

Benefits of O/D and transfer traffic at Schiphol



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Executive summary

In 2016, O/D traffic at Schiphol contributed € 4.3 billion to national welfare. O/D traffic positively contributes to welfare through lower travel costs for passengers and agglomeration impacts for businesses. The average O/D passenger contributed almost 3 times more to welfare than the average transfer passenger.

Background

The Dutch Ministry of Infrastructure and Water Management is preparing a new Aviation White Paper (Luchtvaartnota). easyJet shall provide input for the White Paper, among other things regarding the benefits of air travel. Against this background easyJet requested SEO to assess the welfare contribution of O/D traffic at Schiphol. Welfare contains everything which is considered of value by Dutch society. It includes not only the impacts for Dutch passengers and businesses, but also the impacts on the climate and on local communities. The study draws upon earlier research to provide an up-to-date assessment of the welfare contribution of O/D traffic at Schiphol.

Previous research has shown all passenger segments at Schiphol contribute to Dutch welfare (SEO, 2017). Network carriers and mainport destinations contribute most to welfare in absolute terms, mainly due to their large share in total passenger traffic. The welfare contribution of low-cost traffic at Schiphol was estimated at almost € 1 billion per year (excluding climate impacts). Low-cost carriers mainly operate short-haul routes with O/D traffic. easyJet, being the main low-cost operator at Schiphol, is responsible for a large part of this welfare contribution. The study also showed that on a per-flight basis, low-cost carriers and leisure destinations contribute more to national welfare than network carriers and mainport destinations. This is mainly due to the fact that low-cost flights and flights to leisure destinations carry more Dutch passengers than flights operated by network carriers and flights to mainport destinations. Another study assessed the welfare contribution of transfer traffic at Schiphol (SEO, 2015). Transfer traffic contributes to national welfare in an indirect way. Transfer traffic allows the hub carrier to increase its network scope and density which benefits Dutch passengers and businesses.

The previous studies did not specifically quantify the welfare contribution of O/D traffic at Schiphol. This study fills that hiatus and includes the climate impacts along the way to provide a more comprehensive assessment of the welfare contributions of O/D and transfer traffic at Schiphol.

Results

Table S.1 presents the welfare contributions of O/D and transfer traffic at Schiphol in 2016. Both traffic segments positively contributed to national welfare. Schiphol's O/D traffic contributed € 4.3 billion to national welfare, around 9 times more than the € 0.5 billion contributed by transfer traffic. Part of this difference is explained by the fact that the airport handled around 3 times more return O/D passengers than return transfer passengers. This means that an average return O/D

passenger contributed around 3 times more to national welfare than an average return transfer passenger. This is partly explained by the fact that transfer passengers on average have a larger negative impact on the climate than O/D passengers.

Table S.1 O/D traffic at Schiphol contributes more to national welfare than transfer traffic

Welfare contribution (mln € per year, 2016 price level)		Passenger segment			
		O/D traffic	Transfer traffic	Total	(O/D share)
Impacts for Dutch passengers	Price	5	90	95	(5%)
	Network	1,112	211	1,323	(84%)
	Access journey	3,306	506	3,812	(87%)
	Subtotal	4,421	808	5,229	(85%)
Impacts for Dutch aviation businesses	Subtotal	+PM	+PM	+PM	
External impacts	Climate - CO ₂	-267	-241	-508	(53%)
	Climate - Other emissions	-160	-145	-305	(53%)
	Noise and air pollution	-PM	-PM	-PM	
	Safety	negligible	negligible	negligible	
	Subtotal	-428 -PM	-385 -PM	-813 -PM	(53%)
Indirect impacts	Agglomeration impacts	257	60	317	(81%)
	Employment and tourism	+/-PM	+/-PM	+/-PM	
	Subtotal	257 +PM	60 +PM	317 +PM	(81%)
Total		4,250 +/-PM	482 +/-PM	4,733 +/-PM	(90%)

Note: Due to rounding, numbers may not add up to the totals provided

Source: SEO Amsterdam Economics

Over the 2007-2017 period easyJet improved its fuel efficiency at Schiphol by 27%, around 3 percentage points above the average for Schiphol. As CO₂-emissions are linearly related to fuel consumption, this translates into a 27% reduction of CO₂-emissions per passenger kilometre. easyJet especially improved its fuel efficiency through investments in new aircraft technology, such as the Airbus A320neo. Increased load factors also added to its improved fuel efficiency.

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1 Introduction

The Dutch Ministry of Infrastructure and Water Management is preparing a new Aviation White Paper (Luchtvaartnota). Later this year, easyJet shall provide input for the White Paper, among other things regarding the benefits of air travel. Against this background easyJet requested SEO to assess the welfare contribution of O/D traffic at Schiphol.

The economic importance of Schiphol's network was first acknowledged in the 1980s. Since then, policy has focused on the selective development of its network. In 2008, the airport, its main user, the government and local communities agreed at the Alders Table that Schiphol could grow to 500,000 flight movements per year until 2020. At the same time Eindhoven Airport and Lelystad Airport would be developed as relievers for part of Schiphol's point-to-point leisure traffic. This would allow Schiphol to further develop its mainport traffic. The general idea behind this so-called Selectivity policy is that mainport related traffic generates most economic benefits and should therefore be accommodated at the nation's primary airport.

The economic relevance of Schiphol's network was confirmed by the 2009 Aviation White Paper. It defines network quality as: *'the availability of an extensive, worldwide, frequently operated network of destinations that contribute to the regional and national economy'* (Ministry of Transport, Public Works and Water Management, 2009). Various traffic segments and carriers contribute to Schiphol's network. Since its base-opening, easyJet has consistently expanded its network from Schiphol. It currently offers a dense network of links to primary destinations in Europe operated at high frequencies.

The Dutch Ministry of Infrastructure and Water Management is currently preparing a new Aviation White Paper (Luchtvaartnota). The White Paper will be sent to Parliament in the third quarter of 2019 and outlines the policy agenda for the coming years. easyJet would like to contribute to the White Paper, among other things regarding the benefits of O/D traffic. Against this background, easyJet requested SEO to assess the benefits that O/D traffic at Schiphol brings to Dutch society.

