Appendix A – Alternative assumptions

Two market segments

Let us consider a market with two separate segments, interpreted as the business segment (*B*) and the leisure segment (*L*) in our airline industry setting. Let D^i and P^i denote the demand and price in segment *i*, where *i=B,L*. We apply the inverse demand function in (1) for the business segment, while we assume the following inverse demand function in the leisure segment:

$$P^L = AM - NQ^L \tag{A.1}$$

where Q^L is total sale in the leisure segment. If $M=N=1$, then the two market segment are identical. To capture the fact that the willingness to pay and the price elasticity is higher in the leisure segment than in the business segment, we expect both $M < 1$ and $N < 1$.

A firm installs capacity K_i to serve the business segment. However, for each unit of capacity installed to serve the business segment, it has some idle capacity *t* which it can use to serve the leisure segment. In addition, in the semicollusive regime it can use part of the excess capacity to serve the leisure segment. We assume that a fraction *u* of the excess capacity is used in the leisure segment, where $u < 1$. To simplify, let us assume that C_S is normalized to zero. The rules of the game are as specified in Section 3. Then firm *i* have the following maximization problem in the semicollusive regime:

$$p_i = \max_{K_i} P^B Q_i^B + P^L Q_i^L - C_L K_i \tag{A.2}$$

s.t. (1) *If* $P^L = C_S = 0$ *then* $Q_i^L = \dfrac{AM}{2B}$ *and*

(1.1) $Q_i^B = K_i$ *and* $P^B = A - K$ *if* $K \le \dfrac{A - C_S}{2}$, *and*

(1.2) $Q_i^B = D^B \dfrac{K_i}{K}$ *and* $P^B = \dfrac{A + C_S}{2}$ *if* $K > \dfrac{A - C_S}{2}$

(2) *If* $C_S + C_L > P^L \ge C_S$, *then* $Q_i^L = tK_i + u[K_i - Q_i^B]$, *and*

(2.1) $Q_i^B = K_i$ *and* $P^B = A - K$ *if* $K \le \dfrac{A}{2}$

(2.2) $Q_i^B = D^B \dfrac{K_i}{K}$ *and* $P^B = A/2$ *if* $K > \dfrac{A}{2}$

Case (1) is analogous to the case analysed in Section 3. There is no profits in the leisure segment, and the maximization problem is reduced to the one specified in (6), with short run marginal costs normalized to zero.

In case (2), each firm earns gross profits from serving the leisure segment. We can solve for the equilibrium capacities. For example, if we assume that $M=N=t=1$, then we have the following individual capacity:

$$K_i^S = \frac{(2u+6)A - 2C_L + \sqrt{(48-12u+4u^2)a^2 - (24C_L + 8uC_L)a + 4C_L^2}}{48} \qquad \text{(A.3)}$$

We are interested in the sign of $\frac{\partial^2 K_i^S}{\partial^2 A}$, *i.e.,* how market size affects the relationship between capacity and a change in market size. It can be shown that the sign of $\frac{\partial^2 K_i^S}{\partial^2 A}$ depends on the parameter values. For example, for each combination of M, N, t and C_L, there is a critical value of u which ensures that $\frac{\partial^2 K_i^S}{\partial^2 A} = 0$. In Table *A1* we have shown examples of the critical value of u.

Table A1. Critical values of u for t=1 and C_L=1/4.

	$M = N$					
	1	0.5	0.25	0.12	0.06	0.03
u^*	0.33	0.5	0.66	0.8	0.89	0.94

For $u < u^*$, $\frac{\partial^2 K_i^S}{\partial^2 A} > 0$, and the opposite is true for $u > u^*$.

Let us now assume that the competitive regime is in force. Then there is no gain from installing excess capacity in the business segment. Each firm's maximization problem is then the following:

$$p_i = \max_{K_i} P^B K_i + P^L t K_i - C_L K_i \qquad \text{(A.4)}$$

Then it can be shown that firm i installs the following capacity:

$$K_i^S = \frac{A(1+Mt) - C_L}{3(1+Nt^2)} \qquad \text{(A.5)}$$

Then it can easily be seen that $\frac{\partial^2 K_i^S}{\partial^2 A} = 0$.

