The Dutch Taxation on Airline Tickets

A system dynamics approach to model airport choice

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Abstract

In July 2008 the Dutch government introduced a tax on airline tickets in order to internalize the negative externalities associated with air travel. As a result of the increased ticket price in The Netherlands a substantial number of passengers decided to depart from airports outside of The Netherlands. However, after the tax was abolished one year later passengers kept using foreign airports. Because existing traditional discrete choice models do not explain this asymmetric response a system dynamics model was developed to model mechanisms of information exchange related to airport choice. The simulations show that the development of awareness of an airport plays an important role in the asymmetric response. Further research should be conducted to assess the influence of macro-economic factors and specific airline strategies.

Keywords: bounded rationality; decision modeling; airport competition; system dynamics

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1 Introduction

In the light of a more sustainable environment the Dutch government introduced a taxation on airline tickets in The Netherlands. The measure was intended to internalize negative externalities, mainly the emission of CO_2 an other greenhouse gases, associated with air travel (Ministerie van Financiën, 2007). The economic and environmental effects of several alternatives were studied (SEO, 2007). Finally it was decided to levy a tax on all origin and destination (O&D) flights departing from The Netherlands. For short-haul, intra-European flights the tax amounted to €11.25 per ticket. For long-haul flights to destinations outside of Europe the tax amounted to €45,-. According to the research this scheme would generate 350 million Euro in the first year.

Since its first announcement the tax faced severe resistance from the air transport industry. Airports and airlines feared turnover losses while doubting the real environmental gains of the tax. Being a small country with suitable airports just across the borders in Germany and Belgium a substantial number of travelers decided just to depart from an airport outside of The Netherlands and avoid the tax (Gordijn & Kolkman, 2011). Furthermore, the financial and economic downturn gained increasing strength in the second half of 2008. Together the resistance from the industry and the economic downturn finally led to the abolishment of the tax in 2009, exactly one year after it was introduced.

In an ex-post analysis conducted by The Netherlands Institute for Transport Policy Analysis it was found that the abolishment of the tax did not necessarily mean that the effects were reversed as well. It was found that the number of passengers departing from foreign airports did not decrease as much as it increased when the tax was introduced (Gordijn & Kolkman, 2011). There was however no explanation for this response that could be derived from the traditional and widely used discrete choice models[1]. These models are used for predicting choice based on the attribute values of the alternatives in the choice set, which results in equilibrium market shares. The case in The Netherlands can better be seen as a system in transition, first between the non-taxed and taxed equilibrium and second between some point at the first transition to the non-taxed equilibrium again. Furthermore, if equal attribute values are used to determine the market shares after the tax has been abolished compared to the values prior to the tax, the post-tax outcome will be equal to the pre-tax outcome.

In this paper we will propose an answer to the question *which factors contribute to the asymmetric response of the system to the introduction and abolishment of an airline ticket tax in The Netherlands*? Furthermore, we want to distill the lessons learned from this particular modeling exercise and assess the influence of these new insights on future work in system dynamics. In order to answer the question a system dynamics approach is chosen to complement the traditional airport choice models to enhance our understanding of the factors and mechanisms that influence airport choice. The foundations of the model are derived from literature on consumer choice and marketing. A multinomial logit model is still used to model the actual choice.

The paper is divided into four sections. In Section 2 we will provide an overview of a selection of the existing literature on consumer choice. This section lays the theoretical foundations for the subsequent section (3) in which the structure of the physical system and the model is described on a conceptual level. In Section 4 we will analyze the behavior of the model in response to the introduction of a taxation on airline tickets in The Netherlands. Finally Section 5 concludes this paper.

2 Consumer choice, insights from the literature

2.1 The cognitive decision sequence

Every human being who makes a decision is initially driven by some sort of problem. This problem might be a broken car that needs to be replaced or a need to travel from A to B. The choice process that is initiated by the problem recognition can be depicted as a linear sequence (Erasmus et al., 2001). In Figure 1 this sequence is displayed. After the problem is recognized an information search is initiated. This may sound very laborious but in many cases information is already present in the internal memory[2]. For larger problems with more severe consequences when the wrong decision is taken (buying a house) the information search will be more elaborate.

The next step comprises of the evaluation of the found alternatives based on what has been learned about the specific properties of each of these alternatives. Two concepts play a key role here which are *awareness*, e.g. which alternatives do I know, and *utility* which represents the usefulness of the alternative to me based on my personal preferences.

The last step before there is no way back is the actual choice. In cases where people have to make a decision, heuristics are used to reduce the cognitive load and hence to reduce the effort required

[1] See for example Pels et al. (2001); Hess et al. (2007); Ashley et al. (1995)

[2] The search for information from the internal memory is less costly than the search for information from external sources (Nelson, 1970).

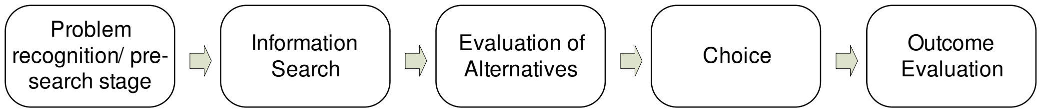

Fig. 1: Cognitive decision sequence, adapted from Erasmus et al. (2001)

to take a decision (Kahneman, 2003). Several different heuristics exist and the choice of the specific depends on the type and character of the problem (multiple criteria, high gains/losses)(Bettman et al., 1991). Furthermore the experience of the decision maker has with taking the same or similar decisions (Kahneman, 2003).