This report presents the contribution of O/D traffic to Dutch welfare. The study draws upon earlier research to provide an up-to-date assessment of the welfare contribution of O/D traffic at Schiphol. Welfare contains everything which is considered valuable by Dutch society. It includes not only the impacts of aviation for passengers and businesses, but also the impacts on the climate and local communities.

Reading guide

The following chapter describes in more detail how Schiphol's extensive route network contributes to national welfare and provides an overview of previous studies into this topic. Chapter 3 outlines the methodology used to assess the welfare contributions of O/D and transfer traffic and presents our findings.

2 Background

Welfare contains everything which is considered of value by Dutch society. It includes not only economic/ social impacts for Dutch passengers and businesses, but also impacts on the climate and local communities. Previous research has shown that all passenger segments contribute to welfare. On a per-flight basis, low-cost carriers and leisure destinations contribute more to national welfare than network carriers and mainport destinations. Transfer traffic contributes to welfare in an indirect way, by allowing the hub carrier to increase its network scope and density from which Dutch passengers and businesses benefit.

This chapter first describes how Schiphol's extensive route network contributes to national welfare. Secondly, it provides an overview of previous studies into the welfare contributions of individual passenger segments at Schiphol.

2.1 What constitutes national welfare?

National welfare contains everything that is considered of value by Dutch society. The welfare contribution of a specific traffic segment at Schiphol is assessed by estimating to what extent national welfare is reduced when the segment would no longer be accommodated at the airport. When a segment would no longer be accommodated, capacity is reduced which leads to higher travel costs for passengers. This reduces the attractiveness of Schiphol's catchment area as a business location and as a tourism destination. At the same time, a capacity reduction reduces the airport's impact on the climate and local communities. To estimate the total welfare contribution of Schiphol's traffic segments these aspects need to be taken into account. In this study the welfare contribution of Schiphol shall therefore be broken down into:

- Impacts for Dutch passengers;
- Impacts for Dutch aviation businesses;
- External impacts: noise, air pollution, climate and safety;
- Indirect impacts: productivity, employment and tourism.

These aspects are subsequently described in more detail in the remainder of this section.

2.1.1 Impacts for Dutch passengers

The extensive route network of Schiphol allows passengers to travel easily and at relatively low costs to many different destinations across the globe. The welfare contribution of a specific passenger segment at Schiphol is assessed by estimating to what extent travel costs for Dutch passengers increase when the market segment would no longer be accommodated at the airport. As mentioned above, this would result in less capacity which reduces passenger choice and competition, leading to higher air fares. Specific destinations may no longer be directly connected which means that passengers face a longer travel time.

Passengers may alter their travel behavior due to these increases in air fares and travel times. Some passengers may choose to depart from an alternative departure airport or take an indirect flight option. Others shall refrain from using air transport altogether. Such passenger choices can be simulated with a choice model. SEO uses its in-house developed NetCost passenger choice model to estimate the impacts of capacity changes on passenger choice. Passenger responses in combination with the change in total travel costs determines the welfare impact for passengers. The NetCost model is described in more detail in the following box.

NetCost passenger choice model

The NetCost passenger choice model simulates how passengers respond to changes in capacity and/or price. The model first identifies all direct flight alternatives available to passengers in the catchment area of Schiphol. This includes not only the direct flight alternatives from Schiphol, but also those from other airports in the Netherlands, the western part of Germany, Belgium and Luxembourg serving Schiphol's catchment area. These direct flight alternatives are sourced from OAG flight schedule data. Next, the model generates the indirect flight alternatives, by allowing connections between flights of the same airline or between flights of partnering airlines.

For each of these direct and indirect flight alternatives serving the Schiphol catchment area, the model estimates the associated total travel costs. The total travel costs include the air fare, the costs of the access journey to the airport and the travel time costs. Based on the total travel costs the model estimates the market share of each alternative.

Air fares are provided by an air fare module within the NetCost model. The air fare module is econometrically estimated on actual ticket sales for flights to and from Schiphol sourced from MIDT. The most important factors that influence the air fares are: flight distance, competition level, airline segment (full service carrier or low-cost carrier) and whether the flight is direct or indirect. Travel times are valued against the most recent travel time valuations for Dutch air travelers provided by the Kennisinstituut voor Mobiliteitsbeleid (KiM, 2013). The other model parameters are calibrated on passenger demand data for Schiphol, which are also sourced from MIDT.

The model distinguishes between leisure and business passengers. This is relevant as both travel motives value time and money differently, i.e. respond differently to changes in travel times and prices. Leisure passengers for instance are more price sensitive (and less time sensitive) than business passengers. When prices increase, leisure passengers are more likely to choose alternatives or refrain from using air transport than business passengers.

2.1.2 Impacts for Dutch aviation businesses

The capacity provided by Schiphol allows businesses in the aviation industry¹ to earn revenues and profits. The welfare contribution of Dutch aviation businesses consists of any excessive profits that they are able to make. When a specific traffic segment would no longer be accommodated at

¹ The welfare impacts for businesses that use air transport are included in the impacts for passengers. As mentioned above, these include the impacts for business passengers. Increases in travel costs, raise production costs for businesses, resulting in less profits. Including such benefits also in the impacts on businesses, would lead to double counting of impacts. Apart from the impacts on travel costs, businesses may benefit from so-called agglomeration impacts (see section 2.4.1).

Schiphol, this may lead to diseconomies of scale and/or the deployment of capacity on less profitable markets. This will likely reduce profitability. This reduction is difficult to quantify as it requires detailed insight into the cost structure and revenues of individual businesses which is generally not publicly available.

For Schiphol we assume that it does not make excessive profits on its aeronautical activities as its charges are regulated. The airport can make excessive profits on its non-aeronautical activities. However, these profits are eventually returned to Dutch society through dividends to public shareholders. This therefore merely represents a shift between groups and not so much a change in total welfare.

