzed the passenger traffic volume on basis of user's preferences and travel types.

4. SUMMARY OF CONTRIBUTIONS / THESES

4.1. I discovered the macroeconomic contact system of civil aviation stakeholders. On basis of this coherences I determined the civil aviations contribution to national GDP-s and its role by workplace creation [see: Sel09, Sel11]

4.1.1. The macroeconomic value of air transportation is the excess for social prosperity created by air transport industry players, which contains the working value needed for this process as well as the generated consumption.

4.1.2. The system of relations in air transportation is shown in figure 1.

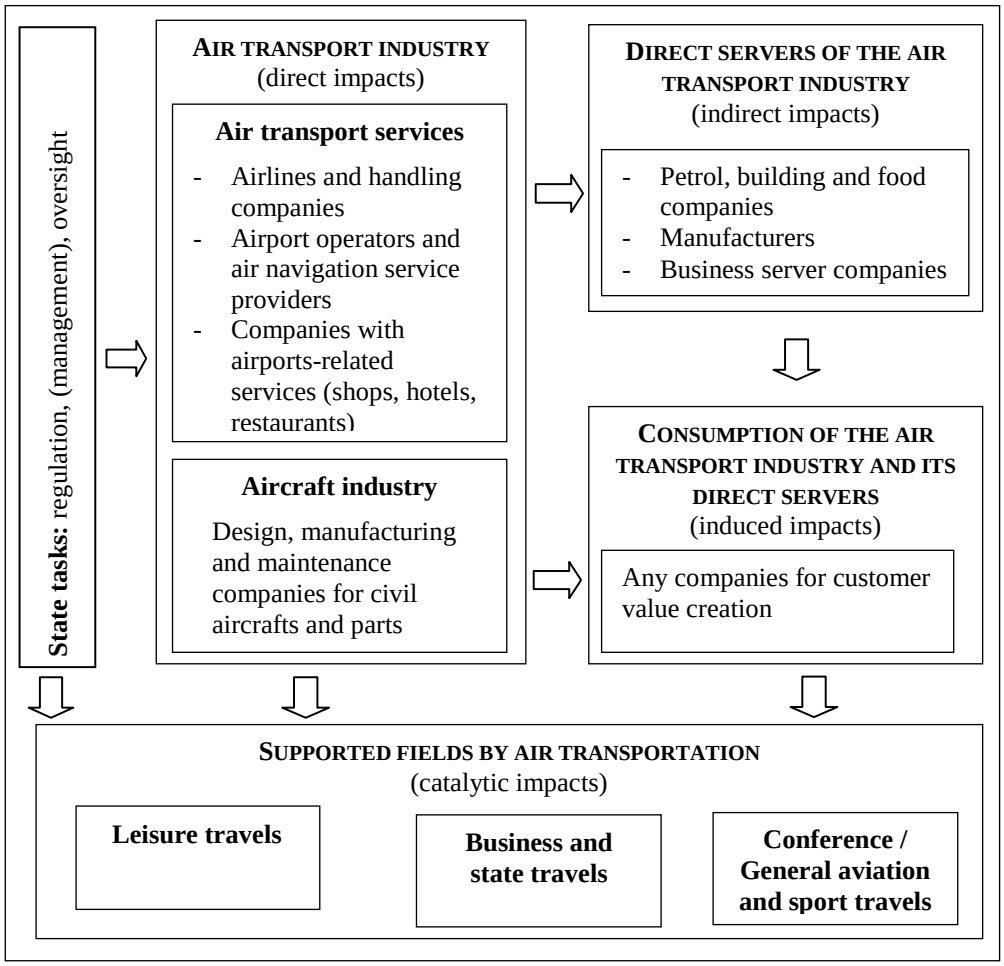

Figure 1: System of relations in air transportation [*source: own resource*]

4.1.3.When working on the research I found that the air transport industry exerts its most important economical influence of over direct, indirect and induced effects is the catalytic effect on the other industries, it assist their growth of high account. These catalytic effects are realized by transaction leisure, business and state and general aviation sport, conference travels.