In the final step of the sequence the outcome of the actual choice is evaluated. In other words the level of satisfaction is determined. In case the outcome exceeds the expected outcome, e.g. in terms of utility, the decision maker is satisfied and will adjust his/her expectations of future outcomes of choosing the same alternative (Howard & Sheth, 1969).

2.2 Information search

Let us go one step deeper into the process of information search. Besides the need to know which alternatives are available, rational choice theory (Simon, 1955) teaches us that two other types of information are required in every decision. These types of information are the properties of the alternatives and the personal preferences of the decision maker. The interrelatedness of these three types of information is depicted in Figure 2. Preference, alternatives and attributes form the main triangle.

Which alternatives are considered depends on three factors. First, the budget and other constraints (geographic etc.) the decision maker might be subject to, limits the choice set. Second, the decision maker might simply be not aware of several alternatives (never heard of it). Third, some alternatives might be discarded because the properties do not satisfy the minimum requirements (threshold level) of the decision maker. The attributes hold the characteristics of the specific alternatives, in case of an airport this can, for example, be the number of passengers departing from that particular airport. The preferences capture what the decision maker considers important factors relative to the other factors that determine his or her choice. Together with the attributes the preferences are used to construct a ranking of alternatives.

In order to acquire the required information three sources can be distinguished. The first source of information based on direct personal experience with an alternative. This corresponds to the final, evaluation, step in the decision sequence. Once we have chosen the specific airport we will learn about the characteristics (travel time to airport, walking distances, level of service, etc) of the airport because we use it (Ackerberg, 2003; Hopkins, 2007).

The second source of information we find in our peers. Our social environment provides a rich source of information. This information transfers from person to person through the commonly known word-of-mouth effect (Arndt, 1967). During the process, the information is shaped in such a way that it becomes more easily acceptable and hence less prone to resistance by the receiver (Bettman et al., 1991; Howard & Sheth, 1969). The acceptance of new information also increases with the degree of confidence the receiver has in the sending party (Tiemeijer et al., 2009). The speed at which this information spreads and the availability of information is highly related to the medium that is used. By using the most modern forms of communication to date (for example twitter or facebook), an individual sender can reach thousands of people within a fraction of a second.

The third source of information constitutes of commercial parties that broadcast information about, for example, a product en masse through radio, TV and other forms of mass media with the intention to achieve commercial goals. These marketing activities work by convincing the receiver about the usefulness of an alternative and to create a certain image around the alternative, and by creating

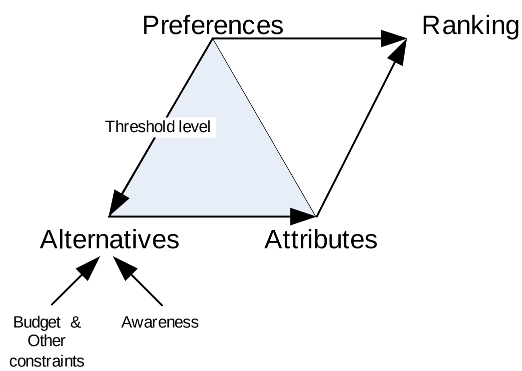

Fig. 2: Information triangle (Steverink, 2010)

awareness of the alternative (everybody knows Coca Cola) (Ackerberg, 2003). Commercial sources of information are most prone to resistance by the receiver.

2.3 Evaluation of alternatives and choice

The evaluation of alternatives is probably the most complex step in making a decision. The task at hand is to value each alternative is such a way that it represents the expected loss/gain resulting from the decision. What is regarded as a loss or gain depends among others on the preferences of the decision maker. Furthermore, an alternative can be evaluated on numerous characteristics that may not be uniformly measurable/addable. One approach to deal with this type of complexity is to conduct stated or revealed preferences research. The goal of this research is to determine the choice factors, i.e. factors that decision makers base their choice on, and the average level of importance of each factor relative to the other factors (preferences). By using the results of this research a utility function can be defined. The outcome of this function is utility, a container concept that is widely used in economics and game theory to organize information about peoples preferences (Straffin, 1996). Utility is embodied in a single numerical value that represents the usefulness of an alternative to a specific entity.

Much research has been conducted to establish the utility function for airport choice among different populations and for different sets of airports or specific routes between city pairs. Most of these studies, including the study conducted by The Netherlands Institute for Transport Policy Analysis among 3000 Dutch residents[3], find airport, access time (travel time to the airport) and frequency of service as most significant determinants of airport choice (Pels et al., 2000). The corresponding utility function that is used in this study is defined in Equation 1.

$$V_i = \beta_p p_i + \beta_t t_i + \beta_f ln\left(f_i\right) \tag{1}$$

Where V_i is the utility of airport i, p_i represents the average ticket price at airport i in Euro's, t_i is the average access time from airport i to a location in the catchment area in minutes, and f_i represents the number of flights (frequency of service) offered at airport i per month. The natural logarithm is used to include the effect of decreasing marginal utility gains with flight frequency. The beta's correspond to each attribute and represent the relative weight given by the decision maker to each attribute. Hence, the beta values capture the preferences and have to be estimated using the stated or revealed preferences research.

