COLLUDE, COMPETE, OR BOTH?
DEREGULATION IN THE NORWEGIAN AIRLINE INDUSTRY

by

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Abstract:

The purpose of this paper is to test the nature of competition concerning price and capacity setting in the Norwegian airline industry after the deregulation in 1994. Did the two airlines, SAS and Braathens, compete on prices and capacities (competition), collude on prices and capacities (collusion) or collude on prices and compete on capacities (semicollusion)? We reject the hypothesis that they achieved collusion, and we find the observed behaviour consistent with semicollusive behaviour and inconsistent with competitive behaviour.

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1. *Introduction*

In April 1994, the Norwegian airline industry was deregulated. All domestic firms were free to enter, and they were free to set prices and to determine the time location of their flights as well as the number of flights on each route. A major argument for the deregulation was to trigger more intense rivalry between firms and thereby to enhance efficiency. As shown in the literature, deregulation can result in substantial benefits.[1] In particular, deregulation can result in more price competition and force the firms to lower its costs. The purpose of this article is to investigate in detail the nature of competition in the post-regulation regime in the Norwegian airline industry. Did deregulation trigger rivalry between the firms? If yes, did they compete on prices, or along other dimensions such as capacity? We construct a theoretical model, and formulate hypotheses which we test on data for the Norwegian airline industry before and after the deregulation.

Two Norwegian airlines, SAS and Braathens, were the active firms in the Norwegian airline industry before deregulation.[2] SAS and Braathens continued to be the only active airlines after deregulation. On 24 out of 32 routes, the legal monopolist from the era of regulation continued to be a monopolist. On the remaining 8 routes, the two firms were both active after deregulation.

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[1]In a survey of the effects of deregulation of American industry, Winston (1993) concludes that '.. the evidence clearly shows that microeconomists' predictions that deregulation would produce substantial benefits for Americans have been generally accurate' (p. 1286). McGowan and Seabright (1989) discuss in a broad context whether the experience from the deregulation of the US airline industry is applicable to the European airline industry. Their study, as well as Good, Røller and Sickles (1993), found that the European carriers have a substantial cost disadvantage vis-a-vis their US rivals, and therefore that a large potential gain from deregulation would come from cost reductions. Norman and Strandenes (1994) showed that there were large potential benefits from deregulating the route Oslo-Stockholm, partly because of lower prices and partly because of larger flight frequency. The results from the empirical studies, though, are more mixed. See, for example, Borenstein (1989, 1990), Borenstein and Rose (1994), Brander and Zhang (1990, 1993), Evans and Kassides (1994), Hurdle et al. (1989) and Whinson and Collins (1992) concerning US, and Encaoua (1991), Neven and Røller (1996), Marin (1995, 1998) and Røller and Sickles (1997) concerning Europe.

[2]The markets in question are all routes in Norway, except for those between small airports (*kortbanenettet*).

Prior to deregulation, both firms threatened to cut prices following deregulation. However, a study indicates that there was no price reduction on the full fare tickets in the business travelers' segment following deregulation, and only a minor increase in the share of discounted tickets.[3] The study, though, is not an empirical test. The conclusions are drawn from observing descriptive statistics.[4] Therefore, one may ask whether the firms colluded on prices or whether customers shifted from purchasing full fare to discounted tickets. If the latter is true, we have de facto competition on prices although the prices of full fare tickets are not affected by the deregulation. Moreover, there are also some casual observations suggesting that it has been a large increase in capacity following deregulation.[5] However, one possible explanation could be that this is due to a general growth in demand. Alternatively, the capacity increase might also be driven by intense rivalry on capacity triggered by collusion on prices. The question we ask is therefore: did the firms compete on capacity and collude on price, or did they either collude or compete along both dimensions following deregulation. This is what we have set out to test.

The article is organized as follows. In Section 2, we formulate the model. Two firms choose price and capacity, and it is either competition or collusion on each (or both) choice variable(s). To test the hypotheses derived in Section 2, we specify in Section 3 an econometric model. The empirical results are reported in Section 4, and in Section 5 we summarize our results.

