# FORECASTING THE IMPACT OF A TICKET TAX IN THE NETHERLANDS

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## 1. INTRODUCTION

Early 2007, a new Dutch coalition government was formed. To balance the budget, it was decided that 350 million euro/year should be raised by imposing a tax on air tickets. This was part of their policy to relate taxes more to environmental burden.

However, it is was not yet decided how exactly this tax should be implemented. Several options were considered: to put a tax on all passengers (transfer and departing/arriving passengers), on freight or on each aircraft movement. Before deciding on the final implementation, the effects of each of the variants under consideration were studied with a strategic air travel demand model: Aeolus.

## 2. AEOLUS

In order to assess the impacts of new policies on the development of Dutch airports, a model to forecast demand for air travel under a wide range of scenarios was developed for the Ministry of Transport, Public Works and Water Management. This model was developed between 2004 and 2007 and was originally named ACCM – Airport Catchment area and Competition Model (Kouwenhoven et al. 2006). In 2008, several improvements were implemented and the model was renamed AEOLUS, after the Greek god of the wind.

The model considers world wide traffic flows from, to, and through the airports within the catchment area of Schiphol airport (Netherlands, Belgium, northern part of France, western part of Germany, Figure 1). The model considers traffic flows to/from 56 zones in the world. These zones are relatively small within the catchment area of Schiphol airport, more aggregated in the rest of Europe and very large in the rest of the World.

The architecture of the simulation system consists of two modules: a module to forecast traveller choices and a module to forecast airline choices (Figure 2). In the first step of a model run, all traffic flows in the base year (i.e. 2006) are simulated. The traveller choice module calculates the number of (one-way) trips that travellers make between an origin and a destination zone in a certain year and it calculates the distribution of these trips over the available alternatives. The market shares of the available travel alternatives are determined by simulating traveller choices at one to three levels (Figure 3): choice between main modes (car, train, or aircraft), choice between available routes (specified by departure airport, airline, and route (direct flight or indirect via a hub)), and choice between access modes to the airport (car or train). We use random utility models of the logit type to define traveller choices (Ben-Akiva & Lerman 1985). Travel and transfer times, travel costs and service frequencies are the main determinants for the utility functions. The module requires current passenger counts and level-of-services for calculating travellers' preferences for the available alternatives in the base year (see Kroes et al. (2005) for more details on how a complete OD-matrix was derived from a partially observed database).