With the utility function available we now have to decide how the decision makers (passengers) will actually decide which airport to depart from. From a fully rational point of view decision makers

[3] KiM Airport Choice Survey 2010

are expected to optimize and thereby maximize their expected utility. Another approach is to use a form of the logit function to determine the probability that a decision maker chooses airport i given its utility and the utility of all the other alternatives (Ben-Akiva & Lerman, 1985). Due to the shape of the logit there will always be a (small) probability, no matter how inferior the alternative, that it is chosen. Furthermore, instead of using the actual utility, which makes sense in fully rational models, we will use the perceived utility that a specific group of people holds of an airport.

In Equation 2 the multinomial logit function that is used in the airport choice model is defined:

$$P(i \rightarrow j) = \frac{C_j \bar{A}_{ij} e^{V_{ij}^p}}{\sum_{k=1}^{n} C_k \bar{A}_{ik} e^{V_{ik}^p}} \tag{2}$$

Where:

$$i \epsilon k, \; j \epsilon k$$

The subscript k that is used ranges from 1 to n and holds all the airports in the model. $P(i \rightarrow j)$ is the probability that a former user of airport i decides to depart from airport j on his/her next trip. C_j is the capacity constraint factor that captures the amount of available capacity at the airport, $\bar{A}_{ij}$ represents the fraction of users of airport i that is aware of airport j, and V_{ij}^p is the perceived utility that users of airport i hold of airport j. The awareness factor ensures that in case an airport is not known within a group of people, the probability to choose it is also zero.

So far we have covered the more theoretical parts that form the foundations of the model. In the next section we will have a closer look at the structure of the model and its individual components represented in causal loop diagrams.

3 Structure of the model and system description

3.1 The system to be modeled

Before starting to explain the technical details of the model it is useful to cover the physical appearance of its elements first. The taxation on airline tickets affected in essence all commercial airports in The Netherlands. However, in order to include the leakage effects, i.e. passengers crossing the national borders in order to avoid the tax, airports that lie just across the borders with Germany and Belgium also have to be considered. Furthermore, to keep the model from becoming overly complex it is decided to model only one specific and homogeneous group of passengers that use group-specific airports. For this paper we will consider the group of passengers that is highly price sensitive and therefore travels with so-called low-cost or low-fare airlines such as Easyjet and Ryanair in Europe. The high price sensitivity also implies that this group of passengers is most likely to respond to the increased ticket price. The final argument for selecting the low-cost segment of the market is that generally airlines that operate in this market are considered to be rather 'footloose' (Graham, 2004), meaning that they do not have strong ties with the airports they are serving (e.g. no or minimal sunk costs).

A set of three airports can be selected in The Netherlands, Belgium and Germany that mainly serve low-cost airlines and which have partially overlapping catchment areas (Figure 3). These airports are Eindhoven airport in the South of The Netherlands that processes around 676.000 passengers p.a., Airport Weeze which is situated approximately 80 kilometers from the city of Düsseldorf in Germany which processes around 590.000 passengers p.a. and has experienced rapid growth, and Brussels South - Charleroi in Belgium which is the largest of the three airports processing almost 1.9 million passengers p.a..

Fig. 3: Airport layout

The passengers are modeled in three groups, each group is bound to a specific geographic region confined by the limits of the catchment area of the airport and the national borders of the country the airport is situated in. The size of the group is determined by the number of passengers at the three airports. For example, the size of the group of passengers that is bound to the German region is equal to the sum of German passengers at all three airports in the model. Besides the geographical division the passengers are also divided based on their traveling motive (business or leisure).

The physical appearance of the system combined with the theoretical base on consumer choice can now be translated into a high level conceptual model. In Figure 4 the schematics of this conceptual model are depicted. The center column captures the mechanisms that are related to the acquisition of information on a group level on both the set of airports (alternatives) and the airport attributes. This information is fed into the decision core resulting, through a multinomial logit function, in a probability to choose an airport, i.e. the resulting probability represents the fraction of the group that chooses a specific airport. The summation of passengers choosing a specific airport between all groups is then fed as demand into the airline strategy module of the model. In the airline strategy module the price of a flight and quantity of flights provided per airport is adjusted in order to match demand and in turn affects the passenger decision to complete the cycle.

3.2 Information diffusion in the system

The information on the number of alternatives and their characteristics is spread among the passenger groups in three different ways; through learning by experience, word-of-mouth and through marketing. Each of these mechanisms has its own characteristics and the information that is acquired has its own specific value as we have discussed in Section 2.2 of this paper. The three mechanisms are depicted in Figure 5. The perceived attractiveness (airport utility) is related to a specific airport and is shared among a group of users. The higher the perceived attractiveness among the group, the