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[3]This is shown in Lian (1996). He finds that the share of the discounted tickets increased with 2.5 %-point from 1992 to 1994-95. According to Lian (1996) this is no dramatic change: '*a 2-3 %-point increase in discount tickets in two-three years is in line with a long term trend and imply no sudden change in this trend*' [our translation] (p. 15). The increase in the share of discounted tickets are larger in the 'leisure' segment than in the business segment [see Lian (1996), tabell 4.4].

[4] Salvanes, Steen and Sørgard (1997) analyse the location pattern of flights in the Norwegian airline industry after the deregulation in April 1994. They find statistical support for the hypotheses that clustering is more prevalent in the business travellers' segment than in general, something which in their model is consistent with more collusion on prices in the business travellers' segment than in general. They also refer to direct statements by the firms' representatives, supporting this view.

2. A theoretical model

Let us consider a duopoly where firms choose both price and capacity. Since prices are typically more flexible than capacity, we assume the following game:

Stage 1: Both firms set capacities

Stage 2: Both firms set prices

If the firms behave non-cooperatively on both stage 1 and 2, we have a game which is analysed in Kreps and Scheinkmann (1983). They show that, when certain assumptions are met, the equilibrium is identical to the Cournot equilibrium. We label this the *competitive regime*.[6] If the firms behave cooperatively on both stages, the firms behave as a cartel and thereby attains the monopoly equilibrium concerning both price and capacity setting. We label this the *collusive regime*. A third alternative is that the firms behave cooperatively for one choice variable, and non-cooperatively for the second choice variable. As we argued, price is typically easier to change than capacity. As is well known from theory of repeated games, it is easier to collude on a choice variable that can be changed very rapidly. Hence, we find it natural to assume that the firms can collude on prices and compete on capacities.[7] We label this the *semicollusive regime*.[8]

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[5]For example, during the first year after deregulation, total capacity for routes to and from Oslo increased by 12.5 % [see Lian (1996), Table 5.2].

[6]If there is no commitment power concerning capacity setting and the firms compete on both capacities and prices, then in equilibrium we would have price equal to long run marginal costs. However, it can be shown that such a change in the definition of the competitive regime would not change the two hypotheses that are formulated later: A competitive regime following deregulation would result in an increase in capacity, and a marginal change in the market size has the same effect on capacity in a small and a large market.

[7]The fourth alternative would be capacity collusion and price competition. Then the firms could achieve the collusive outcome concerning both prices and capacities simply by setting the monopoly capacity. Hence, the outcome of this fourth alternative would be identical to the outcome in what we labelled the collusive regime.

[8]The semicollusion game we analyse here was first introduced in Fershtman and Gandal (1994). All theoretical studies of semicollusion assume collusion in the product market (either on prices or quantity) and competition

Let us assume the following inverse demand function:

$$P = A - Q_1 - Q_2 \tag{1}$$

where P is price, Q_i quantity supplied by firm i, i=1,2, and A a parameter measuring the demand potential. Furthermore, let C_S denote short run marginal cost and C_L cost per unit of installing capacity. K_i denotes capacity for firm i, where i=1,2, and $K = K_1 + K_2$. Let us consider each of the three cases.

Collusive regime (price- and capacity cartel)

Obviously, the firms have no incentives to build idle capacity. Therefore, we have that Q_i=K_i for firm i. The following capacity is installed:

$$K_1^M + K_2^M \equiv K^M = \frac{A - C_S - C_L}{2}. \tag{2}$$

Then we have the following effect of a change in the demand:[9]

$$\frac{\partial K^M}{\partial A} = \frac{1}{2}. \tag{3}$$

Competitive regime (price- and capacity competition)

As for collusion, there is no reason for the firms to install idle capacity. The following capacity is installed in equilibrium:

$$K_1^C + K_2^C \equiv K^C = \frac{2(A - C_S - C_L)}{3}. \tag{4}$$

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along other dimensions. Competition on capacity is analysed in Fershtman and Muller (1986), Osborne and Pitchik (1987), Davidson and Deneckere (1990), Matsui (1989) and Fershtman and Gandal (1994); competition on R & D is analysed in Katz (1986), D'Aspremont and Jacquemin (1987), Kamien *et.al*. (1992) and Fershtman and Gandal (1994); competition on location is analysed in Friedman and Thisse (1993). For a survey of the literature, see Fershtman and Gandal (1994) or Phlips (1995), chpts 9 and 10.