I found that in 2007 air transport industry with its direct, indirect, induced and catalytic effects generated 29 million workplaces and contributed 8% (2.960 billion USD) to the words GDP.

4.1.4. I summarized the national economical value of air transportation splitting in formula (1), paying regard to its workplace creating capability and its contribution to GDP.

(1) $H_{nemzgazd} = H_{Mh} + H_{GDP} + H_{sz} + H_{ü/á} + H_{k/g/s} – E$

ahol:

$H_{nemzgazd}$: national economic value of air transportation [monetary unit – on basis of air transports statistical data USD];

H_{Mh}: workplace creating value of air transport with regard on its direct, indirect and induced impacts [USD] – During the calculation it has to mind the product of created workplaces number and the average salary in the observed country in USD;

H_{GDP}: The GDP contribution of air transportations direct, indirect, induced effects [USD];

H_{sz}: Catalytic value of leisure air transportation, which contains the workplace creating capability and contribution to the national GDP [USD];

$H_{ü/á}$: Catalytic value of business and state air transportation, which contains the workplace creating capability and contribution to the national GDP [USD];

$H_{k/g/s}$: Catalytic value of conference, general aviation and sport air transportation, which contains the workplace creating capability and contribution to the national GDP [USD];

E: External effects of air transportation. [USD] – By the calculation it has to take in regard the external marginal cost by vehicle kilometer. Over the local and global external cost it has to note the cost of bottlenecks and the consequents of cabin crews and passenger's ray charging on board.

The national economic effects of passenger air transport can be added with the formula. By analyzing this formula in different years the changes regarding the national economic role of air transport can be shown over time.

4.1.5. On basis of the constructed model every player of a national economy can benefit from air transportation, even those players which do not use air transport services directly. This has two causes: on the one hand benefits of business and state travels appear in national economies and on the other hand customers can reach products with better quality or lower prices.

4.2. I worked-out the micro economic calculation method of air transport's value (see: Sel10c)

4.2.1. I identified the microeconomic value of air transport on basis of Carl Menger's theorem. I have abstracted from its internal elements and have identified its value for customers at a given place and at a given time where the value is able to satisfy customers's expectations. I summarize the value by passengers and carriers s using air transportation, in a given year and in a given country with formula (2)

$$(2) \quad H_{lk(i,j,k)} = G_{(i,j)} * (A_{(k)} * H_{sz}^{\alpha(i,j)} + B_{(k)} * H_{ü/á}^{\beta(i,j)} + C_{(k)} * H_{k/g/s}^{\gamma(i,j)}) - \sum R_{(i,j,k)}$$

where:

$H_{lk(i,j,k)}$: generated value of air transport in year i, country j for passenger or company k [USD];

$G_{(i,j)}$: average rate of GDP of country j in year i / average rate of word GDP in year i;

$A_{(k,i)}$: number of users k travels in year i [piece];

H_{sz}: average utility of leisure travels [USD];

$\alpha_{(i,j)}$: affect factor of leisure travels in year i and country j.– gross salary, average grows of work activity, effects duration;

$B_{(k,i)}$: number of user k or his company's/ state's business travels in year i [piece];

$H_{ü/á}$: average utility of business / state travels [USD/piece];

$\beta_{(i,j)}$: affect factor of business / state travels in year i and country j – duration of travel, gross salary of traveler, achievement of travel;

$C_{(k,i)}$: number of user k or his company's conference/cultural/ sport/general aviation travels in year i. [piece];

$H_{k/g/s}$: average utility of conference/cultural/ sport/general aviation travels [USD/piece];

$\gamma_{(i,j)}$: affect factor of conference/cultural/ sport/general aviation travels in year i and country j – gross salary, value of reached material and immaterial goods;

$\sum R_{(i,j,k)}$ all of appropriation for travels realization or supplying goods or services of traveler k in year i, country j (cost of travel, accommodation, staying, external costs) [USD/year].

4.2.2. Air transport provides opportunities for leisure travelers for the charging, which contributes to the enhancement of working effectiveness and it provides for realizing several benefits when choosing fast travel, through supporting business and state travels Conference, cultural, sport and general aviation travels are further possibilities provided by air transport, which give benefits for individuals and for the whole society.