**Figure 1. Relevant airports in the catchment area of Schiphol airport**

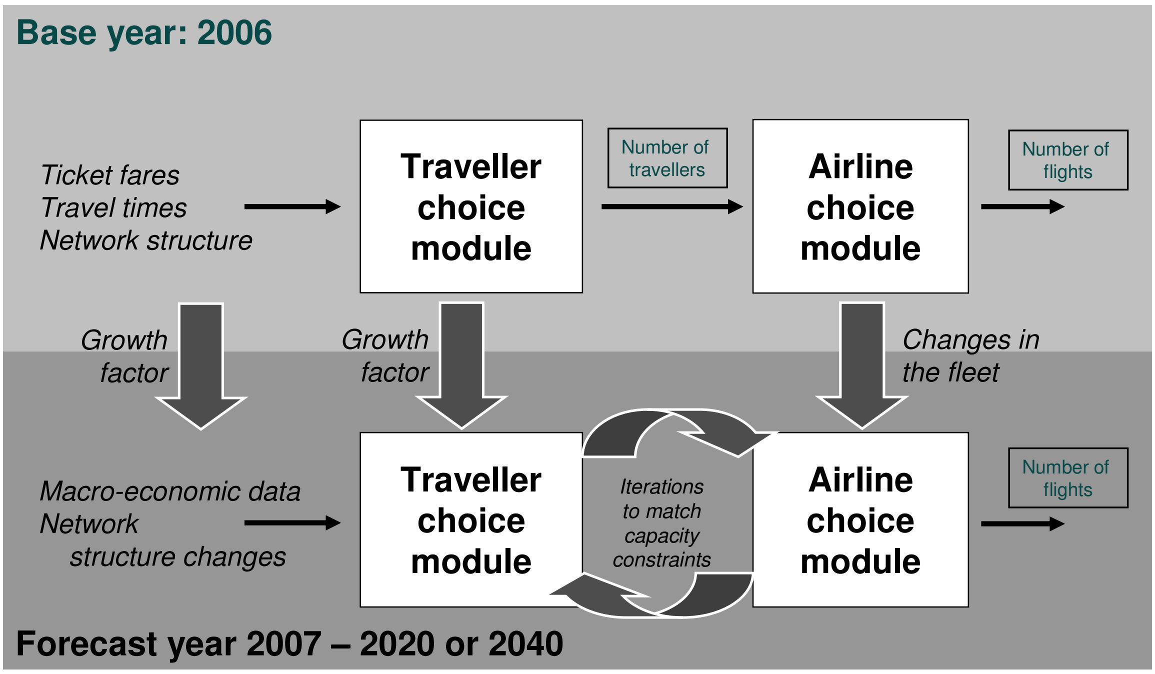


**Figure 2. Structure of the AEOLUS model**

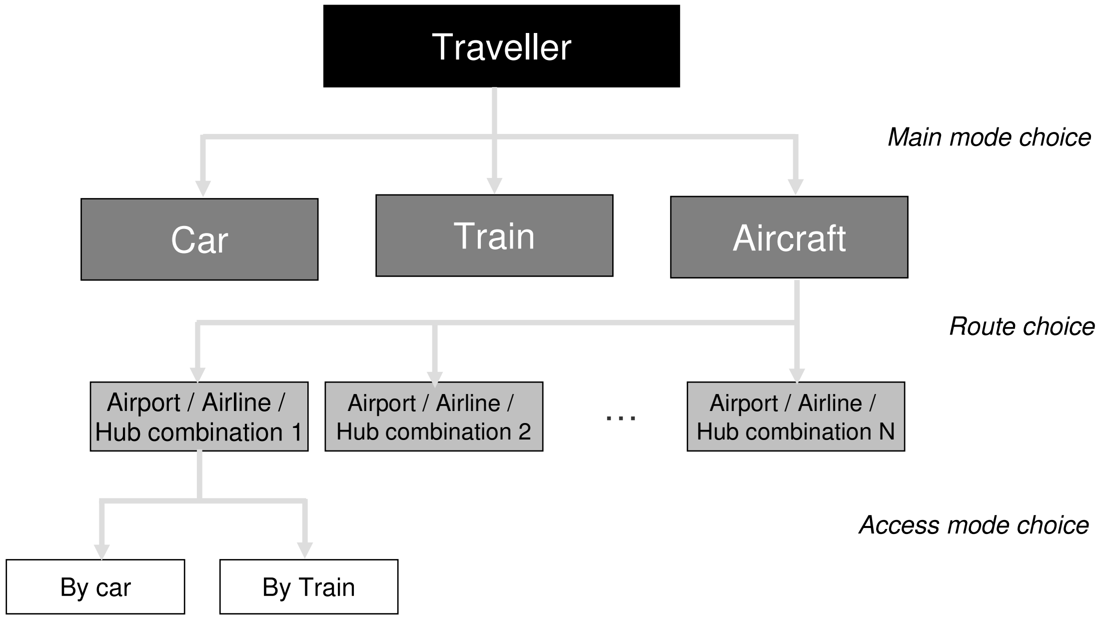


**Figure 3. Structure of traveller choice module**

The airline choice module converts the passenger numbers into number of yearly flights per type of aircraft and per period of the day. Calibration factors were determined so that the calculated number of passengers and number of flights match the observed numbers.

For each traffic flow, the number of travellers in the base year is extrapolated towards the forecast year (up to 2040) using a growth factor that depends on economic and price developments. The distribution over the available alternatives in the forecast year is calculated again in the travellers' choice module using a level-of-service for the forecast year. If the capacity constraints are exceeded, scarcity costs are added (both for passengers and airlines) in an iterative loop in order to reduce the demand and redistribute the passenger flows so that the total number of flights and the amount of noise produced does not exceed the limitations.

*Access mode choice*

There are two alternatives: car and train. Generalised costs for the car mode are determined by fuel cost, parking cost and travel time. Travel times are converted into generalised cost by means of multiplication by an assumed value-of-time, depending on the travel purpose (business or non-business). Generalised costs for the train mode are determined by the train fare and generalised train travel time. Travel fares and times are taken from an input file with level-of-service information. The same model is used to model the egress mode in case the destination of the trip is in the catchment area
.

*Route choice*

Alternatives are defined by airline (Skyteam, Star Alliance, OneWorld, low-cost airlines, other airlines), by hub (direct flight, or one of 64 international hub options), and by access/egress airport (only if origin or destination is in the catchment area). The utility of each alternative is the sum of the logarithm of the number of flights per week, a generalised cost term (determined by an assumed ticket fare and flight time (with an extra penalty for an indirect flight)) and an accessibility term for the airport (only in catchment area). This accessibility term is the logsum of the access mode choice model.

*Main mode choice*
Main mode choice is only included if the origin is in the catchment area of Schiphol and the destination is somewhere else in Europe (or vice-versa). There are three alternatives: car, train and aircraft. The utilities for the first two modes are determined by travel cost (fuel or train fare) and travel time; the utility of the air alternative is determined by the logsum of the route choice model.