[9] Strictly speaking, we investigate the effect of a change in the demand potential, *i.e.*, the demand curve's intercept with the vertical axes. By changing A, we observe a parallel shift in the demand curve.

Then we have the following effect of a change in the demand:

$$\frac{\partial K^C}{\partial A} = \frac{2}{3}. \qquad (5)$$

Semicollusive regime (price collusion and capacity competition)

The firms succeed in coordinating their price setting. At stage 2, the collusive price is found by solving the following problem:

$$\sum_{i=1}^{2} \pi_i = \max_{P} (P - C_S)Q - K \cdot C_L, \qquad (6)$$

If $K < (A - C_S)/2$, the marginal revenue exceeds the short run marginal cost when all capacity is used for production. Hence, the firms set the price so that the entire capacity is used for production. Then, the market price is $P = A - K$.

If $K \geq (A - C_S)/2$, it is optimal to set $P = (A + C_s)/2$. If so, the firms install excess capacity.[10] Then it remains to determine the sharing rule - each firm's quota in the market. In that case we assume that:

$$Q_i^K = \frac{K_i}{K} D(P). \qquad (7)$$

Each firm's market share is thus identical to its share of total capacity. There are, at least, two reasons for a positive relationship between its own share of total capacity and its own share of total sale. First, the larger the capacity the larger the probability that there is a vacant seat at

[10]With excess capacity, we mean capacity in excess of what is needed for supplying this particular market. However, this does not necessarily imply that some capacity is idle. It could be that the residual capacity is used for supplying another market segment. For the market in question, the first market segment can be the business segment and the second one can be the leisure/holiday segment. The interpretation of our model is then that we have modelled the first market segment, and implicitly assume tough competition in the leisure segment so that price in that segment equals short run marginal costs. Alternatively, we could have assumed that the price in the leisure segment was in between the short run and the long run marginal costs. See Steen and Sørgard (1998), where such an alternative model is analysed. They find the same mechanism as the one that turns out to be crucial one here, that capacity is very sensitive to marginal changes in demand in the semicollusive regime when the market is of sufficiently large size. Due to this, our hypotheses is expected not to change if we extend the model to the one in Steen and Sørgard (1998).

the airline firm in question. Second, the larger the capacity the larger the number of flights and thereby the service frequency for the airline firm in question. More generally, when products and prices are identical it is reasonable to assume that the demand is distributed so that each firm's sale is related to its share of total supply in the market.

At stage 1, the firms set capacity non-cooperatively. Firm *i* has the following maximization problem:

$$p_i = \max_{K_i} (P - C_S)Q_i - C_L K_i \tag{8}$$

s.t. (i) $if \quad K \leq \frac{A - C_S}{2}, \; then \; Q_i = K_i \quad and \quad P = A - K$

(ii) $if \quad K > \frac{A - C_S}{2}, \; then \; Q_i = Q_i^K \quad and \quad P = \frac{A + C_S}{2}$

Given that $K \leq (A - C_S)/2$, we are back to the case where all capacity is used for production. Then each firm determines its sale by determining its capacity, and price is set to clear the market. Hence, the firms compete for capacity and we have an outcome analogous to the competition regime we specified previously. If $K > (A - C_S)/2$, then the firms installs more capacity than what is demanded in the market at the collusive price. From the first order conditions, we have the following total capacity in equilibrium:

$$K^S = K_1^S + K_2^S = \frac{2(A - C_S)^2}{16C_L}. \tag{9}$$

Then we have that the firms install more capacity than what is used for production if:

$$\frac{A - C_S}{2} < \frac{2(A - C_S)^2}{16C_L} \tag{10}$$

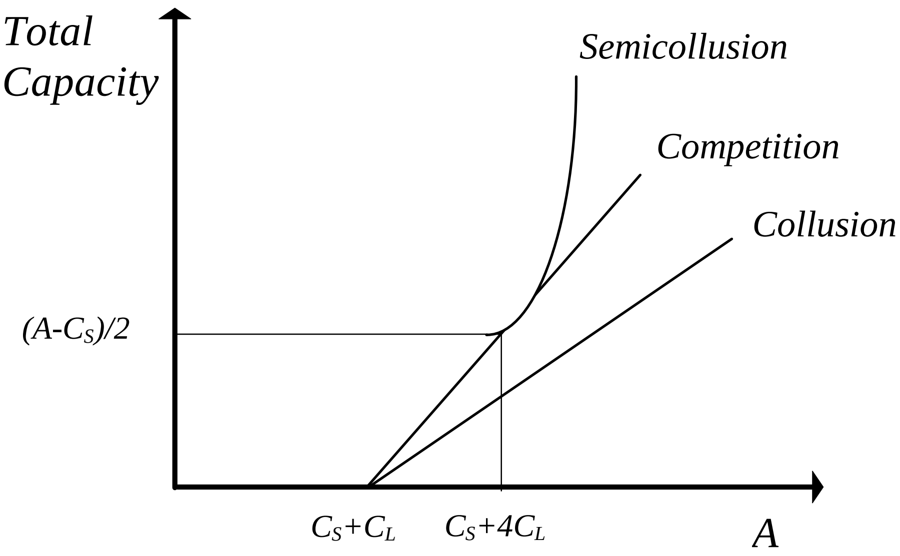
Rearranging, we find that the firms install excess capacity if $A > 4C_L + C_S$. Given that $A > 4C_L + C_S$, we have the following change in equilibrium capacity as a result of a marginal change in the demand:

$$\frac{\partial K^S}{\partial A} = \frac{A - C_S}{4C_L}. \qquad (11)$$

Now we can use two illustrations to summarise our results so far, and to formulate hypotheses which we will apply for empirical testing.

If $P=A$, demand equals zero. Hence, production is zero at $C_S+C_L=A$. We know from the analysis that an increase in A will have a more limited effect on equilibrium capacity under collusion than under semicollusion or competition. Therefore, in Figure 1 the capacity curve is flatter in the collusive regime than in the other two regimes.

Figure 1: Market size and total capacity

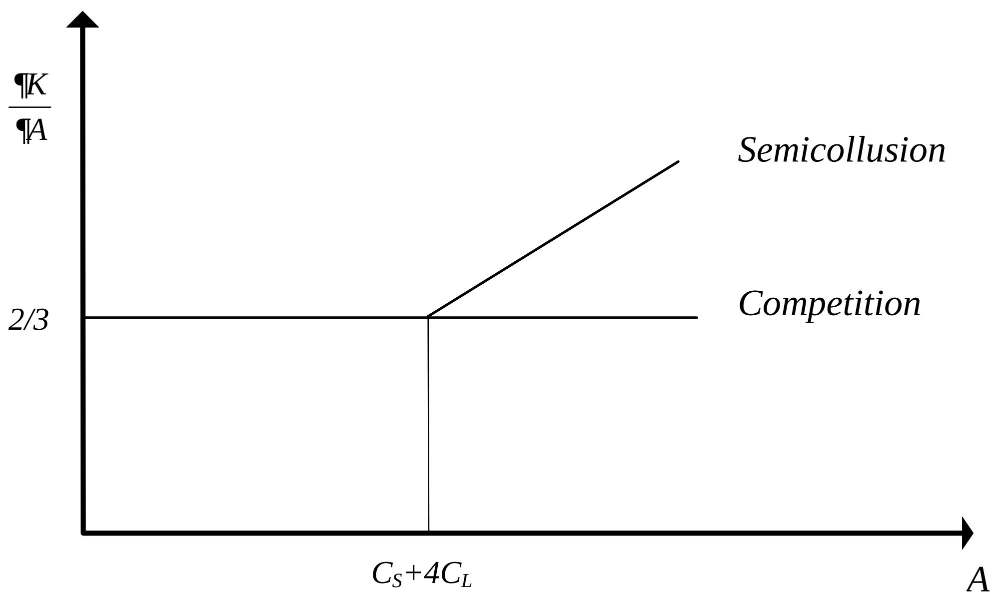


Then we can formulate our first hypothesis, which is relevant for the shift from a regulated regime - which we interpret as a collusive regime - to a deregulated regime:

Hypothesis 1: *If the nature of competition shifts from a collusive regime to either a semicollusive or a competitive regime, a positive shift in the total capacity is observed.*

If we reject the hypothesis that the nature of competition is collusion after the deregulation, the next step would be to distinguish between the two other regimes we have specified. To do so, we have to look at how total capacity is affected by a change in the demand. This is illustrated in Figure 2.