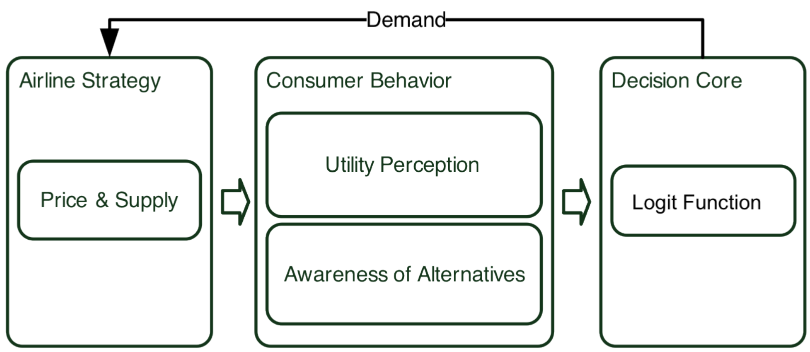

Fig. 4: High level model overview

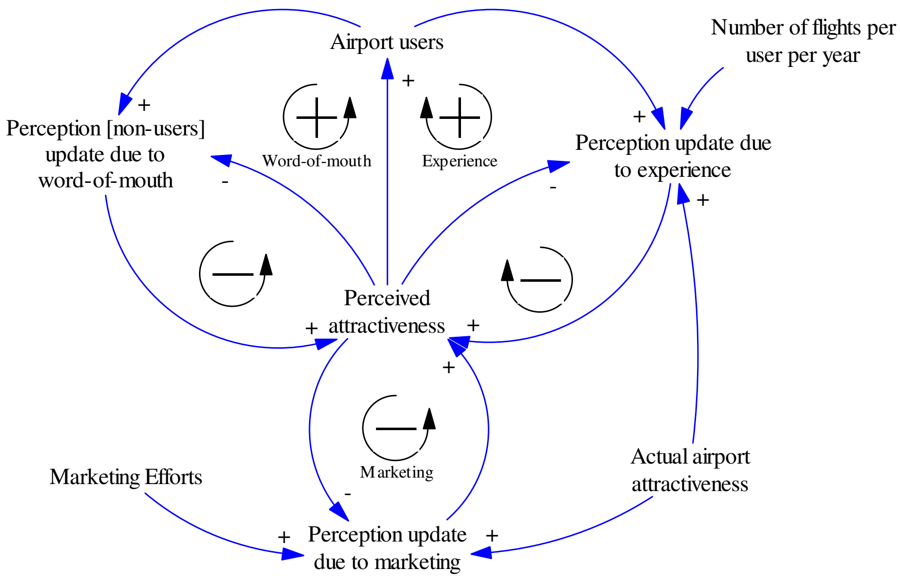

Fig. 5: Information acquisition

more people will choose the airport and hence the number of airport users (and its market share) will increase. The awareness, i.e. knowledge of the existence of an airport, is transferred in a similar fashion except that it has a fixed maximum value of 1 (100%) where all people are assumed to be aware of the airport.

Learning by experience is the form of information acquisition which is prone to the least amount of resistance. The speed at which information is acquired depends on both the current level of knowledge of the airport and its characteristics, and on the frequency of flight, i.e. how often does one travel by air. It is assumed that if the level of knowledge on a specific airport is low, e.g. an airport has never been visited by that specific passenger, the first visit will cause a large increase of knowledge. However, when the knowledge of an airport is high, learning more about that airport will become increasingly difficult. In other words the marginal contribution of learning diminishes with the number of visits. The flight frequency on the other hand determines how often one visits an airport. If the same airport is visited frequently the level of knowledge on that airport will increase faster than for an airport that is visited only once in a while. Moreover, a large time delay between two visits causes the level of uncertainty about the airport characteristics to rise and causes the awareness of the airport to decrease due to forgetting.

The word-of-mouth mechanism updates knowledge through information acquired from social sources such as friends, family and neighbors. The speed at which this knowledge is updated is strongly related to the market share of an airport in a specific geographical region. The larger the market share of an airport, the higher the probability that a non-user of that airport encounters a user of the airport, the more information is transferred on a group level. The effect of diminishing marginal increase of knowledge applies to word-of-mouth as well. Furthermore, the information that is transferred is not the directly observed information, such as the case with experience based learning, but it is the perceived information and therefore might differ from actual utility. The net result of the word-of-mouth mechanism is that the perceived utility of one group follows the perceived utility of the other group with a certain delay.

The last mechanism responsible for the diffusion of information is marketing. The marketing mechanism is quite similar to that of learning by experience. Only this time the speed depends on how much effort the marketeers put into broadcasting the information. Imagine that you would see an advertisement of an airport on every corner of the street, you will quickly start to at least know about the airport. In the model it is assumed that the information provided by the marketeers represents the actual utility of the airport.

In the simulation model, the co-flows structure (Sterman, 2000) has been used to model the tracking of group attributes such as perceived utility and awareness of an airport. The users stock, explained in the next paragraph, can be seen as the central stock in the model since both the stocks of awareness and utility perception are attached to it.

3.3 Decision core

The decision core of the model constitutes of a multinomial logit equation that results in the market shares of each airport within each user group. The logit function and its parameters have been presented in Equation 2 in the previous section. The current number of passengers per month (Flight sales) is determined by multiplying the fraction of market shares of all airports within a specific group with the number of passengers that actually are going to take another flight. A stock “users airport i,j” represents the total number of people within the group. The stock uses subscripts so that it can be tracked what airport the passengers have chosen on their last trip, to what geographic region they belong and which motive they have for traveling. An “Autonomous growth” inflow represents the natural long term growth rate of the airport and is based on the global growth rate of aviation.