Modeling of market size

Let us return to the case of one market segment. If we apply the inverse demand function in (12), we have the following individual capacity in the semicollusive regime:

$$K_i^S = \frac{B(AS - C_S)^2}{16SC_L} \qquad \text{(A.6)}$$

Then we have the following comparative statics concerning B and S:

$$\frac{\partial K_i^S}{\partial B} = \frac{(AS - C_S)^2}{16SC_L}, \quad \frac{\partial^2 K_i^S}{\partial^2 B} = 0 \text{ and } \frac{\partial K_i^S}{\partial S} = \frac{B(AS - C_S)(AS + C_S)}{16S^2 C_L}, \quad \frac{\partial^2 K_i^S}{\partial^2 S} = \frac{BC_S^2}{8C_L S^3} \quad \text{(A.7)}$$

Then we see that the effect on capacity by a marginal change in *B* is unaffected by the initial size of *B*, while the effect on capacity by a marginal change in S is increasing in the initial size of *S*.

Asymmetric market sharing rule

Given the market sharing rule in (13), we have the following equilibrium capacities and sale in the semicollusive outcome:

$$K_1^S = K_2^S = \frac{b(A - C_S)^2}{4C_L(b+1)^2}, \text{ and } Q_1^S = \frac{b(A - C_S)}{2(b+1)}, \; Q_2^S = \frac{A - C_S}{2(b+1)} \quad \text{(A.8)}$$

We see that the asymmetry in the market sharing rule results in asymmetric sale, but identical capacity. The effect of a marginal change in market size on an individual firm's capacity is then the following:

$$\frac{\partial K_i^S}{\partial A} = \frac{b(A - C_S)}{2C_L(b+1)^2} \quad \text{(A.9)}$$

Then we see that the semicollusive effect is present: The lager the market size, the larger the effect on capacity of a marginal increase in market size.

Appendix B - Data definitions and data sources

Capacity and passenger figures

The calculation of capacity on each route is based on departures, flight schedules and information on air carriers in the "Books of Norwegian flight schedules" from 1985 to 1995. Passenger figures on route-level are provided by the Norwegian Civil Aviation Authority.

In order to calculate the capacity on each route, the number of weekly departures are counted for the two air carriers BU and SAS. The capacity for each air carrier is then calculated by multiplying the number of departures by the capacity of the particular plane used. The sum of the capacity for each air carrier is the total capacity for the route. For the calculation of monthly capacity, the weekly capacity is multiplied by a factor 26/6 to reflect the fact that there are more than 4 weeks in a month. The annual capacity is then aggregated using the monthly figures. All non-stop departures are included. The analysed routes are shown in Table B1:

Table B1: The analysed routes, number of departures and competition status

City-pair Number	City-pair Codes	City-pair Names	Non-stop Departures 1995	Competition status*	Definition $LARGE_{it}$
1	FBU-TRD	Oslo - Trondheim	27	D	1
2	FBU-BOO	Oslo - Bodø	7	D	0
3	FBU-TOS	Oslo - Tromsø	9	D	0
4	FBU-BGO	Oslo - Bergen	24	D	1
5	FBU-STV	Oslo - Stavanger	24	D	1
6	BGO-STV	Bergen - Stavanger	20	D	1
7	TRD-AES	Trondheim - Ålesund	4	M	0
8	FBU-KRS	Oslo - Kristiansand	7	M	0
9	FBU-AES	Oslo -Ålesund	6	M	0
10	FBU-HAU	Oslo - Haugesund	8	M	0
11**	FBU-MOL	Oslo - Molde	5	M	0
12**	FBU-KSU	Oslo - Kristiansund	3	M	0

*/ D = Duopoly, M = Monopoly

**/ *Routes 11 and 12*

On the routes from Oslo to Molde and from Oslo to Kristiansund, Braathens SAFE has monopoly. From 1985 to 1991 these two routes were basically one route; first the air carriers flew to Molde and then to Kristiansund. From 1991, Braathens SAFE has increased the number of non-stop flights to Kristiansund considerably. Since only non-stop flights are included in the analysis, and the fact that the figures we use to represent the passenger variable includes all passengers, the capacity and passenger figures are not comparable over time when looking at the individual routes (11 and 12). We have adjusted for this effect in the following way:

- the numbers of passengers are summarised for fbu-mol and fbu-ksu for each year
- from 1985 to 1991 only the capacity numbers for fbu-mol are used. From 1991 on, the capacities also for the route fbu-ksu are included.