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



Note that the effect on total capacity by a marginal change in the demand is not affected by the market size in the competitive regime. On the other hand, in the semicollusive regime the market size matters. The larger the market size, the larger the effect on total capacity by a marginal change in the demand. Now we can formulate our second hypothesis:

Hypothesis 2: *If a marginal change in the demand has a larger effect in a large than in a small market, then the observation is consistent with a semicollusive regime and inconsistent with a competitive regime.*

To understand the distinction between the semicollusive and the competitive regime, note that an expansion of own capacity will result in a lower price in the competitive regime. This dampens the incentive to expand capacity. In the semicollusive regime, on the other hand, such a capacity expansion does not affect the price. The only - and important - effect, is that it increases the firm's market share, since its market share is determined by its share of total capacity. The larger the market size, the larger the absolute increase in sale by increasing its market share with a certain amount. Hence, a firm has stronger incentives to expand its capacity the larger the size of the market.

3. An econometric model

The Norwegian airline industry has many of the features observed in other European countries. The largest routes in Norway are of almost equal size as the routes between many specific airports inside Europe as well as inside United States.[11] Before 1987 one single firm was given the exclusive right to have flights on each route. Both prices, the number of flights and time location were regulated. However, there are indications that the regulation had only

[11]Not surprisingly, the number of flights between city pairs as, for example, San Francisco-Los Angeles and London-Amsterdam, are much higher than between city pairs in Norway. However, when we take into account the fact that there are several airports in each of these large cities, then the number of flights between specific airports are at the same level as the number of flights on the largest routes in Norway [see Strandenes (1990)].

a minor or no impact at all on the firm's price setting.[12] In October 1987, a second airline was permitted to have a limited number of flights for some particular routes - four flights at a maximum on each route. In April 1994, all routes, except those between the smallest airports, were further deregulated, and free entry for all Norwegian firms were permitted.[13]

In order to test our two hypotheses regarding the effect on capacity following deregulation, we have used annual data for 11 routes for the years 1985-95 (see the Appendix for details concerning the data). The routes are shown in Figure 3. The development in the number of passengers and capacity are shown for four of these routes in Figure 4. Apparently, the capacity increase following deregulation is larger on the two duopoly routes then on the two monopoly routes. What we attempt to achieve in the econometric tests is to see whether differences in capacity changes between routes also hold systematically for all the duopoly routes when we control for factors as changes in size of the market and deregulation.

Figure 3 and 4 here

We specify two main models, one for each hypothesis:

Test of hypothesis 1*: Collusion vs. Competition/Semicollusion*

Model (I) $CAP_{i,t} = a + b_{PAS} PAS_{i,t} + b_{REG94} REG94 + b_{REGMON} REG94 * MON_i + e_{i,t}$

[12]The regulation dates back to the 40s. Each firm had to apply to the civil aviation authorities concerning price changes, typically once every year. Then each firm could argue that they have had cost increases, an argument that the authorities would find difficult to disprove. Norman and Strandenes (1994) have calibrated the market equilibrium on the route Stockholm-Oslo prior to deregulation in 1993, and they conclude that '[i]nsofar our calibrated coefficients seem "reasonable", the regulatory constraint cannot be severe'. (p. 96) Hence, their study give support to our conjecture that the regulation had no substantial impact on the price setting.

