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ESTIMATION OF THE WELFARE IMPACT OF AIRLINE FLIGHT SCHEDULE CHANGES WITH NETSCAN

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Introduction

The performance of airline networks may be assessed using distinct types of indicators. Most benchmark analyses between airports or airlines use relative simple, easy to communicate indicators, such as number of destinations and frequencies of direct connections to particular destinations. But also indirect connections contribute significantly to the accessibility by air between airports and regions. Moreover, the large hubs and their airlines focus particularly to indirect connections, as these are indispensable to retain particular market shares.

The performance and quality of networks, including indirect connections, are less easy to communicate, but models have been developed to monitor this. Network quality in general is assessed in two types of models. Firstly, by looking at "*connectivity*": a representation of the physical characteristics of connections: number of frequencies weighted by their *quality*. Quality is defined here as how fast the connection is and this quality is represented by an index. This *quality index* ranges from 1 (one) for direct connections with the shortest possible travel time, to 0 (zero) when travel time (of indirect connections) exceeds particular predefined limits. These connectivity values are determined by the *NetScan-model*, presented and applied at distinct occasions[1] [2].

The other method of measuring network quality looks at "*generalised travel costs*". Generalised travel costs are representations of all travel inconveniences, including travel time, waiting time for the next flight and airfares. All these travel attributes can be determined by analyzing the OAG-schedules. Only information on airfares is not available, but these airfares are approximated by looking to travel distance, type of connection (direct or indirect) and competition level. The latter attributes can be estimated from the OAG-schedules. The conversion into generalised travel costs is made in the *NetCost-model* [3]. By using these travel costs of connections, an assessment can be made of consumer benefits for distinct airline network, their attractiveness and hence their likelihood in route choice.

Both models have their own advantages and disadvantages. The advantage of NetScan is its accuracy. It takes into account the departure and arrival times of each individual connection. In case of indirect connections, also the connecting time at specific hubs can be assessed. This enables the user to determine elapsed (and perceived) travel time of each individual connection. This detailed analysis, including the account of departure and arrival times, makes the NetScan model however inappropriate for use in

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1 Veldhuis, J. (1997): The Competitive Position of Airline Networks. *Journal of Air Transport Management 3 (4)*: 181-188. Also presented at the ATRS Conference in Vancouver, 1997
2 IATA: Global Airport Connectivity Monitor (GACM), distinct issues 1999-2002
3 ATRS 2006: Linda Heemskerk and Jan Veldhuis, Measuring Airline Network Quality: an analytical framework

forecasting studies. Determining departure and arrival times of individual connections in distinct future scenarios is not only a practically impossible task, but may also be undesirable.

This disadvantage is overcome by the NetCost model. This model functions at a slightly higher aggregation level and ignores departure and arrival times. It is less accurate for that reason, but it can be used in forecasting, if network scenarios at higher aggregation level are specified[4] [5]. This makes the NetCost model suitable for using it in strategic evaluations of distinct network policies, not only for today, but also for the future.

This paper is an attempt to combine the advantages of the two models: it is an analysis of current networks, taking into account departure and arrival moments of individual connections, assessing the actual connecting times at hubs (if any), determining its connectivity value (as is done in NetScan) ánd determining the generalised travel costs of that particular connection (as is done in NetCost).

Connectivity and generalised travel costs at city pairs

An example is provided in the table below by looking at one specific connection: from Amsterdam via Paris to San Francisco.

Table 1: Determination of Connectivity and Generalised Travel Costs, September 2006

Origin airport	AMS
Departure time from origin	7:25
Airline	KL
Intermediate hub	CDG
Arrival time at hub	8:45
Elapsed time from origin to hub	1:20
Connecting time at hub	1:30
Departure time from hub	10:15
Airline	AF
Final destination	SFO
Arrival time at final destination	12:30
Elapsed time from hub to final destination	11:15
Total elapsed time	14:05
Quality index	0.59
Frequency per week	7
Connectivity	**4.11**
Generalised travel costs	**€ 1.080**

The example refers to the early morning connection, leaving Amsterdam by KLM at 07:25 with a one and half hour transfer at Paris, arriving at San Francisco at 12:30

4 ACCM: The Airport Catchment Area Competition Model: Forecasting Model, developed for the Dutch Civil Aviation Department, 2004-2007, distinct reports for the Dutch Government, only in Dutch language

5 Network scenarios up to 2020 for leading Asian hubs

local time. The NetScan model computes a quality index. This index is an indication of how fast the connection is. In this case it has a value less than 1 (0.59), as the total elapsed time of 14:05 hours is longer than its minimum, the great circle distance between Amsterdam and San Francisco (11 hours). This connection is operated 7 times weekly and multiplying frequency with this quality index results in 4.11 weekly *connectivity units*.