For airlines we assume that they do not make excess profits as they generally operate in a competitive environment. Capacity restrictions at airports however may allow airlines to charge higher fares, depending on whether or not demand can be met through up gauging and increasing load factors. Given the fact that Schiphol only recently (end of 2017) reached its cap of 500,000 movements and part of the growth has since then been accommodated through the deployment of larger aircraft and load factor increases, we reckon that excess profits (if any) are still relatively small at Schiphol.

2.1.3 External impacts

Although aviation brings positive impacts to consumers and businesses, it also generates negative impacts on the climate and for local communities (noise, air pollution and safety issues). As these impacts are largely unpriced, they are called external impacts.

Climate impacts

Aircraft engines produce various types of emissions which have different impacts on global warming and climate change. CO₂-emissions contribute most to climate change and its impacts are scientifically best understood. Non-CO₂ emissions, such as NO_x, water vapor, sulphate and soot can either have a warming or cooling effect.² Their impact on climate change is less well understood by the scientific community than the impact of CO₂-emissions. Because of their lower scientific understanding, they are sometimes neglected or estimated through a multiplier on the CO₂-impacts. According to Lee et al. (2010) this multiplier lies between 1.2 and 2.0 (depending on whether the impacts of cirrus clouds are included or not).

When a specific segment is no longer accommodated at Schiphol, aircraft emissions are reduced. Some passengers shall refrain from using air transport (see section 2.1.1), also reducing emissions in the access/egress trip to/from the airport. Other passengers may substitute to other (more distant) airports which may increase aircraft emissions at those airports and lead to an increase in emissions during the access/egress trip to/from the airport. These impacts are however difficult

² NO_x does not directly contribute to global warming, but does have an indirect impact. Emitted at high altitude NO_x leads to the forming of O₃. Although this is a strong greenhouse gas, it is short lived and only has local impacts. NO_x also has a cooling impact, as it breaks down another greenhouse gas CH₄. Water vapor (H₂O) can have a warming impact at high altitudes. Sulphate and soot respectively have short lived cooling and warming impacts. Contrails may lead to the forming of cirrus clouds which has a warming impact (CE Delft, 2014).

to quantify due to a lack of data on how passengers within each travel segment travel to the airport and alternative travel modes used by passengers that refrain from using air transport.

Local impacts

Although people living in the vicinity of Schiphol benefit from the closeness of the airport in terms of travel costs and times (included in the impacts for passengers), local communities are also negatively affected by the airport due to noise, air pollution and safety issues. Previous research has shown that these impacts are relatively small compared to the impacts on climate change (Decisio et al., 2014). To illustrate, a recent social cost-benefit analysis on various airport expansion options for The Netherlands showed that the climate impacts constitute 72-98% of the total external impacts, depending on the economic growth scenario and the expansion option considered (Decisio and SEO, 2018).

It should be noted however that although the impacts of Schiphol on local communities are relatively small compared to the climate impacts, they are largely concentrated within a small spatial area around the airport. Close to the airport, noise, air pollution and safety may therefore have a large local impact.

2.1.4 Indirect impacts

Productivity

Research has shown that businesses become more productive when they are located near other specialized businesses. This implies that economies of density exist, also known as ‘agglomeration impacts’. Economic density increases productivity through:

- **Technology and knowledge spillovers:** Businesses are more likely to ‘learn’ from each other’s innovations when they are located in each other’s vicinity;
- **Better access to inputs (products and labor):** Businesses can choose from a wider set of inputs and suppliers when located in agglomerations with other businesses. This allows them to increase the efficiency of their production process. Increased choice also leads to more competition between suppliers, reducing production costs.

In 2017 it was announced that the European Medicines Agency (EMA) would relocate from London to Amsterdam. Various factors contributed to this decision, such as the high education level, attractiveness of living and good accessibility of the Netherlands. The latter factor reduces travel costs for the EMA; this impact is already included in the impacts for passengers. However, when the arrival of EMA leads to additional companies relocating to Amsterdam or the Netherlands, this could increase productivity within the medical industry. In London around 2,000 medical companies located around the old EMA-building (Trouw, 2019).

As mentioned above, travel costs increase when a specific traffic segment is no longer accommodated at Schiphol. For businesses these higher travel costs translate into higher production costs and lower profits. These impacts are included in the impacts for (business) passengers (see section 2.1.1). Because of these cost increases, the region surrounding the airport becomes less attractive as a business location. When a company decides to leave the region as a result of the higher travel costs, economic density decreases and the productivity of the remaining

businesses is negatively affected. This ‘agglomeration impact’ is additional to the impacts for (business) passengers.

For other modalities, the ‘agglomeration impact’ is estimated at 0-30% of the impact for passengers. The Central Planning Bureau (CPB) proposes to value these impacts at 15% of the impacts for business passengers.

Employment

The aviation industry and its suppliers contribute to national employment. When a traffic segment would no longer be accommodated at Schiphol and capacity is not taken over by other segments, employment within the aviation industry is reduced. As a result, the unemployment level increases which leads to lower (income) tax revenues and higher governmental expenditure on unemployment benefits, reducing national welfare. However, in a well-functioning labor market with a low unemployment level, which we have in the Netherlands, most people shall quickly find another job. The unemployment impact therefore is short-lived and the net impact is limited. The impact lasts longer when the economy worsens and the unemployment rate increases. Previous research has shown that increases or reductions in employment within the aviation industry have a relatively small impact on national welfare (Decisio et al., 2014; Decisio and SEO, 2018).

Tourism

Inbound tourists spend money in the Dutch economy. This increases the profitability of Dutch companies which translates into more welfare. When a specific traffic segment is no longer accommodated at Schiphol, travel costs for passengers increase (see section 2.1.1). As a result, the Netherlands becomes less attractive for inbound tourists to visit, which reduces the spending of foreign tourists in the Dutch economy. At the same time, the increase in travel costs may reduce outbound tourism. This means that local residents will spend more in the Netherlands and less abroad. According to the Worldbank the number of Dutch outbound tourists (and their spending) is almost equal to the number of inbound tourists (and their spending) visiting the Netherlands. This indicates that the lower spending by inbound tourists will be largely offset by the higher spending of local residents.