## 3. TICKET TAX IMPLEMENTATIONS UNDER CONSIDERATION

Initially, six variants of the ticket tax have been studied (Significance and SEO Economisch Onderzoek 2007). These variants differ in the amount of tax that each of the segments (departing passengers, transferring passengers, freight) had to pay (Table 1). In all versions, the total amount of tax collected per year is 350 million Euro.

**Table 1. Overview of ticket tax variants under consideration**

| | OD passengers (per departure) | Transfer-passengers (per transfer) | Freight (per 100 kilo loaded or unloaded) | Aircraft (per ton MTOW per take-off) |
|---|---|---|---|---|
| Variant 1 – Departure tax | €23.00 | | | |
| Variant 2 – Departure and transfer tax | €13.75 | €13.75 | | |
| Variant 3 – Departure and freight tax | €15.25 | | €7.63 | |
| Variant 4 – Departure, transfer and freight tax | €10.50 | €10.50 | €5.25 | |
| Variant 5 – Charge per aircraft | | | | €16.50 |
| Variant 6 – Charge per aircraft (depending on technology class) *(highest charge for the oldest type of aircraft)* | | | | €21.00<br>€16.00<br>€11.00 |

The simulations have been done with the third version of the ACCM model (ACCM-III) in 2007. The results have been confirmed with new simulations done with the AEOLUS model. The model simulates the effects of the ticket tax by increasing the fare of air travel starting from the year of introduction of the tax (i.e. 2008), for each of four macro-economic scenarios. These scenarios were developed by the Netherlands Bureau for Economic Policy Analysis (de Mooij and Tang 2005) and they differ in the amount of economic growth (slow – fast) and in the focus on globalisation (small – high).

For the discussion on the effects of the ticket tax, we distinguish between OD and transfer passengers. Arriving passengers do not pay a tax. However, since most passengers buy a round trip ticket, we assume that half of the tax applies to the outward journey and half of it applies to the return journey. Therefore, the effects on arriving passengers are in the model identical to the effects on departing OD passengers. Note that a transfer passenger has to pay the tax twice per journey, since he makes a transfer both during the outward trip and the return trip.

# 4. DESCRIPTION OF THE EFFECTS

## 4.1 Variant 1 – Departure tax

The first variant is a tax for OD passengers of €23 per departure. The effects have been simulated with the Aeolus model and the results are displayed in Table 2.

**Table 2. Effects of ticket tax variant 1 – Departure tax**

| | ***2003*** | ***2011*** *Average over four scenarios* *without tax* | *including tax* | ***Effect tax*** *minimum/maximum of scenarios in 2011* |
|---|---|---|---|---|
| **Netherlands** | | | | |
| Total number of passengers (mio) | 41.0 | 55.6 | 49.6 | -10% to -12% |
| **Schiphol airport** | | | | |
| Total number of passengers (mio.) | 40.1 | 53.9 | 48.2 | -10% to -12% |
| *- OD passengers(mio.)* | *23.7* | *33.7* | *29.2* | *-13% to -14%* |
| *- Transfer passengers (mio.)* | *16.4* | *19.7* | *18.5* | *-5% to -8%* |
| Freight (Mton) | 1.3 | 1.9 | 1.9 | no change |
| Aircraft movements (× 1000) | 393 | 500 | 448 | -9% to -12% |
| **Regional airports** | | | | |
| OD passengers (mio.) *indicative only* * | 0.9 | 1.7 | 1.4 | -18% to -20% |
| **Emissions** | | | | |
| Noise (Schiphol) | | | | about -0.3 dBA |
| Particles during LTO (Schiphol) | | | | -5% to -10% |

* Absolute forecast of passenger numbers for regional airports are indicative only

The tax results in a strong decrease of the number of OD passengers. Instead, they will

- depart from a foreign airport, where they do not have to pay the ticket tax (about 45%);
- travel using another mode (either train or car). This is only an alternative for travel within Europe (about 10%);
- not make the trip (about 45%). These are not so much passengers that actually stop travelling as a result of the ticket tax, but these are passengers that might have travelled more if there were no ticket tax (so, the ticket tax causes a reduction of the growth)

The average ticket price per OD passenger for a round trip is about €350, so the ticket tax is a relative price increase of about 6.5%. The price elasticity for this segment is about -2 according to this simulation, which is high compared to previous studies (Brons et al. 2002). This can be explained since this simulation not only includes the effect of a reduction in total travel demand, but also a switching effect to foreign airports and other travel modes.

The reduction of OD passengers at regional airports is much higher than at Schiphol airport. This can be explained by the relative high share of low cost flights at these airports. As a result, the average ticket price at these airports is much lower: €240 euro) and the relative increase in ticket price much higher (hence, the large decrease in passengers).

The number of transfer passengers at Schiphol airport also decreases, which might be striking since they do not have to pay the ticket tax. However, airlines have to reduce their flight frequencies in order to maintain their average load factor (the model assumes that airlines only have limited options to employ smaller aircraft). As a result, the transfer options at the airport reduce as well and hence, transfer passengers switch to alternative hub airports.