4.2.3. For confirmation the formula, on basis of the available data, in addition completed this data, I checked the formula's applicability with examples. In case of leisure travels I found that traveler with gross salary in 500.000 HUF the 15% growth of work activity by a travel in

120.000 HUF can return in 4 months. For year 2010 I determined the average value of leisure travels about 121.702 HUF. By analysis of business travels I found that travel's expenditures already return by medium estimation, considering the three versions. For year 2010 I determined the average value of business travels about 77.610 HUF.

4.3. I modeled destination choice method of travelers with development of neoclassical economical value based Logit model. (see: Sel10b)

4.3.1. On basis of multicriteria Logit model I characterize the probability of airport choice, as destination choice with basic formula (3):

$$(3)\ P_{ij} = \frac{e^{u_{ij}}}{\sum_{i=1}^{i=m}\sum_{j=1}^{j=m} e^{u_{ij}}}$$

where:

P_{ij}: probability of destination airport j of passenger departed from airport j;

u_{ij}: appeared utility of traveler's in airport and surround i departed from airport j.

The utility function can express with weighting of decision factors with basic formula (4):

$$(4)\ u_{ij} = \sum_{j=1}^{m}(s_j f_j)$$

where:

s_j: a j. weight of decision factor;

s_j: a j. formula of decision factor.

4.3.2. For leisure and business travels I identified the elements utility function in formula 4.3.1. On basis of this the travels real utility is the amount of weighted travel cost and weighted travel time factors and the weighted attractivity in destination place. I show it with formula (5):

$$(5)\ \overline{\overline{U}} = s_t\overline{\overline{\Omega_t}} + s_c\overline{\overline{\Omega_c}} + s_A\overline{A} + \overline{\overline{\varepsilon}}$$

where:

s_t: weigh factor of travel time;
$\overline{\overline{\Omega_t}}$: resistance matrices of travel time;
s_c: weigh factor of travel costs;
$\overline{\overline{\Omega_c}}$: resistance matrices of travel cost;
$s_{A:}$ weigh factor of attractivity;
$\overline{A}$: weigh matrices of destination airport and its surround;
$\overline{\overline{\varepsilon}}$ failure element.

Resistance factors in formula (5) are in (6), (7):

$$(6)\ \Omega_{t_{ij}} = \frac{1}{t_{ij}}$$

where:

$\Omega_{t_{ij}}$: resistance factor of travel time [1/min];
t_{ij}: travel time between airport i and j [min], and

$$(7)\ \Omega_{c_{ij}} = \frac{1}{c_{ij}}$$

where:

$\Omega_{c_{ij}}$: resistance factor of travel cost [1/USD];
c_{ij}: travel tariff between airports i and j [USD].

4.3.3. With use of this model I analyzed statistical data of 180 destination. I minimalized the failure with least square method and I determinate the quantity of leisure and business travelers preference difference Decision of leisure travelers are influenced 39% by destinations attractivity, by 35% travel tariff and by 26% by travel time. Decision of business travelers are influenced by 59% by travel time, by 21% by attractivity and by 20% by travel tariff.

4.4. I developed a coherence system for identify transport mod choice influence factor of travelers, with them I defined the terms of air transport choice. (see: Sel10a)

I reconducted the choice of travel modes to analysis for travel's total expenditure of travel. I show total expenditure of road transport with formula (8) as follows:

$$(8)\ \sum_{i=1}^{n} R_{ia} = \sum_{i=1}^{n}(C_a + T_a * w_i + C_{sz})$$

where:

$\sum_{i=1}^{n} R_{ia}$ total expenditure of road transport travels in the year [USD/year];

C_a: petrol, maintenance, depreciation, assurance, tax and toll cost of travel i by car. [USD/travel];

T_a: total duration of travel i by car a [min/travel];

w_i: average gross salary of traveler i [USD/min];

C_{sz}: cost of accommodation during travel i [USD].