Hence, route 11 and 12 are aggregated, leaving us with 11 city-pair routes to be analysed.

Demand Instruments

The demand instruments used in this study are collected from "The Norwegian Social Science Data Service, "The Municipal Database" and are as follows:

- Population in total, collected from the "census of population".
- Gross Expenditures in total, collected from municipal accounts at the municipal level. Chapter 1, item 000-599 until 1991, and chapter 1 item 01-59 from 1991.
- Taxes, collected from the municipal accounts; chapter 1.900 until 1991, and chapter 1.800, from 1991.

In order to be able to use the figures in the analysis, the numbers are aggregated to regions corresponding to the city-pairs. The basis for the aggregation is the classification of municipals explained below, where closeness in terms of commuting area around each airport are used as the aggregation criterion. The figures from each municipal that is located in the airport region are aggregated. Using these airport region figures we then aggregate into 11 city-pair regions.

Classification of Municipals

The classification of municipals is based on *"The Norwegian Official Statistics, Standard for Municipal Classification - 1994"*, and *"Regional classification in the general equilibrium model, MISMOD"*, WP 63/1990, Centre for Applied Research, by Frode Steen. Municipals are categorised and given a centrality code which indicates the commuting possibilities (closeness) between the airport area and the municipal. Dependent on the size of the nearby cities, the municipals are given centrality codes. For the largest cities; Oslo, Bergen, Trondheim, Stavanger and Kristiansand, centrality code "3" indicates good commuting possibilities and short distance in time to the airport (which always are located within, or very close to its city municipal). For the airports located in the smaller cities; Haugesund, Ålesund, Molde, Kristiansund, Bodø and Tromsø, the centrality code "2" indicates good commuting possibilities. Hence, the classification used here is based on these codes, where all relevant (close) municipals are attributed to one of the 11 airports included in our 11 city-pairs. Then these 11 regions are aggregated into city-pair variables. Table B2 summarises the municipals, and their airport region codes.

Table B2: The municipals' airport region codes

Airport Code *	Municipal No	Municipal Name	Airport Code *	Municipal No	Municipal Name	Airport Code *	Municipal No	Municipal Name	Airport Code *	Municipal No	Municipal Name
1	104	Moss	1	533	Lunner	3	1120	Klepp	6	1532	Giske
1	123	Spydeberg	1	534	Gran	3	1121	Time	6	1534	Haram
1	124	Askim	1	602	Drammen	3	1122	Gjesdal	7	1502	Molde
1	135	Råde	1	604	Kongsberg	3	1124	Sola	7	1535	Vestnes
1	136	Rygge	1	605	Ringerike	3	1127	Randaberg	7	1543	Nesset
1	137	Våler	1	612	Hole	3	1129	Forsand	7	1547	Aukra
1	138	Hobøl	1	623	Modum	3	1130	Strand	7	1548	Fræna
1	211	Vestby	1	624	Øvre Eiker	3	1141	Finnøy	7	1551	Eide
1	213	Ski	1	625	Nedre Eiker	3	1142	Rennesøy	8	1503	Kristiansund
1	214	Ås	1	626	Lier	3	1145	Bokn	8	1554	Averøy
1	215	Frogn	1	627	Røyken	4	1106	Haugesund	8	1556	Frei
1	216	Nesodden	1	628	Hurum	4	1146	Tysvær	8	1557	Gjemnes
1	217	Oppegård	1	702	Holmestrand	4	1149	Karmøy	8	1572	Tustna
1	219	Bærum	1	711	Svelvik	5	1201	Bergen	9	1601	Trondheim
1	220	Asker	1	713	Sande	5	1241	Fusa	9	1624	Rissa
1	221	Aurskog-Høland	1	714	Hof	5	1242	Samnanger	9	1638	Orkdal
1	226	Sørum	2	904	Grimstad	5	1243	Os	9	1648	Midtre Gauldal
1	227	Fet	2	926	Lillesand	5	1245	Sund	9	1653	Melhus
1	228	Rælingen	2	935	Iveland	5	1246	Fjell	9	1657	Skaun
1	229	Enebakk	2	937	Evje og Hornnes	5	1247	Askøy	9	1662	Klæbu
1	230	Lørenskog	2	1001	Kristiansand	5	1251	Vaksdal	9	1663	Malvik
1	231	Skedsmo	2	1002	Mandal	5	1253	Osterøy	9	1664	Selbu
1	233	Nittedal	2	1014	Vennesla	5	1256	Meland	9	1714	Stjørdal
1	234	Gjerdrum	2	1017	Songdalen	5	1259	Øygarden	9	1719	Levanger
1	235	Ullensaker	2	1018	Søgne	5	1260	Radøy	10	1804	Bodø
1	236	Nes	2	1021	Marnardal	5	1263	Lindås	10	1840	Saltdal
1	237	Eidsvoll	2	1027	Audnedal	6	1504	Ålesund	10	1841	Fauske
1	238	Nannestad	2	1029	Lindesnes	6	1517	Hareid	11	1902	Tromsø
1	239	Hurdal	3	1102	Sandnes	6	1523	Ørskog	11	1933	Balsfjord
1	301	Oslo	3	1103	Stavanger	6	1528	Sykkylven	11	1936	Karlsøy
1	419	Sør-Odal	3	1114	Bjerkreim	6	1529	Skodje			
1	532	Jevnaker	3	1119	Hå	6	1531	Sula			