Other effects include a relative shift towards intercontinental destinations (because the relative price increase is smaller and because for european destination passengers also can switch to car or train travel). Furthermore, the market share of the home carrier (KLM) is strengthened since other airlines do not have a transfer option at Schiphol, so all their passengers have to pay the tax, while only part of the KLM passengers have to pay this.

## 4.2 Variant 2 – Departure and transfer tax

In this variant, departing OD passengers have to pay €13.75 per departure and transfer passengers have to pay this tax per transfer (OD passengers pay this tax only once per round trip, while transfer passengers have to pay it twice). The forecasted effects are displayed in Table 3.

**Table 3. Effects of ticket tax variant 2 – Departure and transfer tax**

| | ***2003*** | ***2011*** *Average over four scenarios* | | ***Effect tax*** *minimum/maximum of scenarios in 2011* |
|---|---|---|---|---|
| | | *without tax* | *including tax* | |
| **Netherlands** | | | | |
| Total number of passengers (mio) | 41.0 | 55.6 | 44.2 | -19% to -22% |
| **Schiphol airport** | | | | |
| Total number of passengers (mio.) | 40.1 | 53.9 | 42.8 | -19% to -22% |
| *- OD passengers(mio.)* | *23.7* | *33.7* | *30.3* | *about -10%* |
| *- Transfer passengers (mio.)* | *16.4* | *19.7* | *12.1* | *-37% to -39%* |
| Freight (Mton) | 1.3 | 1.9 | 1.9 | no change |
| Aircraft movements (× 1000) | 393 | 500 | 407 | -17% to -20% |
| **Regional airports** | | | | |

| | | | | |
|---|---|---|---|---|
| OD passengers (mio.) *indicative only* | 0.9 | 1.7 | 1.5 | -13% to -15% |
| **Emissions** | | | | |
| Noise (Schiphol) | | | | -0.7 to -0.8 dBA |
| Particles during LTO (Schiphol) | | | | -14% to -19% |

Since the tax for OD passengers is lower than in variant 1, the decrease of this segment is lower as well, both at Schiphol and at regional airports. However, the effect on transfer passengers is enormous. This is not only because they have to pay the tax twice per round trip (in total €26.50 on top of the average transfer ticket price of about €300), but also because transfer passengers have very good alternatives (e.g. making a transfer at Londen, Frankfurt or Paris, or flying directly).

This variant results in a relative shift towards intercontinental destinations, though this shift is not as large as caused by variant 1. The competitive position of the home carrier deteriorates compared to other airlines since his transfer segment is dramatically reduced.

## 4.3 Variant 3 – Departure and freight tax

This variant involves a tax of €15.25 for each departing OD passenger and a charge of €7.62 per 100 kilo loaded or unloaded vracht. The main effects are summarised in Table 4.

**Table 4. Effects of ticket tax variant 3 – Departure and freight tax**

| | ***2003*** | ***2011*** *Average over four scenarios* | | ***Effect tax*** *minimum/maximum of scenarios in 2011* |
|---|---|---|---|---|
| | | *without tax* | *including tax* | |
| **Netherlands** | | | | |
| Total number of passengers (mio) | 41.0 | 55.6 | 51.5 | -7% tot -9% |
| **Schiphol airport** | | | | |
| Total number of passengers (mio.) | 40.1 | 53.9 | 50.0 | -7% tot -8% |
| *- OD passengers(mio.)* | *23.7* | *33.7* | *30.6* | *-9% tot -10%* |
| *- Transfer passengers (mio.)* | *16.4* | *19.7* | *18.9* | *-4% tot -5%* |
| Freight (Mton) | 1.3 | 1.9 | 1.3 | ca. -31% |
| Aircraft movements (× 1000) | 393 | 500 | 459 | -9% tot -12% |
| **Regional airports** | | | | |
| OD passengers (mio.) *indicative only* | 0.9 | 1.7 | 1.5 | -13% tot -15% |
| **Emissions** | | | | |
| Noise (Schiphol) | | | | -0.5 tot -0.6 dBA |
| Particles during LTO (Schiphol) | | | | -9% tot -14% |

The effects on the OD passengers are more moderate compared to variant 1, since the tax in this variant is lower. The reduction of freight, however, is very strong. This is caused by the relative strong increase of freight transport costs (as a rule of thumb, the average transport costs are €100 per 100 kilo freight, though this amount strongly depends on distance, available capacity, competition etc.), but also because freight can easily be shipped through other (foreign) airports: the freight transport market is very price competitive.

In this variant, the emission of particles is reduced more than in variant 1, since the number of freight aircraft is reduced. Typically, these are larger and older aircraft with high emission levels.