Total expanditures by plane or by rail can summarize by formula (9):

$$(9)\ \sum_{i=1}^{n} R_{r/v} = \sum_{i=1}^{n}(C_{r/v} + T_{br/v} * w_i + C_{sz})$$

where:

$\sum_{i=1}^{n} R_{r/v}$: total expenditure of air/ rail travels in the year. [USD/year];

$C_{r/v}$: cost of travel i by air / rail (ticket and airport-toll) [USD/travel];

$T_{br/v}$: gross duration of travel i by air / rail [min/travel].

4.4.1. I assigned quantitative data to the coefficients, which modify transport mode choice. I appointed that gross travel time and passenger's gross salary influences the selection of optimal transport mode by the transport tariff. I identified independent factors from destinations; these are the ability of car driving, the attitude to the flight and the passenger's health condition.

4.4.2. I observed 28 European destination and compared road, rail and air transport modes on three different gross salary level. I appointed that over 576 km air transport choice is optimal by all gross salary level. Figure 2 shows the results of my examination. I did regression analysis taking into account a gross salary about 500,000 HUF; regression lines are marked on the figure 2.

Regression equation and correlation coefficients are follows:

a) rail transport: $y = 13.315x + 15.088$; $r^2 = 0,8472$
b) road transport: $y = 8.427,5x + 37.191$; $r^2 = 0,8513$
c) air transport: $y = 1.848,7x + 83.175$; $r^2 = 0,3037$

Results shows, that taking into account a gross salary level 500,000 HUF there are strong connection between travel distance and travel fees in case of rail and road transport. In case of air transport the connection is light, because pricing system of air transport companies is not in proportion with their efficiency; they use strategically pricing method to maximize their benefits.