2.2 Literature review

This section provides an overview of recent studies into the welfare contributions of various passenger segments at Schiphol. As the studies assessed the same type of impacts and were based on the same methodology, they are comparable in terms of impacts. It should however be borne in mind that the studies represent different years.

2.2.1 Study on the welfare contribution of various passenger segments

In 2017 the Dutch Ministry of Infrastructure and Water Management commissioned SEO to conduct a study into the welfare contribution of various market segments at Schiphol.³ The market segmentation was based on:

³ This study is currently being updated, but the results were not publicly available at the time of publication.

- **Business model:** Network carriers and low-cost carriers. Low-cost carriers mainly operate short-haul routes with O/D traffic, whereas network carriers operate both short- and long-haul routes with a mix of O/D and transfer passengers;
- **Type of destination:** Mainport destinations and leisure destinations. The list of mainport destinations was compiled by the Ministry based on various criteria.⁴ The study used 2016 data and focused on the welfare contributions for passengers and businesses. The external impacts were not quantified.

The study shows that all passenger segments contribute to Dutch welfare. Network carriers in absolute terms contribute 3.5 times more to national welfare than low-cost carriers (see Table 2.1).⁵ This is largely attributable to the fact that 80% of all flights at Schiphol were operated by network carriers in 2016, whereas low-cost carriers operated around 20% of all flights. Hence, network carriers operate 4 times more flights than low-cost carriers but contribute 3.5 times more to national welfare. This means that an average low-cost flight contributes more to national welfare than an average flight operated by a network carrier.

Table 2.1 All passenger segments contribute to Dutch welfare

Welfare contribution (mln € per year, 2016 price level)		Business model		Destination type	
		Network carriers	Low-cost carriers	Mainport	Leisure
Impacts for Dutch passengers	Price	100	23	91	4
	Network	889	231	1,198	125
	Access journey	2,288	693	3,270	542
	Subtotal	3,277	947	4,558	671
Impacts for Dutch aviation businesses	Subtotal	+PM	+PM	+PM	+PM
External impacts	Climate - CO ₂	-PM	-PM	-PM	-PM
	Climate - Other emissions	-PM	-PM	-PM	-PM
	Noise and air pollution	-PM	-PM	-PM	-PM
	Safety	negligible	negligible	negligible	negligible
	Subtotal	-PM	-PM	-PM	-PM
Indirect impacts	Agglomeration impacts	214	42	304	13
	Employment and tourism	+PM	+PM	+PM	+PM
	Subtotal	214 +PM	42 +PM	304 +PM	13 +PM
Total		3,491 +/-PM	989 +/-PM	4,862 +/-PM	684 +/-PM

Note: Due to rounding, numbers may not add up to the totals provided

Source: SEO Amsterdam Economics, 2017

⁴ Destinations were labelled as mainport destinations when at least one of the following criteria applied: (1) the destination is a national capital or (2) at least 10% of all passengers travelling to the destinations transferred at Schiphol or (3) the flight distance was shorter than 700 kilometres or longer than 4,000 kilometres. This definition was initially used by the Dutch government in the application of the Traffic Distribution Rule (TDR) for Lelystad. The definition was however rejected by the European Commission. In a revised application the only criterion that remained was the 10% transfer criterion (Ministry of Infrastructure and Water Management, 2019). This means that under the current definition fewer destinations are labelled as mainport destinations and the share of mainport destinations therefore has decreased. The definition does not necessarily optimize national welfare.

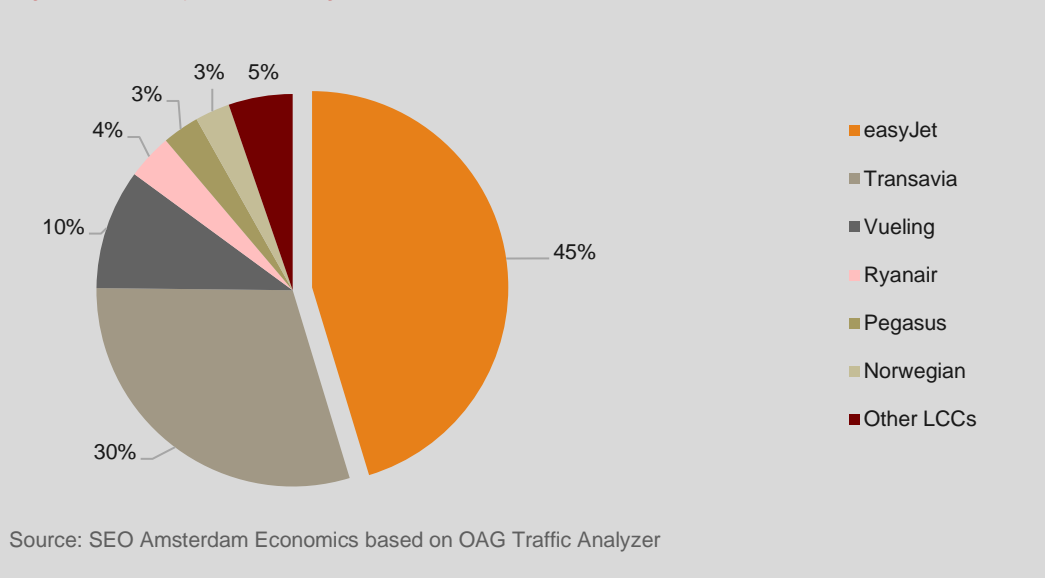
⁵ The following airlines operating out of Schiphol were labelled as low-cost: easyJet, Ryanair, Vueling, Norwegian, WOW Air, Air Arabia, Transavia, Eurowings, Germanwings, Jet2.com, Pegasus and Onur Air.

easyJet's contribution to national welfare

The 2017 study did not assess the welfare contributions of individual airlines. However, based on easyJet's share of Schiphol's low-cost traffic at Schiphol we can make a rough estimation of its share in the welfare contribution of low-cost traffic.