## 4.4 Variant 4 – Departure, transfer and freight tax

This variant comprises a €10,50 tax for each passenger (OD and transfer) and a tax of €5,25 per 100 kilo loaded or unloaded freight. A summary of the main effects can be found in Table 5.

**Table 4. Effects of ticket tax variant 4 – Departure, transfer and freight tax**

| | ***2003*** | ***2011*** *Average over four scenarios* | | ***Effect tax*** *minimum/maximum of scenarios in 2011* |
|---|---|---|---|---|
| | | *without tax* | *including tax* | |
| **Netherlands** | | | | |
| Total number of passengers (mio) | 41.0 | 55.6 | 46.5 | -15% tot -17% |
| **Schiphol airport** | | | | |
| Total number of passengers (mio.) | 40.1 | 53.9 | 45.0 | -15% tot -17% |
| *- OD passengers(mio.)* | *23.7* | *33.7* | *31.1* | *ca. -8%* |
| *- Transfer passengers (mio.)* | *16.4* | *19.7* | *13.6* | *-30% tot -32%* |
| Freight (Mton) | 1.3 | 1.9 | 1.5 | ca. -23% |
| Aircraft movements (× 1000) | 393 | 500 | 421 | -14% tot -17% |
| **Regional airports** | | | | |
| OD passengers (mio.) *indicative only* | 0.9 | 1.7 | 1.5 | -10% tot -13% |
| **Emissions** | | | | |
| Noise (Schiphol) | | | | -0.8 tot -0.9 dBA |
| Particles during LTO (Schiphol) | | | | -16% tot -20% |

This variant is comparible to variant 2. However, the effects on passengers are more moderate, while the effects on freight is additional. This impact on freight is less than in variant 3 due to the lower taxes.

The reduction of emission is stronger than in the previous variants, since both transfer passengers and freight transport are taxed. Both are using relatively large aircraft that have a large level of emission (both of particles and of noise).

## 4.5 Variant 5 – Charge per aircraft

In this variant, each departing aircraft is charged €16.50 per ton MTOW. It is assumed that this charge is passed on fully to the passengers and/or the freight, without distinction between OD- and transfer passengers, and without distinction between business and non-business passengers. All passengers in an aircraft have to pay the same extra price, which only depends on the size of the aircraft. The main results are shown in Table 6.

**Table 6. Effects of ticket tax variant 5 – Charge per aircraft**

| | ***2003*** | ***2011*** *Average over four scenarios* | | ***Effect tax*** *minimum/maximum of scenarios in 2011* |
|---|---|---|---|---|
| | | *without tax* | *including tax* | |
| **Netherlands** | | | | |
| Total number of passengers (mio) | 41.0 | 55.6 | 46.2 | -15% tot -18% |
| **Schiphol airport** | | | | |
| Total number of passengers (mio.) | 40.1 | 53.9 | 44.6 | -15% tot -18% |
| *- OD passengers(mio.)* | *23.7* | *33.7* | *31.1* | *ca. -8%* |
| *- Transfer passengers (mio.)* | *16.4* | *19.7* | *13.2* | *-32% tot -34%* |
| Freight (Mton) | 1.3 | 1.9 | 1.6 | -18% tot -19% |
| Aircraft movements ($\times$ 1000) | 393 | 500 | 421 | -14% tot -17% |
| **Regional airports** | | | | |
| OD passengers (mio.) *indicative only* | 0.9 | 1.7 | 1.5 | -8% tot -11% |
| **Emissions** | | | | |
| Noise (Schiphol) | | | | -0.9 tot -1.0 dBA |
| Particles during LTO (Schiphol) | | | | -16% tot -19% |

This variant is similar to variant 4, since in both variant both passengers and freight are taxed.

## 4.6 Variant 6 – Charge per aircraft depending on technology

In this variant, each departing aircraft is charged €21, €16 or €11 per ton MTOW depending on the technology class of the aircraft. The highest charge is for older type aircraft (lower end of Chapter 3 aircraft in the so-called ICAO classification), current technology class aircraft (Chapter 3 in ICAO classification) are charged €16 per ton MTOW, while the newest type aircraft are charged €11 per ton MTOW. The main results are displayed in Table 7.