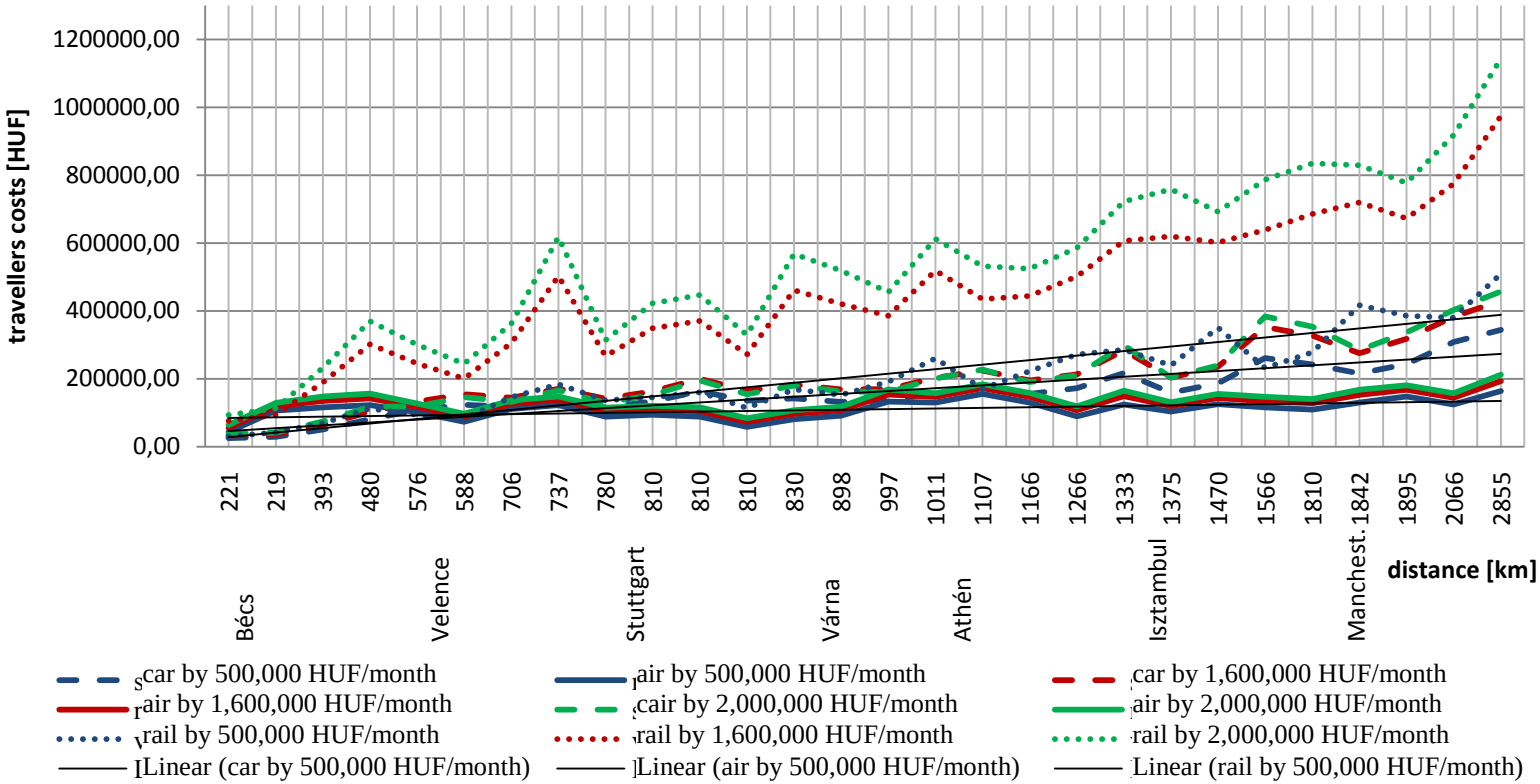

figure 2: Cost of companies by transport modes if one person travels by different gross salary level.

[*source: own resource*]

5. USABILITY AND DEVELOPMENT OF NEW SCIENTIFIC RESULTS

In the dissertation during macroeconomic analyses used and developed methods and results are eligible for determination personal air transport's global function and for following it's alteration in the time. With the developed method it is possible to appraise personal air transport's and the connecting industry's account over macroeconomic function compared by countries. Tools and results of macreconomic analysis can assistance by elaborating 10 years air transport strategy in Hungary.

The micro economical value methods are capable for arrange company's decision: daily medium- and long distance travels can effective advocate business contacts of global companies. Optimizing this travel costs can support company's competition and reduce their expenditure.

Results of micro economical analysis can support furthermore leisure traveler's decision making; optimal destination choice cover better efficiency of holiday travels. Identification of destination choice factors can be basis of air transport companies. It can support the construction of a company strategy, which assist to achieve flight with high load factor.

On basis of results of my dissertations analysis and calculations I suppose and recommend for air transports development followings:

- Correct identification of air transports function in multimodal transport system can support better exploitage of flights.;
- Because of external effects it is not useful to enlarge the frequency between destinations; it is expedient to operate aircrafts with bigger capacity and with higher load factor;
- It is useful by price allocation to handle different preferences of business and leisure travelers: for business passengers first and last working day on the week and the early and late hours in the day are

preferable. It is beneficial for those flights leisure travelers only with higher tariff to carry or to solicit them with lower tariff on travels out off rash hours.

- for better improvement of hub airports its necessary to build out contacts with rail system, which is an important element of European Union's Transport Policy;
- adequate rail contacts and aligned schedule advance load factor's growth and so increased environmental protection;
- rail, road, bike and walker mode are all preferable to reach the final destination from airports;
- to complete air transport's function it is necessary to build convenient road connection, lake of this can causes losing of passengers and decrease the effectiveness of the integrated transport system;
- for reducing ray-charging the shadow of aircrafts can be expediential over in dissertation mentioned time-, distance- and altitude defense and over the adequate track choice;
- for ensuring sustainable mobility it is necessary to reduce the noise emission and air pollution with recent aircrafts and air navigation procedures;
- Aircrafts with reduced fuel consumption and recent flight and air navigation procedures (cost index continues descent approach,…) can assist the sustainable development.

The in dissertation evaluated decision making models and methods can integrate into air transport's grad and post grad training; which can accede management skills of air transport's expert. Results of the dissertation fit in the course of air transport management, but they can be part of decision making or other courses of air transport too.

Main flow of elaborated method's evaluation is to handle the problems of deficient data. It can be solve by broaden of analyzed databases, on the other hand it is useful to examine the elimination of data gaps with operation resource methods.

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