Figure 2.1 shows that easyJet is the largest low-cost carrier at Schiphol in terms of passenger traffic. In 2016 it had a share of 45% in Schiphol's low-cost traffic. As opposed to other low-cost carriers, easyJet's business model focuses on connecting primary airports at high frequencies. This allows easyJet to capture a larger share of the business market than other low-cost carriers. As business passengers contribute more to national welfare than leisure passengers (due to their higher valuation of time), this means that easyJet's share in the total welfare contribution of low-cost carriers is likely higher than 45%.

Figure 2.1 easyJet is the largest point-to-point carrier at Schiphol, 2016



The study also showed that mainport destinations contribute 7 times more to national welfare than leisure destinations. Again this is mainly due to the large share of flights to mainport destinations: in 2016 around 90% of all flights departing from Schiphol was bound for a mainport destination. Hence, although 9 times more flights were bound for mainport destinations, these destinations contributed 7 times more to national welfare. An average flight to a mainport destination therefore contributes less to national welfare than an average flight to a leisure destination.

The larger contribution of low-cost flights and flights to leisure destinations is explained by various factors:

- Share of Dutch passengers:** The most important explanatory factor is the share of Dutch passengers. As outlined in section 2.1, welfare includes everything that is valued by Dutch society, i.e. Dutch passengers, businesses and citizens. Welfare impacts for foreign passengers and businesses are excluded from a welfare analysis for the Netherlands. A larger share of seats on low-cost flights and flights to leisure destinations is occupied by Dutch passengers than on flights operated by network carriers and to mainport destinations. This translates into a larger welfare contribution for low-cost flights and flights to leisure destinations.

The share of Dutch passengers on flights operated by network carriers and to mainport destinations is lower than on low-cost flights and flights to leisure destinations. This is mainly due to the fact that flights operated by network carriers and to mainport destinations are occupied by a large share of (foreign) transfer passengers. In an indirect way these transfer passengers do contribute to Dutch welfare, as they allow the network carriers to operate at higher frequencies and to more (intercontinental) destinations. Dutch passengers benefit from this increased network size in terms of lower travel costs (see section 2.1.1);

- **Share of business passengers:** Business passengers value time savings more than leisure passengers. A one hour travel time reduction (either by a reduction in flight time or access time) for a Dutch business passenger therefore adds more to national welfare than for a Dutch leisure passenger. Although the share of business passengers is relatively high on flights operated by network carriers compared to low cost carriers and on flights to mainport destinations compared to flights to leisure destinations, this would include total business passengers including those who are transferring. Network carriers would therefore have a smaller proportion of O/D passengers, of which a smaller segment is Dutch business passengers. Since the average number of Dutch business passengers is relatively low on flights operated by network carriers and to mainport destinations, this adds to the lower welfare contribution per flight.

As mentioned in the previous box, easyJet's business model is focused more on the business market than the models used by other low-cost carriers. As easyJet is focused on O/D flights, it therefore carries relatively more Dutch business passengers per flight than network carriers which adds to the larger welfare contribution per flight than network carriers and other low-cost carriers. The contributions of individual airlines have not been estimated however;

- **Available alternatives:** Destinations that are only offered by one operator contribute relatively more to national welfare than destinations that are offered by multiple operators. When a unique destination is no longer offered from Schiphol, passengers will need to depart from a (more distant) airport or travel indirect, which increases travel costs and reduces welfare. Network carriers offer relatively many direct and indirect flights to unique intercontinental destinations. This translates into relatively large welfare benefits per passenger. It should be noted however that flights to intercontinental destinations generate more emissions, which offsets part of the welfare impacts for passengers;
- **Average aircraft size and load factor:** The welfare contribution per flight also depends on the size of the aircraft and the load factors that are achieved. The larger the aircraft and the higher the load factors, the more Dutch passengers can theoretically be transported per flight. Network carriers operate a diverse fleet of aircraft consisting of regional jets, narrow body and wide body aircraft to operate short-, medium- and long-haul routes. Low-cost carriers on the other hand generally operate only one type of aircraft. At Schiphol, low-cost carriers on average operate slightly larger aircraft than the network carriers. Furthermore, low-cost carriers are also operating at higher load factors. This means that per flight more passengers are carried. Flights to leisure destinations are also operated by larger aircraft than flights to mainport destinations.

To summarize, low-cost flights and flights to leisure destinations contribute more to national welfare than flights operated by network carriers and to mainport destinations. This is explained by the fact that flights operated by low-cost carriers and to leisure destinations are occupied by more (Dutch) passengers. The fact that flights by network carriers and to mainport destinations are occupied by a larger share of business passengers and are more unique, contributes positively

to the welfare they provide, but this does not compensate for the relatively low share of Dutch passengers carried.

2.2.2 Study on the welfare contribution of transfer traffic

Transfer passengers contribute to national welfare in an indirect way; they allow network carriers to operate at higher frequencies and to more (intercontinental) destinations. Dutch O/D passengers benefit from this increased network scale and scope in terms of lower travel costs.

In 2015 the Dutch Ministry of Infrastructure and Water Management commissioned a study to assess the impacts if Schiphol would lose (part of) its hub function (SEO Amsterdam Economics, 2015). The study analyzed three scenarios:

- **Complete loss of the hub function:** Schiphol would lose all transfer passengers and only serve O/D-passengers;
- **Network rationalization:** The hub carrier would reduce its network by 50%;
- **Consolidation at Paris:** The hub carrier would shift part of its operations to Paris Charles de Gaulle as part of its dual-hub strategy. This included the flight operations that were only served from Schiphol, but for which the local market demand from Paris was larger.

The impacts of these scenarios on national welfare were calculated based on 2013 data. Again the focus was on the impacts for passengers and businesses; the external impacts were not quantified. The findings of the study are presented in Table 2.2.