Connectivity is a representation of the physical network characteristics. The other valuation of this connection is made by expressing all travel inconveniences in monetary units: *generalised travel costs*. These inconveniences refer to elapsed travel time, waiting time for the next travel opportunity and airfares.

The airfare component is the most visible part of generalised costs. It is recognized that statistical information on airfares is very limited available, and therefore can not be used consistently in the model. Instead, *expected airfares* are computed in a consistent framework. The airfares are depend on the great circle distance between the origin airport (AMS) and the destination airport (SFO), irrespective of an eventual connection at intermediate hubs, even if longer detours are necessary via that hub. Another important factor is the competition level on this air route. If more competitors are present on the route, airfares are – in the model - assumed to be lower. Finally, in the model it is assumed that airfares on direct connections are higher than on indirect connections as airlines tend to cross-subsidize indirect routes from the revenues on direct routes.

The other component of generalised costs is related to travel time. Detours via intermediate hubs are independent from airfares, they however lead to longer travel times and consequently to higher perceived costs associated with these extra travel times. It is not only the extra travel time due to the fact that an extra flight has to be made that counts here, also the waiting time at the hub must be taken into account. Generalised costs related to travel time are determined by multiplying travel time with a perceived value of travel time.

Finally there is the frequency component, and the costs related to frequency. The cost component related to air frequency can be substantial, as there can be substantial differences between the desired moment of the air trip and the actual next departure, particularly if the frequency is low. Generalised costs related to frequency are determined by multiplying the time between two subsequent frequencies with a perceived value of ‘waiting time’. Note that the value of time related to frequency is generally less than the value of time related to actual travel time.

Total generalised costs are determined by aggregating all three components: the expected airfare, the costs related to time and to frequency. In this particular example, the total generalised costs are computed at € 1.080, one way.

Next table 2 provides an overview of total connectivity and average generalised costs of all connections from Amsterdam to San Francisco, including the one analysed above. Direct connections have a quality index of 1, as their elapsed travel time is in most cases equal to the great circle flight distance, but indirect connections have lower quality indices. The quality index of indirect connections depends not only on the longer route flown, but also on connecting time at the hubs of individual connections. The route via Rome (FCO) has a large detour and therefore involves long flight times. Hence this route has a low quality index. The routes via New York Kennedy and Newark have equally large detours and flight times. On average the connecting time at Newark (for this specific city pair) is longer and therefore the quality index via Newark is lower.

Table 2: Route Alternatives from Amsterdam (AMS) to San Francisco (SFO), September 2006

Route via:	Frequency	Connectivity	Quality Index	Generalised Costs
Sky Team				
Direct	7	7,00	1,00	933
CDG	21	12,38	0,59	1060
FCO	7	0,84	0,12	1595
IAH	29	10,28	0,35	1247
MSP	21	7,42	0,35	1207
JFK	14	6,44	0,46	1185
EWR	28	4,29	0,15	1279
DTW	7	3,66	0,52	1168
ATL	14	2,27	0,16	1394
CVG	7	1,95	0,28	1303
STAR Alliance				
FRA	21	10,16	0,48	1098
LHR	25	7,68	0,31	1156
MUC	21	6,00	0,29	1183
IAD	14	5,06	0,36	1263
DEN	21	4,94	0,24	1352
ORD	14	3,85	0,28	1235
PHL	7	2,13	0,30	1304
LAX	7	0,58	0,08	1549
CLT	1	0,12	0,12	1532
oneWorld				
LHR	27	10,84	0,40	1155
Independent				
KEF	1	0,54	0,54	1874

	Frequency	Connectivity	Quality Index	Generalised Costs
Direct Routes	7	7,00	1,00	933