3.4 Airline strategy

The last module of the model represents the supply-side of the market. It is assumed that there is a single airline on all three airports in the model. The strategy of the airline is therefore similar on all three airports. To further simplify the model it is assumed that the market is purely demand driven. That is, the airport choice of the passengers determines how many flights are provided by the airline. The airline does not pro-actively alter the number of flights in order to generate additional demand. The airline does, however, use forecasting to estimate the future number of passengers.

In Figure 6 the causal loop diagram is depicted. Besides the number of flights supplied, the average ticket price is included as an endogenous factor in the model. It is assumed that the higher the load factor (fraction of the seats occupied) the higher the average price of an airline ticket. In other words, where demand is high and/or supply is low, the prices are high and vice versa. The average ticket price influences the attractiveness of the airport The higher the price the lower the attractiveness, the less seats demanded. If demand decreases the airline responds by decreasing the supply, leading to an even lower attractiveness. There are two delays between the reduction of the number of flights. The first delay is associated with the forecasting process and is the time to perceive the trend (Sterman, 2000). The second delay is related to the operational side and stems from scheduling issues and slot availability (in case of additional supply).

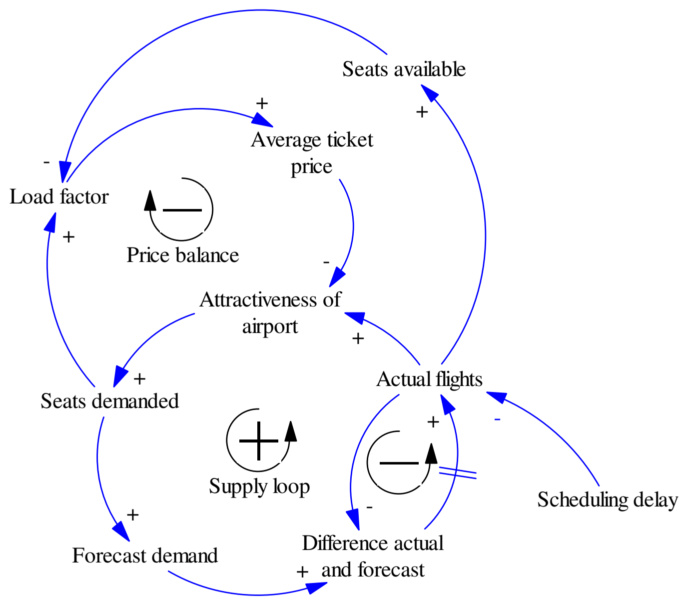

Fig. 6: Airline strategy

3.5 Data sources

Forrester (1991) in his chapter about system dynamics and the lessons of 35 years describes the three sources of information; mental, written and numerical, where the information content decreases respectively. For the development of the simulation model at hand we have combined the three sources. Mental and written data has been mostly used to construct the mechanisms that drive the behavior whereas numerical data is used to set initial values and quantify exogenous variables. The numerical data stems from a variety of sources among which the Official Airline Guide (OAG) that holds information on flight schedules on a route level. Furthermore, statistics published by the airports themselves has been used. The preference related values are estimated based on the study of Terpstra (2009) on the effects of a high-speed railway connection at Schiphol airport. In order to extend the validation of the model, a survey among 3000 Dutch citizens on airport choice specifically developed to investigate the effects of the taxation has been used.

All the components of the model have now been briefly described. In the next section we will analyze the behavior of the components when put together.

4 Behavior of the model

4.1 Simulation setup

The system is simulated for a period of ten years starting at the first of January 2005, well before the introduction of the tax. It was decided to start ahead of the introduction of the tax in order to be able to compare the simulation results with “undisturbed” empirical data. The time unit that is used in the model is months and the system of differential equations is integrated using the Euler integration method with a time-step of 0.1 month. Euler was chosen in order to be able to better handle the discrete step function that is used to introduce the ticket tax. Vensim DSS has been used (in order to be able to utilize subscripts in stock variables).