Table 2.2 Loss of transfer traffic reduces national welfare

Welfare impact		Scenario		
(mln € per year, 2013 price level)		Complete loss of hub function	Network rationalisation	Consolidation at Paris
Impacts for Dutch passengers	Price	-66	-20	9
	Network	-154	-46	-36
	Access journey	-370	-78	-31
	Subtotal	-590	-145	-59
Impacts for Dutch aviation businesses	Subtotal	+PM	+PM	+PM
External impacts	Climate - CO ₂	+PM	+PM	+PM
	Climate - Other emissions	+PM	+PM	+PM
	Noise and air pollution	+PM	+PM	+PM
	Safety	negligible	negligible	negligible
Indirect impacts	Subtotal	+PM	+PM	+PM
	Agglomeration impacts	-44	-11	-5
	Employment and tourism	- PM	- PM	- PM
	Subtotal	-44 - PM	-11 - PM	-5 - PM
Total		-634 +/- PM	-156 +/- PM	-63 +/- PM

Note: Due to rounding, numbers may not add up to the totals provided

Source: SEO Amsterdam Economics, 2015

It shows that when Schiphol loses (part of) its hub function, national welfare is reduced. A reduction in network scope and density leads to higher travel costs for Dutch passengers, making

the region surrounding the airport less attractive for businesses to locate to and for tourists to visit. When Schiphol would lose its entire hub function and therefore all of its transfer passengers, the total welfare loss would amount to over € 600 million per year (2013 price level). In other words, the indirect contribution of transfer passengers to the benefit of local O/D passengers was estimated at over € 600 million per year. As transfer passengers are predominantly carried by network carriers and to mainport destinations, the contribution of transfer passengers to the welfare of Dutch O/D passengers is mainly included in the contribution of network carriers and mainport destinations (see Table 2.1).

3 Welfare contribution of Schiphol

In 2016, O/D traffic at Schiphol contributed € 4.3 billion to national welfare. O/D traffic positively contributes to welfare through lower travel costs for passengers and agglomeration impacts for businesses. The average O/D passenger contributed almost 3 times more to welfare than the average transfer passenger.

Previous studies did not specifically quantify the welfare contribution of O/D. In this chapter we fill that hiatus and include the climate impacts to provide a more comprehensive assessment of the welfare contribution of O/D and transfer traffic at Schiphol. Section 3.1 outlines the methodology used. Section 3.2 presents the findings.

3.1 Methodology

The analysis partly builds upon the previous research described in section 2.2 and extends it by incorporating the climate impacts. The analysis consists of the following steps:

1. Calculate Schiphol's total welfare contribution (excluding climate impacts);
2. Calculate the welfare contribution of O/D and transfer traffic;
3. Calculate the climate impacts of O/D and transfer traffic.

Each of these steps is described in more detail below:

Step 1: Calculate Schiphol's total welfare contribution (excluding climate impacts)

The 2017 study described in section 2.2.1 shows the welfare contributions of network carriers versus low-cost carriers and of mainport destinations versus leisure destinations using 2016 data. We use the findings from this study to calculate Schiphol's total welfare contribution.

Adding the welfare contributions of the network carriers and low-cost carriers would lead to an underestimation of Schiphol's total welfare contribution. This is because: (1) it does not include the welfare contribution of charters and (2) network carriers and low-cost carriers serve overlapping markets. The latter means that when either network carriers or low-cost carriers would no longer be accommodated at Schiphol, certain destinations would still be served by the other business model (albeit at higher costs due to extended travel times and/or higher air fares due to less competition). When both business models would no longer be present at Schiphol, most passengers would need to depart from more distant airports, which would significantly increase travel costs and reduce welfare. The welfare contribution of all carriers operating at Schiphol is therefore larger than the sum of the contributions of the individual business models.

The welfare contributions of mainport and leisure destinations can be added to obtain Schiphol's total welfare contribution, as (1) also the flights of charters to these destinations are included and

the destinations are mutually exclusive.⁶ The total welfare contribution of Schiphol is therefore obtained from the 2017 study by summing the last two columns of Table 2.1.

Step 2: Calculate the welfare contributions of O/D and transfer traffic

The 2015 study presented in section 2.2.2 quantified the welfare contribution of Schiphol's transfer traffic based on 2013 data. The total welfare contribution of Schiphol (calculated in step 1) is however based on 2016 data. To be able to compare the findings of these studies, we need both studies to represent the same year.

Therefore we update the findings from the 2015 study regarding the contribution of transfer traffic to represent 2016 based on the market developments that occurred between 2013-2016.⁷ Relevant market developments that have influenced the contribution of transfer traffic to national welfare are the:

- **Increase in local traffic:** The hub carrier increased its O/D traffic by around one third over the 2013-2016 period;
- **Reduction in the share of transfer traffic:** The hub carrier's growth in O/D traffic outpaced the growth in transfer traffic by 2:1 over the 2013-2016 period.

This means that an increasing number of local passengers and businesses benefitted from the increased network scope and density. This increased scope and density is partly made possible by transfer traffic, but the contribution of transfer traffic to network development has declined, i.e. the network has become less dependent upon transfer traffic.

We correct for these factors to estimate the welfare contribution of transfer traffic in 2016. Furthermore, we adjust the price level from 2013 to 2016 by using the development in the consumer price index for aviation over this period. Subsequently, the welfare contribution of Schiphol's O/D traffic in 2016 is calculated by deducting the contribution of transfer traffic from Schiphol's total welfare contribution (from step 1).

Step 3: Calculate the climate impacts of O/D and transfer

The 2015 and 2017 studies did not quantify the climate impacts. However, as these impacts take an increasingly prominent role in policy debates about the future growth of air traffic, we shall include them in this study. This results in a more comprehensive overview of the total welfare contribution of O/D and transfer traffic.

CO₂-emissions are linearly related to fuel consumption: burning one kilogram of fuel leads to 3.15 kilograms of CO₂ (Eurocontrol, 2018; Larsson et al., 2018). This means that CO₂-emissions for specific traffic segments can be assessed by calculating their fuel consumption and multiplying this by 3.15. Some studies only include emissions during the Landing/Take-off phase (LTO). This leads to an underestimation of total emissions, especially for longer flights. This study takes the emissions during all flight phases (Landing/Take-off (LTO), climbout, cruise and descent) into account.