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Imdirect Routes via European hubs	123	48,43	0,39	1116
via USA-hubs	184	52,99	0,29	1241
Sky Team	155	56,53	0,36	1076
STAR Alliance	131	40,52	0,31	1165
One World	27	10,84	0,40	1155
Independent	1	0,54	0,54	1874
TOTAL Amsterdam-San Francisco	314	108,42	0,35	1103

Average generalised travel costs are determined for each type of connection. The direct routes have the lowest cost, as their travel time is shortest, although the airfare component is higher for direct connections. Note also the differences in connectivity and costs between the three large European hubs. The geographical locations of the three hubs are close to each other. However, the average quality index via Heathrow is lower, which is related to the longer connecting time at Heathrow compared to Paris and Frankfurt. These differences are also reflected in the generalized costs of using the three hubs. In summary, the average generalized travel costs on this route equal € 1.103.

We will illustrate three applications of this analysis. Firstly, this analysis is used to estimate the consumer benefits (welfare effects) of using particular European airports for distinct final destinations. For this, OAG-schedules of September 2006 have been used. Secondly, we illustrate to which extent and at which routes welfare effects have increased of passengers using Amsterdam Schiphol and at which routes these welfare effects have changed between 2005 and 2006. Finally, as the third application, we show how welfare effects are related to the network of one particular airline, in this case KLM.

Consumer Benefits of using particular airports

In the above paragraph, a quality assessment has been provided of the network quality on a particular route: in this case the route between Amsterdam and San Francisco. Table 3 below presents a similar analysis of selected European airports and their routes to San Francisco. Note that most of these airports have no direct connection to San Francisco, but by looking at connections from these airports via several hubs to the final destination San Francisco such a quality assessment can still be made.

The central question in this paragraph is: what airport provides the best network product to San Francisco? Again we take two airports to illustrate the methodology: Amsterdam and Brussels. The costs of using Amsterdam are € 1103, as determined in the earlier paragraph. Applying the same methodology to Brussels, the costs of using Brussels are € 1137, being a difference of € 34 in the advantage of Amsterdam. There is however an additional advantage of using Amsterdam. Not only are the average costs lower, also the number of travel opportunities is higher: 314 per week for Amsterdam and 167 for Brussels. This latter difference has in our analysis an additional consumer value of € 31, again in the advantage of Amsterdam. The conclusion is that the consumer is better off using Amsterdam than using Brussels, with a difference in consumer benefits of € 65 in total.

For the time being we ignore the fact that there are additional costs of surface transport of traveling to the airports. Clearly, for consumers in the region near Brussels, Brussels is a better option as the surface travel costs to Amsterdam are higher than to Brussels. The above analysis enables however to draw "*iso-cost lines*", the collection of points in the hinterland for which the costs of using alternative airports are equal. Hence, this also enables to indicate the size of catchment areas, rather than drawing circles around airports of 50 or 100 kilometers or so. Finally, if one would conduct such an analysis, one would come to the conclusion, that there is no such thing as a '*catchment area*' for airports, but that these areas can be different in size for different final destination points in the world.

Table 3 shows also the differences in consumer benefits of using various airports to fly to San Francisco in comparison to using Amsterdam Airport.

Table 3: Product characteristics of connections of selected European airports to San Francisco (SFO), September 2006

	Frequency	Connectivity	Quality Index	Generalised Costs (€)	Consumer benefit compared to AMS (€)
LHR London Heathrow	605	239,22	0,40	1071	65
CDG Paris Ch.de Gaulle	423	142,13	0,34	1098	20
FRA Frankfurt	677	228,94	0,34	1193	-52
AMS Amsterdam	314	108,42	0,35	1103	
BRU Brussels	167	54,38	0,33	1137	-65
MAN Manchester	200	66,34	0,33	1120	-40
DUB Dublin	130	41,57	0,32	1132	-74
MUC Munich	305	112,85	0,37	1211	-110
CPH Copenhagen	150	52,92	0,35	1175	-109
ZRH Zurich	286	97,23	0,34	1189	-91
MAD Madrid	159	49,64	0,31	1167	-98
FCO Rome	208	75,64	0,36	1140	-58

From the table it appears that consumers have the most benefits of using London Heathrow (again ignoring the costs of surface transport to London and other quality attributes of the airport). We acknowledge that the *great circle flight distance* is one of the elements taken into account in these costs, as this contributes to the travel time and hence to generalised travel costs. Clearly, the distance from London to San Francisco is shorter than the distance from Munich, which is one of the factors behind the lower costs of Heathrow. With a difference of one hour travel distance (Heathrow is approximately one hour closer to San Francisco), this would in our analysis be € 35 in the advantage of Heathrow in comparison to Munich. The actual difference is however larger: € 175 in our analysis and the remaining € 140 can be attributed to other factors than the great circle flight distance.