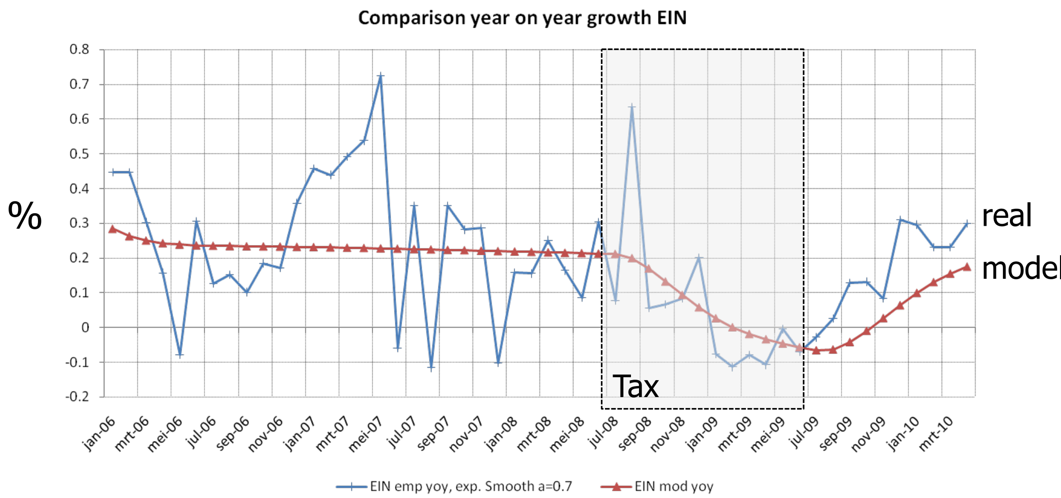

Fig. 7: Comparison with empirical data

4.2 Model testing and comparison with empirical data

Besides the general checks that have been performed continuously during the build to ensure the model is built properly the model has been subjected to a number of test cases. These test cases where designed to take the model to the extremes of the normal operating envelope. Before each test was performed the expected behavior was discussed with experts from the fields and documented. Each time the results deviated from the expectations the reason for deviation was analyzed. Besides the test cases an extensive sensitivity analysis was conducted. The most sensitive factors in the model are the ones related to preferences of consumers and the utility of the airports. In other words, changing the choice of consumers highly influences the overall model outcomes. It is however important to mention that this sensitivity is mostly numerical.

The last check that has been done is to compare the simulated results with the empirical data. In Figure 7 this comparison is depicted. The data shows the passenger year on year growth for Eindhoven airport over the period of January 2006 to March 2010. In order to reduce the extreme values present in the empirical data exponential smoothing with a factor 0.7 has been applied.

4.3 Introduction of the tax

Let us start by exploring the dynamics of the system in response to the introduction of an additional tax on airline tickets with departure point Eindhoven. The tax is modeled as a step increase in the actual ticket price, which is part of the factor "actual airport attractiveness" in Figure 5. In Figure 8 the development of the perceived and actual ticket price of an airline ticket at Eindhoven is represented. The graph shows four curves for the perceived utility among passengers in The Netherlands. A distinction has been made between passengers that have last used Weeze (Germany) and passengers that have last used Eindhoven (The Netherlands). Another distinction has been made between leisure and business passengers (higher flight frequency). Interesting to notice is that business passengers learn faster, as could be expected, and that passengers that have last used Eindhoven learn faster about the price change than passengers that have last used Weeze. This indicates the importance of the learning by experience mechanism.

In Figure 9 the awareness development of passengers residing in The Netherlands for the three airports is shown. The graph shows two different experiments. In the first experiment the tax is introduced without any additional effort from marketeers (silent introduction). In the second

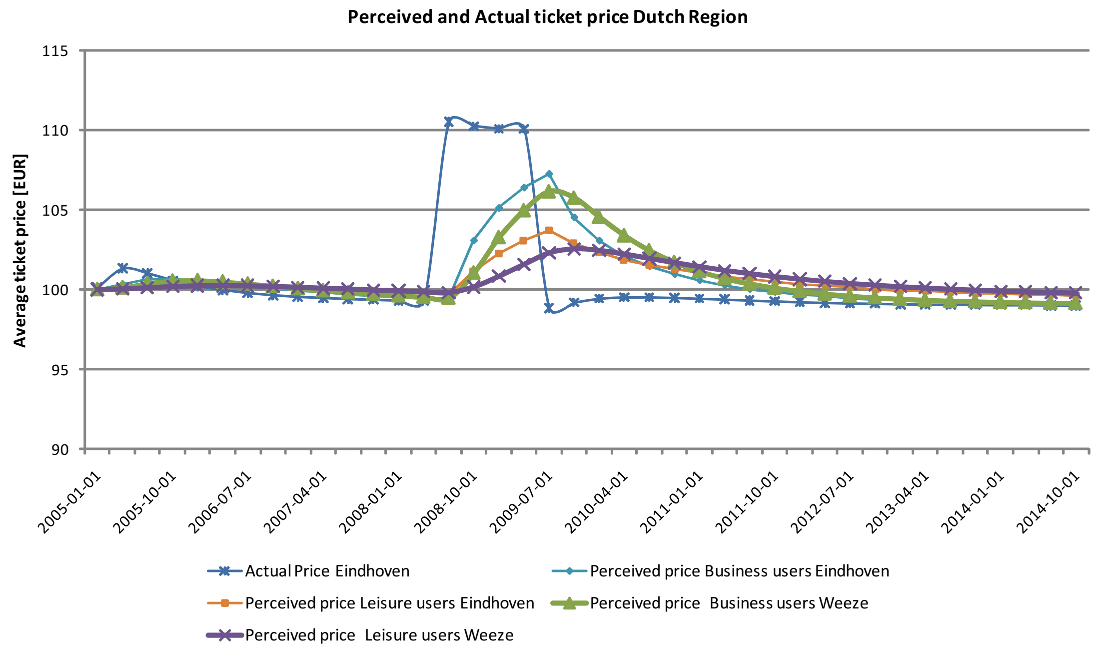

Fig. 8: Perceived ticket price

experiment, indicated with "Boost" behind the airport names an extra effort of the marketeers (e.g. launching an advertisement campaign) is introduced at the same time as the tax was introduced. Important to notice is that in the case of a silent introduction the awareness of the non-taxed airports Weeze and Charleroi still increases while the awareness of Eindhoven decreases. This increase is the result of a higher market share of the non-taxed airports. Due to the decreased attractiveness of Eindhoven more people decide to travel from the non-taxed airports, which leads to a higher equilibrium awareness[4].