**Table 7. Effects of ticket tax variant 6 – Charge per aircraft depending on technology class**

| | *2003* | *2011* Average over four scenarios without tax | *2011* Average over four scenarios including tax | *Effect tax* minimum/maximum of scenarios in 2011 |
|---|---|---|---|---|
| **Netherlands** | | | | |
| Total number of passengers (mio) | 41.0 | 55.6 | 46.9 | -15% tot -16% |
| **Schiphol airport** | | | | |
| Total number of passengers (mio.) | 40.1 | 53.9 | 45.3 | -15% tot -17% |
| *- OD passengers(mio.)* | *23.7* | *33.7* | *31.4* | *-6% tot -7%* |
| *- Transfer passengers (mio.)* | *16.4* | *19.7* | *13.6* | *-30% tot -31%* |
| Freight (Mton) | 1.3 | 1.9 | 1.5 | -19% tot -21% |
| Aircraft movements (× 1000) | 393 | 500 | 427 | -14% tot -16% |
| **Regional airports** | | | | |
| OD passengers (mio.) *indicative only* | 0.9 | 1.7 | 1.5 | -6% tot -10% |
| **Emissions** | | | | |
| Noise (Schiphol) | | | | -0.8 tot -0.9 dBA |
| Particles during LTO (Schiphol) | | | | -16% tot -19% |

Generally, the effects on traffic are slightly more moderate than in variant 5, while the effects on the emissions are the same. Most passengers have to pay slightly smaller charges, except on those routes on which relatively old aircraft are employed. However, the effects on freight are slightly larger since freight aircraft are generally older than passenger aircraft. The effects have been calculated under the assumption of a normal replacement of aircraft. Strategic decisions by airlines to employ their new aircraft especially on routes to Amsterdam are not included in the model. Note that this is only an option for foreign airlines. For the home carrier no such strategy is available.

# 5. FINAL IMPLEMENTATION

## 5.1 Comparison between variants

The following figure summarises the effects of the six variants on four points: effect on OD passengers (Figure 4), transfer passengers (Figure 5), freight (Figure 6) and particle emissions during landing and take-off (LTO, Figure 7).

The effect on OD passengers is strongest in variant 1, where the tax for this segment is highest (Figure 4). The tax causes a shift in travel behaviour for slightly less than 5 million travellers (averaged over all scenarios): about 45% will travel to/from a foreign airport, about 10% will use car/train as their travel mode and the remaining 45% is a caused by a reduction of the growth (people do not make the extra trips they would have made if there were no ticket tax).

The effect on transfer passengers is strongest in variants 2, 4, 5 and 6 (Figure 5). After introduction of the tax about 7 million transfer passengers will switch to other hub airports, will travel directly, or will stop travelling. In variants 1 and 3, the number of transfer passengers at Schiphol decreases as a result of a decrease in flight frequencies.