A similar assessment has been made for a sample of selected final destinations in North America and Asia/Pacific. This analysis is provided in table 4 below.

Table 4: Consumer benefits (in €) of network product from selected European airports to selected airports in North America and Asia/Pacific, compared to Amsterdam (AMS), September 2006

	LHR	CDG	FRA	AMS	BRU	MUC	CPH	ZRH	MAD	FCO
JFK New York Kennedy	99	31	-5	0	-26	-73	-115	-46	-42	-98
EWR New York Newark	115	35	30	0	-3	-35	-1	-39	-35	-86
IAD Washington	66	27	-26	0	-59	-80	-80	-82	-121	-117
BOS Boston	100	44	-15	0	-61	-51	-116	-46	-85	-94
ATL Atlanta	51	24	64	0	23	-43	-51	-37	-26	-88
IAH Houston	3	4	27	0	-34	-58	-109	-40	-103	-144
MIA Miami	69	63	39	0	-54	-57	-84	-28	73	-76
ORD Chicago	63	-9	-29	0	-48	-99	-77	-88	-103	-120
DTW Detroit	22	-18	-1	0	-104	-94	-114	-117	-171	-156
MSP Minneapolis	3	-83	-3	0	-69	-116	-160	-105	-194	-182
LAX Los Angeles	61	12	-45	0	-47	-104	-94	-65	-91	-91
SFO San Francisco	65	20	-52	0	-65	-110	-109	-91	-98	-58
DEN Denver	95	32	27	0	-16	-64	-50	-43	-62	-64
YYZ Toronto	46	-6	-61	0	-98	-111	-186	-110	-175	-129
YVR Vancouver	12	-64	-49	0	-38	-139	-107	-72	-226	-241
HKG Hong Kong	37	23	61	0	-45	-4	-73	-52	-132	-28
PEK Beijing	6	2	32	0	-66	5	-31	-71	-114	-107
PVG Shanghai	3	25	41	0	-36	-26	-39	-79	-101	-64
TPE Taipei	10	22	33	0	-502	-485	-217	-172	-622	-119
NRT Tokyo Narita	43	42	18	0	-52	-22	-41	-40	-88	-54
ICN Seoul Incheon	52	15	82	0	-61	-25	-72	-49	-107	-68
BKK Bangkok	44	18	26	0	-36	-7	-50	-47	-92	2
KUL Kuala Lumpur	34	-28	16	0	-125	-73	-148	-65	-220	-121
SIN Singapore	49	20	31	0	-52	-33	-94	-39	-83	-9
MNL Manila	82	46	89	0	-134	-119	-204	-88	-122	-8
SGN Ho Chi Minh City	110	117	155	0	-221	-31	-65	56	-135	54
CGK Jakarta	94	-6	78	0	-162	-133	-129	-18	-215	17
SYD Sydney	91	63	134	0	-176	-10	-24	-15	-171	8

Not only to San Francisco, but also to most of the final destinations in North America (except to Houston), Heathrow is the best airport to use, at least when looking at the consumer benefits of connections. However, conclusions must be taken with care. The difference with Paris Charles de Gaulle is small. A part of this difference can be attributed to the difference in great circle flight distance. Heathrow is little closer to North America, for which Heathrow may have an advantage that can be estimated at € 10 compared to Paris, € 10 compared to Amsterdam and € 25 compared to Frankfurt. While Heathrow is the best option for North American destinations, Frankfurt is best for most of the selected Asian/Pacific destinations, also when one corrects for the relative small differences in travel distance.