⁶ From Table 2.1 it becomes clear that the sum of the welfare contributions of both destination types is indeed higher than the sum of the welfare contributions of the business models.

⁷ A full update of the 2015 study was not feasible within the timeframe of this study.

How emissions of international flights are allocated to individual countries is far from obvious. This issue is discussed since the 1990s and various options have been proposed, i.e. based on where the jet fuel is sold, based on where the emissions occur, or based on the country of residence of the passenger (Larsson et al., 2018). Generally, aviation emissions are allocated to the country of departure. We follow this approach. This means that all emissions of flights departing from Schiphol are taken into account. Emissions of arriving flights are assigned to the country of origin to prevent double counting. This is in line with how countries report their CO₂-emissions to the UNFCCC. Dutch emissions from aviation are calculated based on fuel deliveries to the Dutch airports, which should represent the total fuel consumption of flights departing from Dutch airports (CE Delft, 2018).

We use our in-house developed emissions model to calculate fuel consumption and CO₂-emissions for individual passenger flights departing from Schiphol in 2016 sourced from OAG's Schedule Analyser. For each passenger flight, the model calculates the fuel consumption and emissions in the various flight phases: Landing/Take-off (LTO), climbout, cruise and descent. To do so, the model specifically takes aircraft and engine types into account.

Next, fuel consumption and emissions for individual flights are assigned to O/D and transfer traffic based on their shares in those flights. The share of O/D and transfer traffic on individual flights is calculated using passenger OAG Traffic Analyser data. The average transfer share for Schiphol in 2016 appeared slightly higher than the figure provided by Schiphol in its Traffic Review (Schiphol, 2017). Therefore we scaled the transfer shares for the individual flights such that the average transfer share corresponded to the figure published by Schiphol.

The CO₂-emissions of departing flights are monetized (expressed in euro's) through multiplication with the social cost of carbon. A range of valuations for carbon exist (Lieshout, 2018). In the Netherlands a value of € 48 per ton (excluding VAT, price level 2015) is recommended given the current climate policy (CE Delft, 2017). We convert this value to the 2016 price level using the consumer price index for aviation and apply 18% VAT as suggested by Koopmans et al. (2016).

The climate impacts of non-CO₂ emissions are included by using a multiplier on the CO₂-impacts. As mentioned in section 2.1.3 this multiplier ranges between 1.2 and 2.0. We use the intermediate value of 1.6, i.e. the additional climate impacts of non-CO₂ emissions are estimated at 60% of the impacts of CO₂-emissions.

3.2 Results

This section contains the findings of our analysis. Section 3.2.1 presents the overall welfare contributions of O/D and transfer traffic at Schiphol. Section 3.2.2 discusses the findings in more detail.

3.2.1 Overall contribution

Both O/D and transfer traffic at Schiphol contribute positively to national welfare (see Table 3.1). In 2016, O/D traffic contributed € 4.3 billion to national welfare; transfer traffic contributed € 0.5 billion. This implies that the contribution of O/D was almost 9 times higher than the contribution

of transfer. Part of this difference is explained by the fact that the airport handled around 3 times more return O/D passengers than return transfer passengers. This means that an average return O/D passenger contributed around 3 times more to national welfare than an average return transfer passenger.

Table 3.1 O/D traffic at Schiphol contributes more to national welfare than transfer traffic

Welfare contribution (mln € per year, 2016 price level)		Passenger segment			
		O/D traffic	Transfer traffic	Total	(O/D share)
Impacts for Dutch passengers	Price	5	90	95	(5%)
	Network	1,112	211	1,323	(84%)
	Access journey	3,306	506	3,812	(87%)
	Subtotal	4,421	808	5,229	(85%)
Impacts for Dutch aviation businesses	Subtotal	+PM	+PM	+PM	
External impacts	Climate - CO ₂	-267	-241	-508	(53%)
	Climate - Other emissions	-160	-145	-305	(53%)
	Noise and air pollution	-PM	-PM	-PM	
	Safety	negligible	negligible	negligible	
	Subtotal	-428 -PM	-385 -PM	-813 -PM	(53%)
Indirect impacts	Agglomeration impacts	257	60	317	(81%)
	Employment and tourism	+/-PM	+/-PM	+/-PM	
	Subtotal	257 +PM	60 +PM	317 +PM	(81%)
Total		4,250 +/-PM	482 +/-PM	4,733 +/-PM	(90%)

Note: Due to rounding, numbers may not add up to the totals provided

Source: SEO Amsterdam Economics

3.2.2 Discussion

Impacts for Dutch passengers

Price impacts

The price impacts of transfer traffic are larger than for O/D. When Schiphol would no longer accommodate O/D traffic, it is no longer a competitor to other airports in the O/D market. The resulting price impacts are therefore limited to those at neighboring airports. The price impacts appear relatively small. This is in line with scientific literature which shows that price impacts of airlines competing head-to-head from the same airport are larger than price impacts of airlines competing from adjacent airports (Brueckner et al., 2013). However, when transfer traffic is lost, O/D passengers still have flight alternatives available to them from Schiphol. In this case, competition between airlines operating at Schiphol is reduced which has a larger impact on air fares.⁸

Network and access impacts

The network and access impacts for Dutch passengers are however larger for O/D than for transfer. In case O/D would no longer be accommodated at Schiphol, all O/D passengers would

⁸ This also explains why the price impacts for Dutch passengers are higher when only part of Schiphol's traffic, such as low-cost or leisure traffic, is no longer accommodated (see Table 2.1).

need to substitute to an alternative (more distant) airport or refrain from using air transport altogether. In the former case, this leads to a significant increase in access/egress times to/from the airport and therefore increased travel costs (represented by the access impact). Furthermore, passengers would more often have to travel indirectly from those other airports as these airports offer less direct connections than Schiphol currently does. This also adds to travel time and travel costs (represented by the network impact).