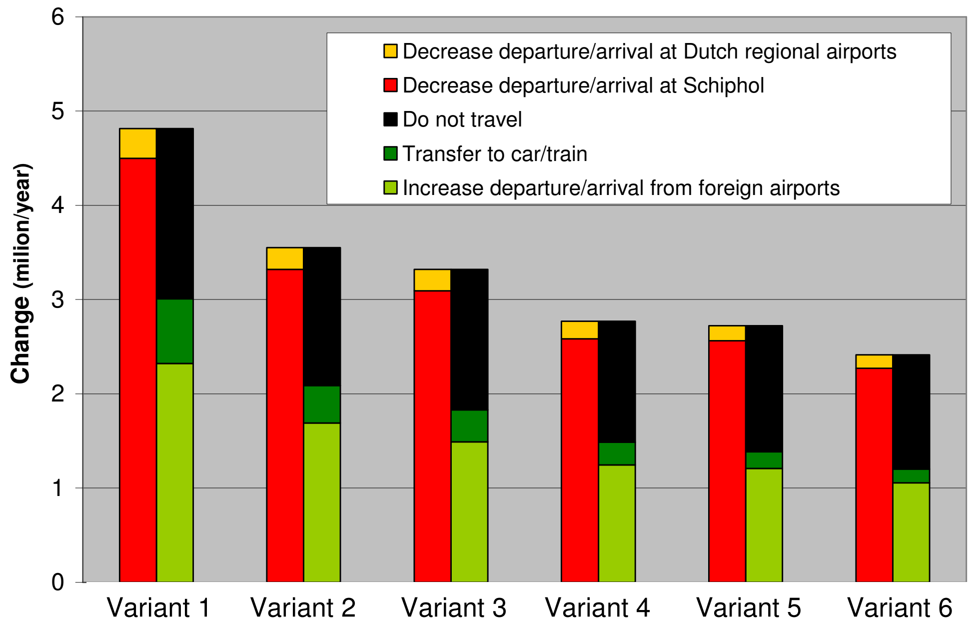


**Figure 4. Effects of the ticket tax on OD passengers**

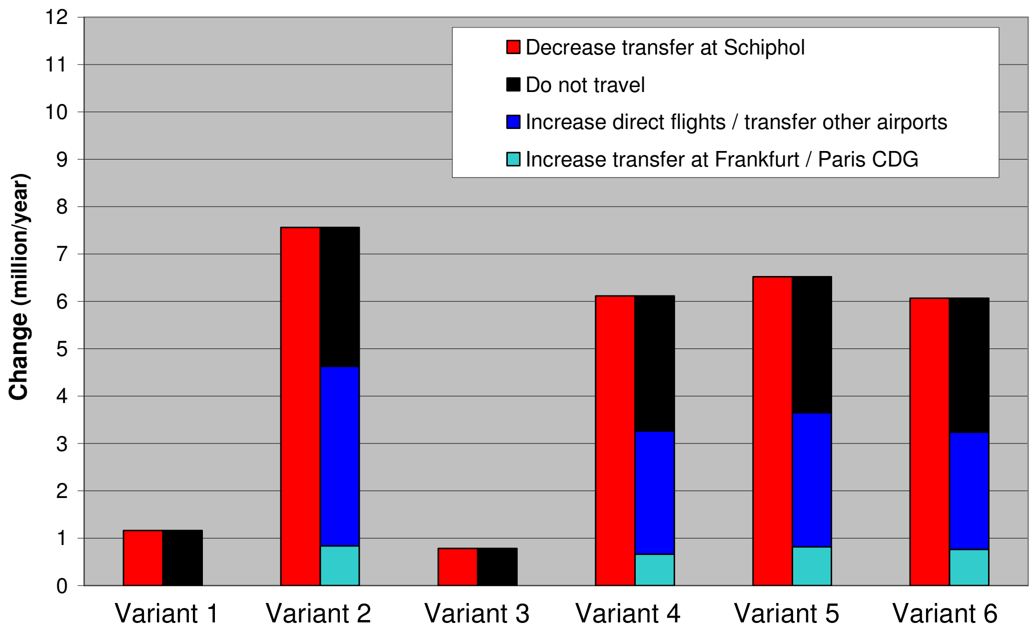


**Figure 5. Effects of the ticket tax on transfer passengers**

The effect on freight is highest in variant 3, since in that variant the tax per 100 kilo freight is highest (Figure 6). The effect on emissions is lowest in variant 1 and 3 (Figure 7), since in those scenario the number of aircraft movements reduces less than in the other scenarios.