The other observation is the clearly leading position of the four major European hubs London, Paris, Frankfurt and Amsterdam. Amsterdam seems to lag little behind within the four. The other six airports in the table show significantly lower performances. These airports offer only in limited cases direct connections to intercontinental destinations, whereas direct connections contribute relatively much to consumer benefits.

Note also the differences between the two SkyTeam hubs, Paris and Amsterdam. Paris is in most cases a little better option to North American destinations, despite the slightly shorter travel distance to North America from Amsterdam. Here one may also draw conclusions about the extend to which networks are overlapping or complementary. In case of overlapping networks both airports have direct connections, in case of complementary networks, one of the two airports has none. In the latter case the consumer benefit is lower. To most of the intercontinental destinations both airports have direct connections and hence overlapping networks. However in some cases the networks are complementary. Paris has no direct connection to Vancouver. All SkyTeam connections to Vancouver are channeled through Amsterdam. Hence from Paris, indirect travel is necessary, with longer travel times and relative large differences in consumer benefits with Amsterdam. Similar observations can be made for Detroit and Minneapolis, the two hubs of KLM's long time partner Northwest. All SkyTeam connections to these airports are channeled through Amsterdam as there are (still) no direct SkyTeam connections from Paris to these two destinations. The typical Asian destination in this context is Kuala Lumpur.

This table and particularly the differences between hubs of the same alliance (such as Paris and Amsterdam) show therefore also the extent to which the hub systems are equivalent or hierarchical. In case the hub systems are hierarchical, it shows which hubs have a primary or secondary role in the alliance. Looking at the table, both SkyTeam hubs are more or less equivalent and have still a primary role, with relative small differences in consumer benefits between the two hubs, although Paris has generally a slight advantage, with the exceptions mentioned for Amsterdam. This is in sharp contrast with the three STAR-hubs in the table: Frankfurt, Munich and Copenhagen. Rather than an equivalent hub system, the STAR hub system is clearly hierarchical: Frankfurt is the primary hub, with Munich and Copenhagen being the secondary hubs. Munich and Copenhagen have limited direct connections to intercontinental destinations, at least to the ones listed in this table, and most of the STAR connections are channeled through Frankfurt.

There is another remarkable observation to be made from the table: the relative poor performance of Frankfurt to – notably – the two major STAR-hubs Washington and Chicago. Despite the larger number of direct connections from Frankfurt to these hubs (5 resp. 4 flights daily), the performance of Frankfurt is poor, even the worst compared to the other three major European hubs. Here one sees two effects. Firstly, the marginal utility of additional (direct) connections is decreasing: further increasing direct connectivity from Frankfurt to these hubs would only increase consumer benefits to a limited (and decreasing) extent. Secondly, probably more significant, the STAR alliance is highly dominant on these routes. Therefore, competition level is low, which adds to airfares, generalised travel costs and hence reduced consumer benefits. Similar observations can be made for the two Asian STAR-hubs: Bangkok and Singapore. Even though the alliance has 3 daily flights to both hubs and it is closer to Asia, the performance of Frankfurt to these Asian destinations is still worse than that of London.

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Changes in Consumer Benefits of using Amsterdam Schiphol between 2005 and 2006

Another relevant question that may be addressed from this analysis is: "Have consumer benefits increased or decreased over time?" For this analysis, we zoom in – for an illustration - at one specific airport, Amsterdam Schiphol. This analysis is particularly relevant for regional authorities around airports to monitor the changes in welfare effects of its airport(s) in balance with the environmental impact of the airport(s). We have compared two subsequent years, 2005 and 2006. Even more relevant is a comparison over a longer time, to monitor structural effects. These structural effects can be monitored in the light of the above considerations: "Has the role of two particular hubs in the alliance changed?". Nevertheless, we confine us to observe short term effects between subsequent years for one airport only: Amsterdam. This illustration is made in table 5 below.