Another important feature to notice is the development of the awareness of Weeze in the case of a marketing boost. As can be observed, the result of the boost is a permanently increased equilibrium awareness for Weeze. This indicates that due to the temporarily (artificially) increased awareness more passengers will choose Weeze, leading to a reaction of the airlines in terms of providing additional flights that is sufficiently large to permanently increase the attractiveness of the airport. The results from these experiment imply that in order for a taxation to have a permanent effect at least two conditions have to be satisfied. First, there should be sufficient attention for the increased ticket price by means of marketing. Second, airlines should be able to respond quickly to the change in demand by providing additional flights so that the attractiveness is increased sufficiently.

The awareness development plays an important role in the asymmetric character of the system response to the tax. As described before awareness can increase through the three mechanisms of learning, word-of-mouth and marketing in a similar fashion as utility is updated. However, awareness can only decrease through forgetting. The speed at which awareness can increase depends on the frequency of flight, the market share of an airport, and the intensity of marketing. The speed at which awareness can decrease depends on how quickly people will forget about an airport they have once used or have known about in another way. In the model it has been assumed that forgetting has two components. The first is a variable component which is inversely related to social exposure (combined effect of word-of-mouth and marketing). The second component is a constant which captures the effect of habit formation. Habits form when a single alternative is repetitively chosen

[4] The equilibrium awareness represents the balance between learning by experience, word-of-mouth and marketing on the one hand and forgetting on the other hand.

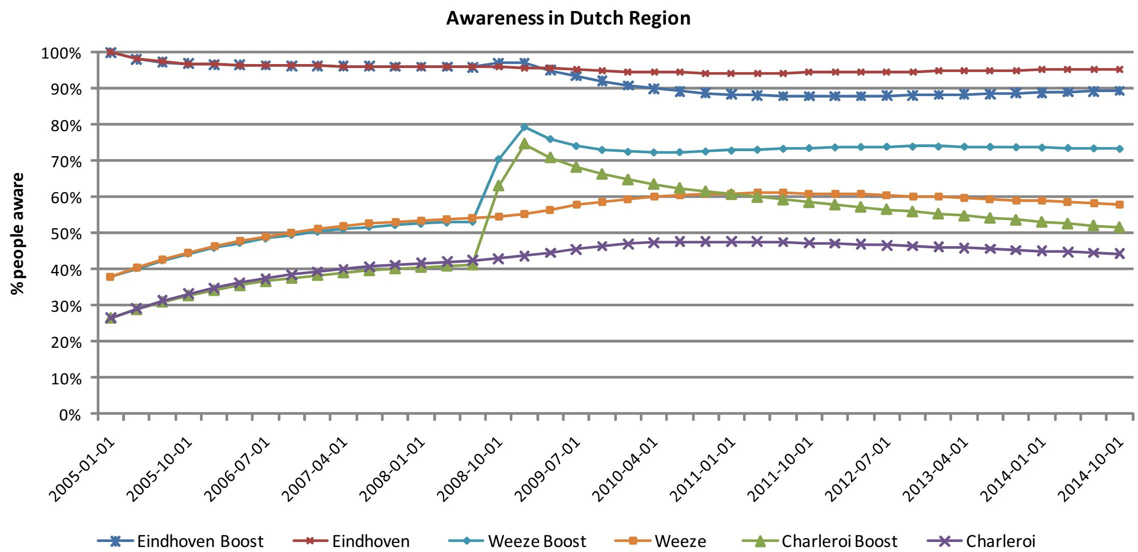

Fig. 9: Awareness development in the Dutch region

while the level of deliberate reasoning decreases (a.o. Tiemeijer et al. 2009). In other words, the stronger the habit, the more the other alternatives are ignored. In the model there will always be some level of decay of awareness. The only way to neutralize this decay is to have sufficient social exposure and/or to frequently use the specific airport.

In Figure 10 the impact of the difference in speed in awareness development is shown on passengers choosing Weeze in The Netherlands. The graph shows two curves for each passenger group, one curve for the case where a tax is introduced and one curve for the case where no tax is introduced. A distinction has been made between passengers that last used Eindhoven and passengers that last used Weeze. The figure shows that after the implementation of the tax the fraction of passengers that choose Weeze increases quite rapidly. Especially passengers that have already flown from Weeze before, and hence are well aware of the airport, will choose Weeze more frequently. After the abolishment of the tax a quick drop occurs, similar in speed compared to the initial increase. After some time however, the speed of change decreases and the curves only slowly converge back to the non-tax levels. The change in speed is explained by the difference in speed of learning about the changed price and the speed at which awareness is lost. Right after the abolishment of the tax, passengers learn rather quickly about the new prices. However, it takes much more time before they have lost the additional awareness they gained from the implementation of the tax.

5 Conclusions and discussion

In this paper we have provided an answer to the question *which factors contribute to asymmetric response of the system to the introduction and abolishment of an airline ticket tax in The Netherlands?* First of all we gave an overview of a selection of literature on consumer choice. We learned about the five steps of decision making starting with the recognition of a problem and ending with the evaluation of the chosen alternative. Information acquisition is one of the fundamental steps of consumer choice. We can distinguish between three types of information required in any decision making process; (personal) preferences, the set of alternatives, and the attributes of those alternatives. Information can be obtained through at least three basic mechanisms which are; own experience, word-of-mouth, and marketing. Given the information a choice is made, in the model this is represented by a multinomial logit function.