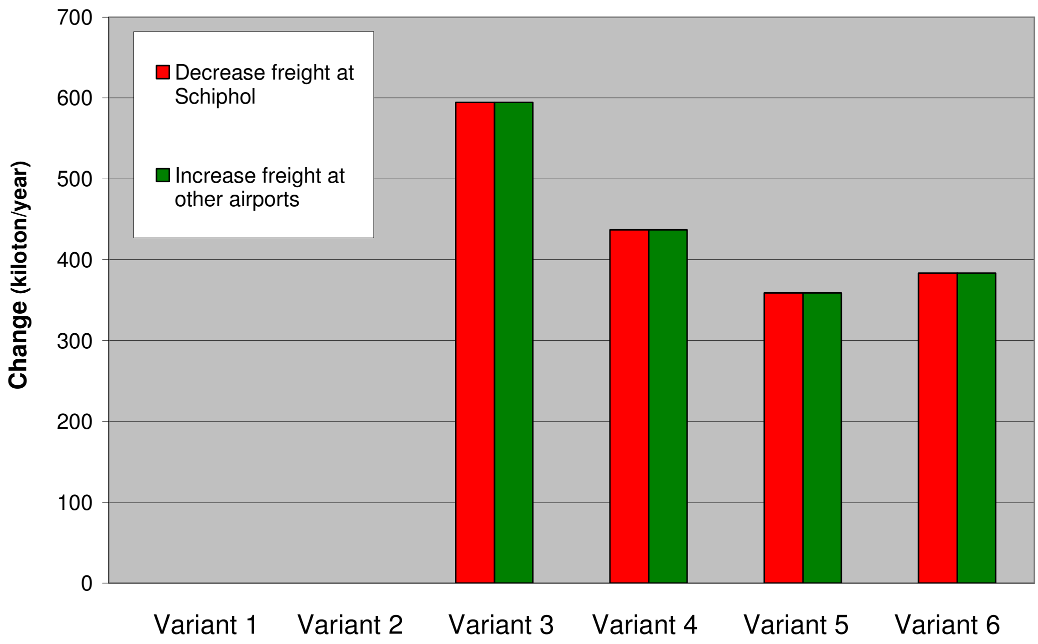


**Figure 6. Effects of the ticket tax on freight**

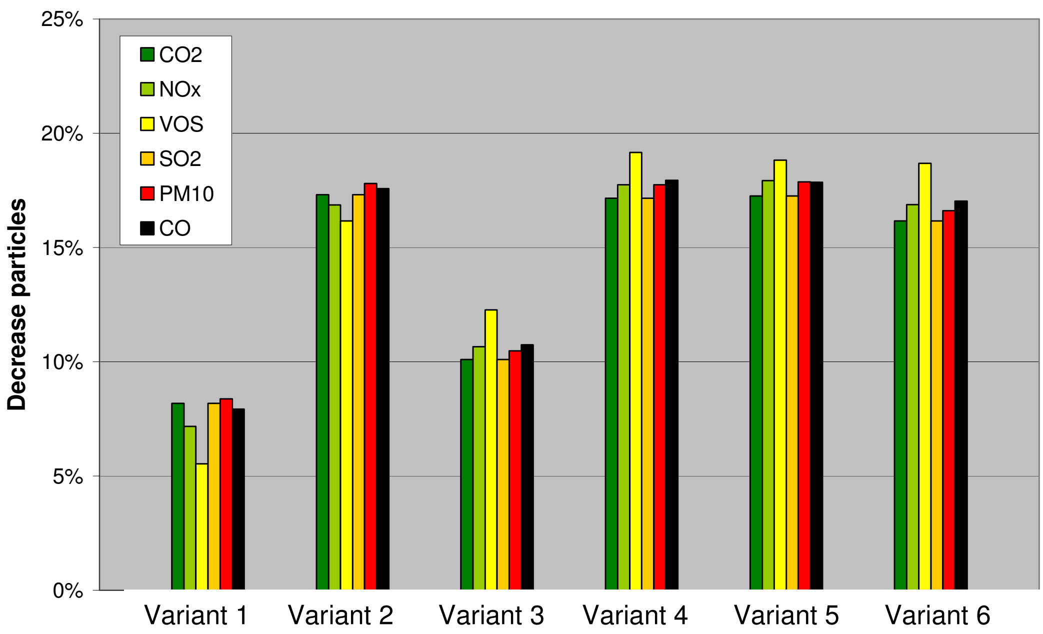


**Figure 7. Effects of the ticket tax on particle emissions**

## 5.2 Additional variants

In addition to these variants, another the effects for another 10 variants have been forecasted. These variants were merely variations on the variants discussed before. In several of these extra variants, the tax was differed for destinations within and outside Europe. Due to a lower tax for European destinations, the effect on this segment was mitigated, which was especially reduced the impacts for regional airports and for low cost airlines. Due to the higher ticket prices and the absence of alternatives, the effects on intercontinental destinations did not increase too much.

## 5.3 Final variant

In order to mitigate the effects of the ticket tax on the airlines and airports (particularly on Dutch regional airports), the government decided to implement a version that is very similar to version 1. It was decided that the tax would be € 11.25 for all destinations within 2500 kilometre, including all EU member countries) and € 45 for other destinations. An exception is made for countries with destinations on both sides of the 2500 km border. The low tax of € 11.25 also applies for other destinations in those countries, provided that they are not further away than 3500 km.

The effects of this variant are summarised in Table 8.

**Table 8. Effects of ticket tax (final variant)**

| | ***2003*** | ***2011*** *Average over four scenarios* | | ***Effect tax*** *minimum/maximum of scenarios in 2011* |
|---|---|---|---|---|
| | | *without tax* | *including tax* | |
| **Netherlands** | | | | |
| Total number of passengers (mio) | 41.0 | 55.6 | 50.9 | -8% to -10% |
| **Schiphol airport** | | | | |
| Total number of passengers (mio.) | 40.1 | 53.9 | 49.4 | -8% to -10% |
| *- OD passengers(mio.)* | *23.7* | *33.7* | *30.2* | *-10% to -11%* |
| *- Transfer passengers (mio.)* | *16.4* | *19.7* | *18.7* | *-4% to -8%* |
| Freight (Mton) | 1.3 | 1.9 | 1.9 | no change |
| Aircraft movements (× 1000) | 393 | 500 | 463 | -7% to -8% |
| **Regional airports** | | | | |
| OD passengers (mio.) *indicative only* | 0.9 | 1.7 | 1.5 | -11% to -13% |
| **Emissions** | | | | |
| Noise (Schiphol) | | | | -0.3 dBA |
| Particles during LTO (Schiphol) | | | | -3% tot -9% |

This tax took effect on 1 July 2008 and its consequences are already noticeable. The number of passengers departing from foreign airports is increasing according to travel agencies. One of these agencies (D-reizen) reports an increase of this number of 350% (Volkskrant, 2008a). Schiphol airport expects that passenger growth will stagnate (NRC 2008). KLM expects to loose half a million to a million passengers in 2008 (Volkskrant 2008b).

## 7. CONCLUSION

A change in the accessibility of a single airport (or a group of airports) can have large effects on the passenger choice of airports, especially if good alternatives are available. In this specific situation, the average ticket price for journeys departing from/arriving at a Dutch airport increases by about 5%.

Since the reduction in the number of passengers departing/arriving at Dutch airports is about 10%, the elasticity of demand is about -2 (of which about half is attributed to a switch to a foreign airport, while the other half is attributed to a growth reduction).

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