Table 5: Changes in Consumer benefits (in €) of network product from Amsterdam to selected airports in North America and Asia/Pacific, September 2005 and 2006

	2005				2006				
	Frequency	Connectivity	Quality Index	Generalised Costs (€)	Frequency	Connectivity	Quality Index	Generalised Costs (€)	Welfare Changes (€)
JFK New York Kennedy	512	179	0,35	838	553	197	0,36	840	+2
EWR New York Newark	481	165	0,34	933	445	147	0,33	925	+4
IAD Washington	354	130	0,37	889	403	146	0,36	886	+10
BOS Boston	298	85	0,29	857	318	92	0,29	847	+13
ATL Atlanta	667	238	0,36	1066	677	248	0,37	1069	- 2
IAH Houston	464	185	0,40	1103	444	177	0,40	1111	- 11
MIA Miami	209	88	0,42	1005	184	78	0,42	1007	- 8
ORD Chicago	560	205	0,37	915	493	184	0,37	901	+8
DTW Detroit	380	145	0,38	933	341	136	0,40	939	- 11
MSP Minneapolis	312	108	0,35	1011	301	111	0,37	989	+20
LAX Los Angeles	588	220	0,37	1112	582	217	0,37	1102	+ 9
SFO San Francisco	365	125	0,34	1106	314	108	0,35	1103	- 5
DEN Denver	243	90	0,37	1078	233	75	0,32	1112	- 36
YYZ Toronto	316	109	0,35	846	337	121	0,36	845	+4
YVR Vancouver	98	42	0,43	1001	131	54	0,41	991	+24
HKG Hong Kong	226	95	0,42	1066	278	108	0,39	1083	- 6
PEK Beijing	129	54	0,42	920	141	64	0,45	919	+5
PVG Shanghai	118	47	0,39	1031	155	66	0,42	1033	+11
TPE Taipei	56	27	0,48	1162	58	27	0,46	1161	+3
NRT Tokyo Narita	347	140	0,40	1094	335	128	0,38	1093	- 1
ICN Seoul Incheon	207	82	0,39	1083	211	74	0,35	1077	+7
BKK Bangkok	316	141	0,45	1051	278	127	0,46	1046	- 1
KUL Kuala Lumpur	63	32	0,51	1085	60	36	0,59	1076	+7
SIN Singapore	339	149	0,44	1127	304	135	0,45	1137	- 15
MNL Manila	56	24	0,43	1219	67	25	0,37	1219	+9
SGN Ho Chi Minh City	48	16	0,34	1287	52	19	0,36	1279	+12
CGK Jakarta	78	39	0,50	1270	87	37	0,43	1251	+24
SYD Sydney	90	34	0,38	1674	81	31	0,38	1684	- 15

Total welfare effects on a route can be decomposed into two underlying effects: changes in the number of travel opportunities (frequencies) and changes in the average

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general travel costs of the frequencies. Taking again the example of the route from Amsterdam to San Francisco, we see that the average generalised costs have declined, from € 1106 to € 1103. This can be related to several factors, which cannot be identified exactly from the table, although the underlying analysis enables us to make such a decomposition. One of these factors may be shorter travel times, for instance by (on average) better coordinated departure and arrival times at intermediate hubs. The improved quality index (from 0,34 to 0,35) is indeed suggesting this. Other factors may be changes in competition levels, which results in the model in changes in expected airfares and hence to travel costs changes. All possible factors together have resulted in lower travel costs by € 3. However, the number of travel opportunities has decreased from 365 to 314. This results in a decrease in welfare effects, which in our model is estimated at € 8. All together, there has been a welfare decrease on the route of € 5, one way.

This amount may seem moderate, but to have an impression of the overall effects, one must multiply this with the number of passengers traveling from Amsterdam to final destination San Francisco. If there are – say – 100 thousand return passengers in this market the total negative welfare effects can be estimated at € 1 million for the market to San Francisco only.

Although welfare effects on most of the routes from Amsterdam have increased, there are some routes that show significant decreases, such as the route to Denver, € 36 one way. For this particular example, a breakdown into distinct routes to Denver has been made, which is illustrated in table 6.