When transfer traffic would no longer be accommodated, Schiphol's network would decline, but many destinations will still be offered from the airport. As a result, fewer passengers would need to use alternative (more distant) airports or travel indirect. This translates into a smaller impact on travel times and travel costs.

Impacts for Dutch aviation businesses

Section 2.1.2 outlined that it is unlikely that Schiphol makes excessive profits on its aeronautical activities due to the regulation of its charges. Any excessive profits on non-aeronautical activities flow back to society through dividends and therefore merely represent a shift in welfare between groups and not so much a change in total welfare.

For airlines it is assumed that they operated in a competitive environment, which prevents them from making excessive profits. Although capacity restrictions at airports may allow airlines to charge higher fares, Schiphol had not reached its maximum capacity in 2016 (the year on which the study is based). For these reasons, we predict that excessive profits to Dutch aviation businesses are negligible and therefore are not quantified.

External impacts

Climate impacts

Although the share of O/D traffic at Schiphol was around 62% in 2016, its share in total CO₂-emissions and therefore in the total climate impacts was only 53%. This means that an average O/D passenger movement has a smaller impact on the climate than an average transfer passenger movement. In terms of return passengers the difference is even more pronounced, because a return O/D passenger generates two movements, whereas a return transfer passenger is responsible for four movements. As a result, a return transfer passenger has a three time larger impact on the climate than a return O/D passenger. This is explained by the fact that transfer passengers on average travel over longer distances and their trips involve an additional landing and take-off. The larger impact of transfer passengers on the climate partly explains why transfer contributes less to national welfare than O/D.

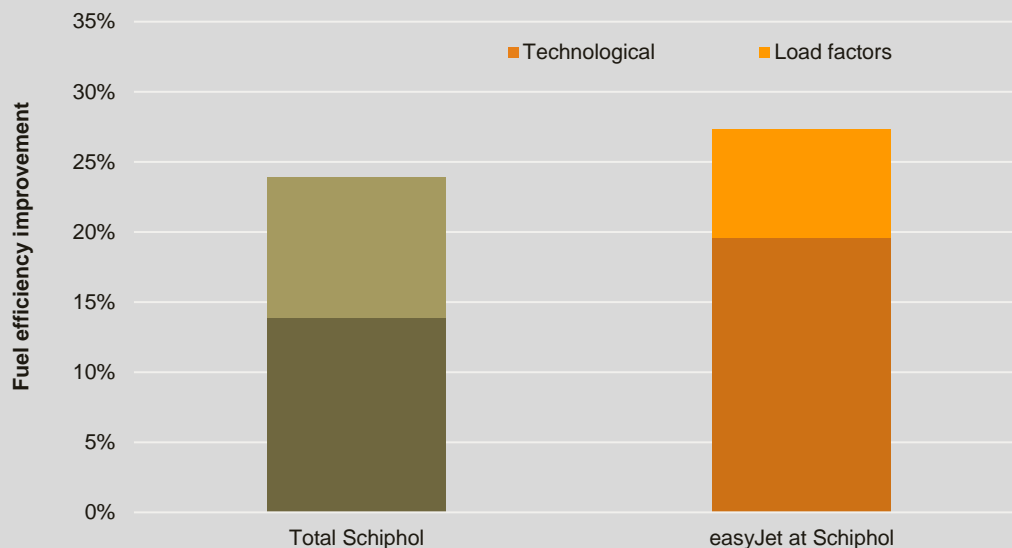
Local impacts

As outlined in section 2.1.3, noise, air pollution and safety are concentrated close to the airport. Such impacts may therefore have a large impact on local areas, but in terms of overall welfare these impacts are relatively limited compared to the climate impacts and impacts for passengers and businesses. Therefore the local impacts were not quantified. Doing so would not alter the conclusions of the study.

Fuel efficiency improvements at Schiphol

Figure 3.1 shows that Schiphol's fuel efficiency, defined as the fuel consumption per revenue passenger kilometre (RPK), has improved by 24% over the 2007-2017 period. The improvement realised by easyJet over the same period was 3 percentage points higher: 27%. As CO₂-emissions are linearly related to fuel consumption (see section 3.1), this means that easyJet reduced its CO₂-emissions per passenger kilometre at Schiphol by 27%.

Figure 3.1 easyJet's fuel efficiency improved more than that of other carriers at Schiphol



Source: SEO Amsterdam Economics

easyJet especially improved its fuel efficiency through investments in new aircraft technology. Increased load factors further contributed to the airline's improved fuel efficiency. Compared to other carriers at Schiphol, higher load factors contributed less to easyJet's fuel efficiency improvement. This is explained by the fact that easyJet was already operating at a relatively high load factor in 2007.

Indirect impacts

Agglomeration impacts

As mentioned above, both O/D and transfer traffic contribute to lower travel costs for passengers. When a specific segment is no longer accommodated at Schiphol, travel costs increase and the region around the airports becomes less attractive for businesses to locate to. Some companies may decide to relocate to other regions as a result. These impacts are captured by the impacts for Dutch (business) passengers. Because of such relocation decisions, other companies in the region may become less productive. To what extent this is the case depends on the number of relocations which in turn depends on the extent to which travel costs for business passengers increase. This explains why the agglomeration impacts are largely proportional to the impacts for Dutch passengers.

Employment and tourism

When Schiphol would no longer accommodate specific traffic segments, employment at the airport and its suppliers decreases. Section 2.1.4 outlined that any employment impacts of a capacity change are probably short-lived due to the fact that the Netherlands has a well-functioning labor market with low unemployment. Impacts may last longer when the economy worsens and the unemployment rate increases. Furthermore, increases in travel costs reduce inbound, but also outbound tourism. As the number of tourists visiting the Netherlands (inbound tourism) is almost equal to the number of local residents visiting foreign countries (outbound tourism), the reduced spending of visiting tourists largely offsets the increased spending of local residents. The employment and tourism impacts are therefore considered to be relatively small and therefore have not been quantified.

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