*/ Airport region codes used in the table translate to airports as follows:

1 - Oslo
2 - Kristiansand
3 - Stavanger
4 - Haugesund
5 - Bergen
6 - Ålesund
7 - Molde
8 - Kristiansund
9 - Trondheim
10 - Bodø
11 - Tromsø

Figure 1: Market size and total capacity

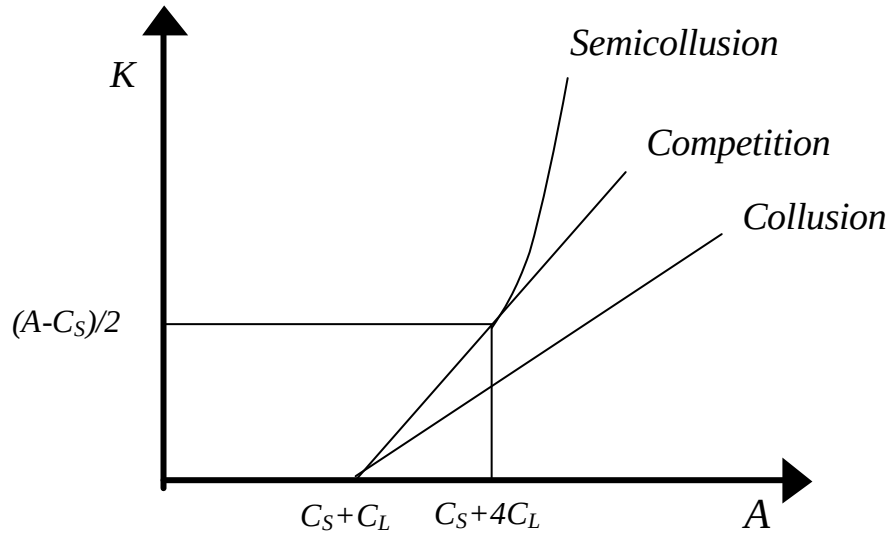

Figure 2: Market size and the effect on total capacity by changes in demand

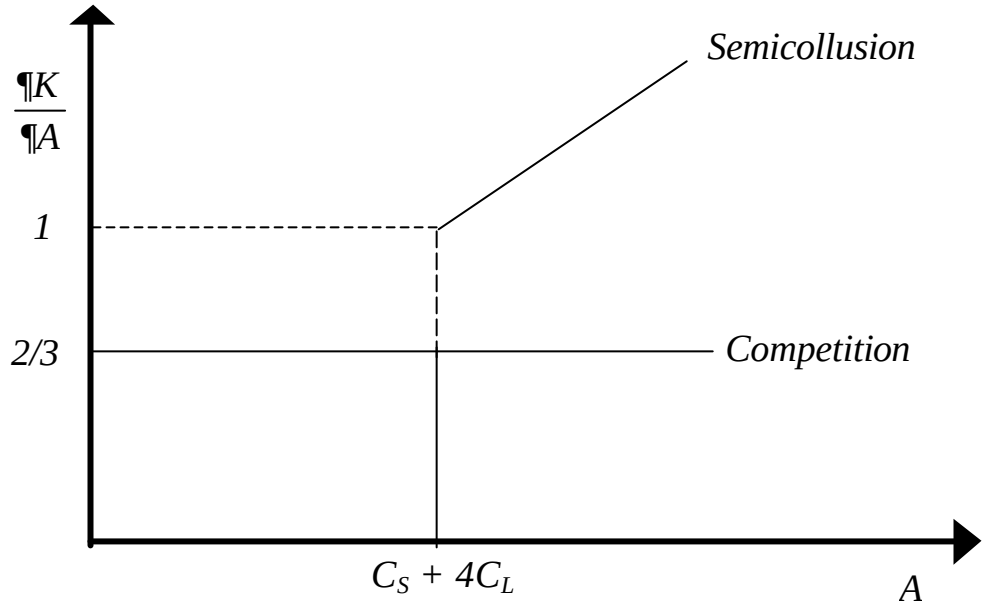

Table 1: Results for Model (I).

Variable	Model (I), OLS		Fixed Effects (I)		Model (I), Instrument		Model (I), Instrument/robust	
	Param.	St.error	Param.	St.error	Param.	St.error	Param.	St.error
PAS	1.828*	0.056	2.12*	0.167	1.55*	0.083	1.54*	0.165
REG94	89051*	24727	65308*	24291	136299*	28738	137730*	52326
*REG94*MON*	-82560*	34373	-76035*	28753	-145487*	39772	-147393*	55618
Constant	10.57*	12322	-52988*	29489	47570*	16588	49011*	28412
Cook-Weisb.	Chi2(1)=14.84							
$\overline{R}^2$	0.92		0.92		0.91		0.82	
# OBS	121		121		121		121	
Root MSE	74351		74351		81600		81913	

*/ Significance level 95 percent.

Table 2: Results for Model (II), using all routes.

Variable	Model (II), OLS		Fixed Effects (II)		Model (II), Instrument		Model (II), Instrument/robust	
	Param.	St.error	Param.	St.error	Param.	St.error	Param.	St.error