Table 6: Decomposition of Consumer benefits (in €) of network product from Amsterdam to Denver, September 2005 and 2006

	2005				2006				
	Frequency	Connectivity	Quality Index	Generalised Costs (€)	Frequency	Connectivity	Quality Index	Generalised Costs (€)	**Welfare Changes (€)**
SkyTeam via:									
DTW Detroit	14	6	0,41	1104	7	4	0,56	1045	**+23**
MSP Minneapolis					21	8	0,38	1065	--
ATL Atlanta	45	15	0,33	1138	28	11	0,39	1127	**- 13**
CVG Cincinnati	13	5	0,40	1096	7	1	0,16	1268	**- 203**
STAR Alliance via:									
YYZ Toronto	14	5	0,35	1057	14	8	0,55	1027	**+29**
FRA Frankfurt	28	9	0,32	1037	21	7	0,33	1125	**- 102**
IAD Washington	14	7	0,48	1072	21	5	0,22	1201	**- 109**
ORD Chicago									
oneWorld via:									
LHR London	19	6	0,30	1053	14	1	0,09	1300	**- 263**
DFW Dallas	14	7	0,48	1078					--

On the route to Denver, the product characteristics of the oneWorld alliance have significantly deteriorated. The route via London Heathrow has lost in connectivity: its quality index has decreased from 0,30 to 0,09, suggesting that average connecting time at Heathrow on this route has increased. This is consistent with an increase in overall generalised travel costs via Heathrow from € 1053 to € 1300. The other alternative of oneWorld, via Dallas had in 2006 no realistic travel options left.

We see similar deteriorations on routes of other alliances, such as the route via Cincinnati with SkyTeam (Delta) and the routes of the STAR Alliance via Frankfurt and Washington. The only significant improvements are seen at the routes via Detroit and Minneapolis.

The above analyses are illustrations of what can be done with such an analysis. Not only are regional authorities able to monitor the welfare effects of their local markets. Also, when a more detailed analysis is made, airlines and their alliances may see to what extent their network performance has improved or deteriorated vis-à-vis competing airlines and alliances at particular routes.

The significance of intercontinental KLM-connections

Consumer benefits of airline connections are at the larger airports often attributed to the home carrier, who provides in some cases the majority of direct intercontinental connections. These arguments are often brought forward by these carriers, also to justify their environmental impact at these airports. This raises another relevant question: "what part of consumer benefits can be attributed to the network of a specific carrier". In other words: "What is the significance of the network of a specific carrier?" We have chosen to illustrate this by using the intercontinental KLM-network as an example by comparing the consumer impact of the current intercontinental network with the hypothetical situation that it would not exist.

The intercontinental KLM-network provides benefits to more consumers than the ones using Schiphol alone. Clearly, if the intercontinental KLM-network would not exist, users of Schiphol would see their benefits reduced significantly. In some cases direct connections would disappear and longer travel times would be the result with a corresponding reduction in consumer benefits. In other cases, the direct connections of the competing counterparts would still remain, in which cases the reduction in consumer benefits is much smaller. However, the KLM-network provides also benefits to users of other European airports, who travel to intercontinental destinations by connecting at KLM's hub Amsterdam Schiphol. If the intercontinental KLM-network would not exist, these users would see their travel opportunities reduced, and hence their consumer benefits.

Table 7 below provides an illustration of the consumer benefits that can be attributed to KLM's intercontinental network.

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Table 7: Welfare effects (in €) to be attributed to KLM's intercontinental network, September 2006

	AMS	BRU	CDG	Rest France	LHR	Rest United Kingdom	FRA	Rest Germany
JFK New York Kennedy	-26	-5	2	1	-4	-9	-3	-8
EWR New York Newark	-16	1	2	-1	0	6	-3	-1
IAD Washington	-16	-12	1	0	-2	-5		-13
BOS Boston	4							
ATL Atlanta	-18	2	0	1	-3	2	0	-2
IAH Houston	-12	-50	-3	5	-11	-4	0	5
MIA Miami	4							
ORD Chicago	-25	-15	-2	-3	-3	-6	-3	-12
DTW Detroit	5							
MSP Minneapolis	6							
LAX Los Angeles	-19	-14	0	-1	-6	-14	-10	-21
SFO San Francisco	-51	-36	-5	-7	-3	-18	-5	-14
DEN Denver	-2							
YYZ Toronto	-36	-8	-7	0	-5	-9	-6	-20
YVR Vancouver	-66	-43	-32	-100	-16	-26	-7	-38
HKG Hong Kong	-34	-30	-10	-6	-7	-22	-2	-15
PEK Beijing	-43	-13	6	1	-3	-32		-7
PVG Shanghai	-64	-23	3	1	0	-11	-1	-8
TPE Taipei	-27		-15		-12		-6	
NRT Tokyo Narita	-22	-32	2	2	0	-14	-2	-11
ICN Seoul Incheon	-33	-52	-3	1	3	-10	-2	-8
BKK Bangkok	-32	-19	-15	-19	-8	-27	-6	-26
KUL Kuala Lumpur	-76	-162	-71	-174	-17	-284	-19	-149
SIN Singapore	-20	-16	-10	-13	-5	-18	-11	-30
MNL Manila	-95	-181	-17	-87	-21	-141	-12	-134
SGN Ho Chi Minh City	-1							
CGK Jakarta	-44	-132	-38	-119	-16	-116	-16	-120
SYD Sydney								