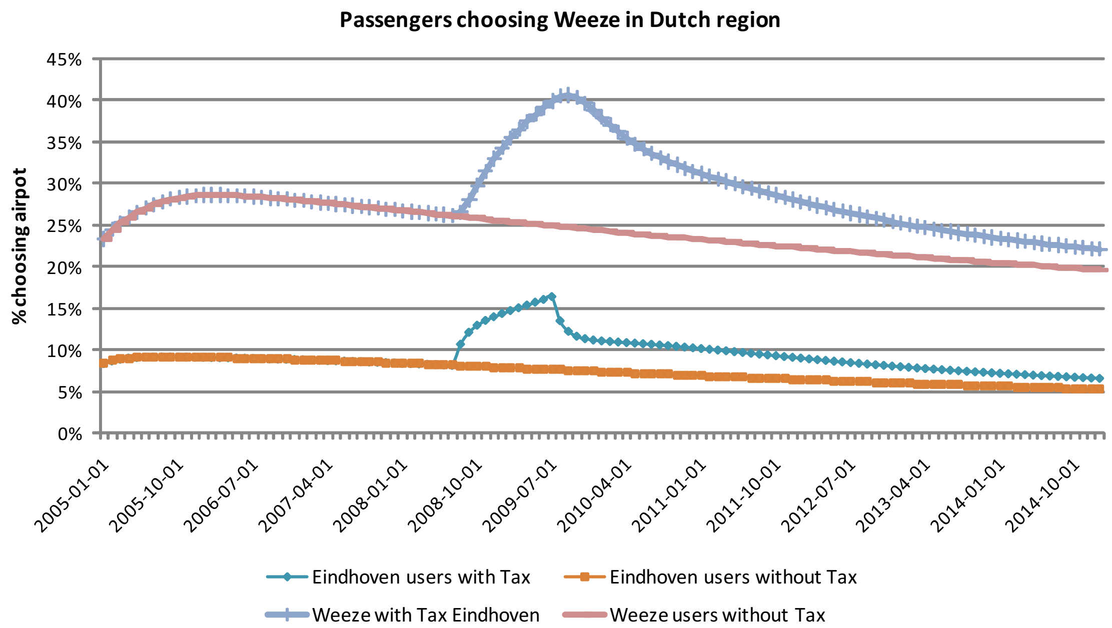

Fig. 10: Passenger choice in the Dutch region

The notion of awareness of alternatives proved to be a key variable in the model and greatly influences the behavior of the model as a result of the introduction of a taxation on airline tickets. Due to the relatively fast increase of awareness at the time of the introduction of the taxation and the slow reduction of awareness after the abolishment of the tax, an asymmetric response occurs. The awareness and hence the market share is found to increase permanently as a result of a taxation on a competing airport if two conditions are satisfied. First the airlines should respond quickly to changes in demand by providing additional flights, especially to increasing demand. Second, there should be sufficient exposure of the alternative airports at the time of the tax introduction.

One of the conditions for a sustained effect of the taxation on airline tickets on airport choice is that there should be sufficient attention by means of media (e.g. marketing) for the increase in price and for the available alternatives. In fact a key condition for every new or changed product to attract market share is that consumers are at least aware of its existence, and can learn about the new or changed features of that product. Since learning by direct own experience is subject to the condition that consumers have already picked a particular product and have started using it, the initial focus should be on the diffusion of information through the market. Now this is where a couple of things have changed over the past few years. Let us take a little side-step into marketing. At this point we seem to be in a transition phase between the use of mass media on one hand and the use of smart marketing injections on the other (Godin, 2003). Mass media is thought no longer to be very effective, instead, specific marketing targeted at a group of "sneezers" as Seth Godin calls them would be more effective. These sneezers will then "infect" the rest of the market with the new idea much like how a virus would work (Godin & Gladwell, 2000). The group of sneezers is carefully picked based on their interest in new ideas and their influence on larger groups in the market. But how does this translate to our current approach in system dynamics?

The word-of-mouth effect strongly resembles the dynamics of a virus. The more people use a product, the quicker the information spreads until almost everyone is aware and the speed decreases again. But the environment in which the word-of-mouth effect occurs has changed, as well as the technology that is at our disposal. One of the trends we saw in the airport business is that more and more people started using airports abroad. In the old days, in case of The Netherlands, we had one national airport everybody used when taking a flight. With the availability of the internet and the empowerment of passengers everyone is now able to book their flight at the cheapest rate from any airport. Hence, airports just across the borders see increasing numbers of foreign passengers. News about new routes and fares spreads at the speed of light through new media such as twitter, facebook, hyves, etc. Word-of-mouth is not longer confined to a specific geographical location but has become an international and inter-cultural mechanism in which national borders are of no importance. How does this change the way we model the spread of information? Do we have to redefine word-of-mouth in our models. How will these developments affect the diffusion of innovation? How should we include marketing in these models? Will the dynamics related to success or failure of new products change, or will they just be more volatile? These aspects are all interesting in the light of for example modeling energy transition, diffusion of innovation and consumer choice and in our point of view deserve the attention of system dynamicists. We find ourselves in a world that is going through rapid technology-driven social change. If we want to anticipate on the future we have to understand the mechanisms of today.

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