PAS	1.77*	0.057	2.15*	0.177	1.56*	0.078	1.56*	0.143
REG94	6941*	20747	8652*	17989	-1720	22073	-1720	21526
*REG94*LARGE*	131361*	36260	56471*	31688	196048*	41094	196048*	74867
Constant	8134*	12322	-56968*	31348	46042*	15619	46042*	26188
Cook-Weisb.	Chi(1)=18.77							
$\overline{R}^2$	0.93		0.95		0.92		0.92	
# OBS	56712		56712		121		121	
Root MSE	72219		56712		76635		76535	

*/ Significance level 95 percent.

Table 3: Results for Model (II), using only the duopoly routes.

Variable	Model (II), OLS		Fixed Effects (II)		Model (II), Instrument		Model (II), Instrument/robust	
	Param.	St.error	Param.	St.error	Param.	St.error	Param.	St.error
PAS	1.85*	0.1001	2.11*	0.25	1.3222*	0.188	0.3478*	1.282
REG94	23114	48653	43106	43106	-13372	59216	60680	1843427
*REG94*LARGE*	104340**	62370	8945	53295	237651*	83242	102885**	5.615
Constant	-13754*	28013	-78155	61576	116695	490223	94268	330302
Cook-Weisb.	Chi(1)=15.21							
$\overline{R}^2$	0.89		0.93		0.84		0.85	
# OBS	66		66		66		66	
Root MSE	92916		74443		110000		110000	

*/ Significance level 95 percent, **/ Significance level 90 percent.

Figure 3. Market structure in 1995 on the 12 domestic routes

Figure 4. Capacity and number of passengers 1985-96 on four routes

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