In discussing this table, we make a distinction between the consumer impact at the basis of KLM, Amsterdam (represented in the first column), and at other European airports (in the other columns).

Looking at the impacts at Amsterdam (AMS), the changes in consumer benefits of the intercontinental KLM-connections ranges. The impact is relatively low if there are more carriers on the direct routes than KLM alone. This is the case for most of the destinations in the table. Examples are New York JFK (operated also by Delta), Newark (also by Continental), Hong Kong (also by Cathay) etc. If direct KLM-connections would not exist, there would be at least another carrier with direct service, in which cases the reduction in consumer benefits would be relatively low. There is in these cases however a compensating effect though, as the dominance of the remaining carrier(s) would increase and hence the expected airfares on the route. This would further reduce the consumer benefits on these routes. The latter effect is particularly manifest on the routes from Amsterdam to Vancouver and Kuala Lumpur.

There are also routes where KLM is the only carrier with a direct service. Examples are the routes from Amsterdam to San Francisco, Manila and Jakarta. If KLM would leave the routes, the negative impact on consumer benefits would be much larger, as there would be no direct service left. On the other hand, these routes would see – by leaving dominant KLM - increasing the competition level, which compensates the reduction in benefits.

Finally, there are routes where KLM has no direct service, although there may be direct service by others. There may still be changing consumer benefits. KLM has – for instance – no direct service to Denver. But the route to Denver is fed by the KLM-services via Newark, Atlanta and Houston, in which cases the number of indirect travel opportunities would decrease and hence the consumer benefits from Amsterdam to Denver. The described effects are seen at the routes from Amsterdam to Boston, Detroit, Minneapolis (not served by KLM, but by Northwest), to Miami (by Martinair), Denver (by United) and Ho Chi Minh City (no direct service at all). Also in these cases the decreasing consumer benefits may be compensated by increasing competition level. In some cases the positive effects of increased competition level are higher than the negative effects of less indirect travel opportunities (the routes from Amsterdam to Boston, Miami, Detroit and Minneapolis).

Looking to the impacts at other airports, the other columns in the table, the effects are fewer indirect services from these airports via Amsterdam to intercontinental destinations. One sees in this context a clear distinction between the airports with many direct intercontinental services, the main airports (Paris CDG, London Heathrow and Frankfurt) and the other airports. Although the main ones have intercontinental services by KLM via Amsterdam, the consumer benefits decrease only little if such services would not exist. Not only do they have intercontinental service themselves, also there are still many indirect travel options left, also without the ones by KLM. This is seen by the low negative welfare impacts at these airports. In some cases there is even a positive effect, when the resulting increased competition level compensates the effect of less indirect services.

Much larger are the effects when looking at the other airports than the three main ones. These airports have only occasional direct intercontinental services and are much more dependent of indirect services via European hubs. In these cases the negative impacts are much higher of the hypothetical situation that intercontinental KLM-services would not exist. In some cases the dependence of KLM is exceptionally large. Examples of such cases are the connections from regional UK-airports to Kuala Lumpur, which are almost completely dependent of the connection via Amsterdam.

Conclusions

This paper has introduced a methodology that describes changes in welfare effects that result from changes in airline networks. The methodology may be relevant for airports, airlines and regional (or national) governmental authorities who deal with air transport. Airports and airlines may monitor changes in their network performance vis-à-vis competing airports and airlines in particular markets. Governments deal with the impact of their airports on the local economy and may use this analysis to monitor the welfare effects of airport development in their airport regions. Moreover, governments deal with aeropolitical issues and one of the considerations they may make is how particular connections contribute to the welfare of their local market.