[13]The traffic at the smallest airports, all included in the so-called "*kortbanenettet*", was licensed to a third Norwegian carrier; *Widerøe.*

***Test of hypothesis 2**: Competition vs. Semicollusion*

Model (II) $CAP_{i,t} = a + b_{PAS} PAS_{i,t} + b_{REG94} REG94 + b_{REGLARGE} REG94 * LARGE_i + e_{i,t}$

$CAP_{i,t}$ is capacity by routes *i=1-11*, for *t=1985-95*, $PAS_{i,t}$ is the number of passengers by routes representing the demand for airline services, *REG94* the deregulation dummy defined as one for 1994 and onwards, MON_i defines whether a route is a monopoly route also after the deregulation with non-monopoly routes as the reference category.[14] $LARGE_i$ defines the four largest routes, and $\varepsilon_{i,t}$ is an error term with standard properties. The reason for not choosing a continuous variable like passengers to represent size in model (II), is the size structure of these routes, where the four largest routes are on average four times the size of the smaller routes.[15] Furthermore, the four largest routes are very similar in size. See Table A1 in the Appendix for an overview over which routes are included, and how the $LARGE_i$ variable is defined.

In model (I) we test whether deregulation of the Norwegian airline regime led to intense rivalry. By assumption, a collusive regime was reached under regulation. The prediction from theory (Hypotheses 1) is that a shift to a semicollusive or a competitive regime results in a positive shift in total capacity. In model (I) we test this by interacting the regulation indicator variable and the monopoly variable. If this interaction terms is negative, and controlling for the increase in demand by including $PAS_{i,t}$, this implies that deregulation led to increased capacity for the routes shifting from monopoly to duopoly.

Given that we find that deregulation led to an increase in capacity, our second model tests whether deregulation led to a competitive or a semicollusive regime. If a marginal change

[14] An alternative specification would have been to construct the capacity utilisation index (*CU=PAS/CAP*), and used this as the right hand side variable. However, and as noted in footnote 10, the firms might try to sell the extra capacity in the leisure segment, thereby reducing the number of idle seats. If this is the case, *PAS* will become higher, *CU* lower and we would obtain a biased measure of the capacity increase in the business segment using the *CU* measure on the right hand side. Note that if this effect is important, the specification used will also be biased; with *CAP* at the right hand side where we control for the market size using *all* passengers, our test is biased in favour of finding no capacity increase after the deregulation.

in demand for airline services had a stronger impact on total capacity the larger the market is (Hypotheses 2), this would be consistent with a semicollusive regime and inconsistent with a competitive regime. Hence, the main variable in model (II) is thus the interaction term between the size of the market and the regulation indicator, *REG94*LARGE*, defining the impact on capacity of the four largest routes following the deregulation. Again, we control for market size and the deregulation by including the passengers and the regulation dummy also in model (II). A possible problem in model (II) is too much overlap in flights between large routes and duopoly routes; a possible difference between small and large routes mirrors the difference between duopoly and monopoly, rather then the difference between large and small routes. As a refinement of the test between semicollusion and a competition regime, we therefore estimate a second version of model (II) where we only include duopoly routes.

In addition to estimation using OLS we extend the analysis to include fixed effect estimation, an instrument variable technique, and control for heteroscedasticity. The interpretation of the within estimator is that differences over flights which are fixed in the data period and not captured by included variables, particular characteristics such as load factor etc., are controlled for. Since demand for airline services may well be an endogenous variable - and thus a biased control variable in our equations caused by a correlation between the error term and the PAS variable - we instrument out this effect by including instruments expected to be highly correlated with demand for airline services for each route and not correlated with capacity. The included instruments are tax income to the region corresponding to each route, population in the region, and the expenditures of the municipalities in the regions (see the Appendix for details on the construction of these variables). Furthermore, we will expect that heteroscedasticity might be a problem here since increased size of the routes may lead to

[15] On average there are 23.75 flights per day on a large route, a small route have an average of 6.13 flights per

higher variance. Heteroscedasticity is first tested for and then corrected for by using a robust estimator with route size as the grouping variable. For all the models we estimate and report results for the OLS, the Instrument and Instrument/robust estimators.

4. *Empirical results*

Test of hypothesis 1: Collusion vs. Competition/Semicollusion

In Table 1 the results from estimating Model 1 with the four estimators are presented.

Table 1 here

The model explains well the variation in total capacity. The explanatory power is convincing, and the control variables *PAS* and *REG94* have the expected signs and have significant impact. When exploiting the panel structure of the data and estimating with the within estimator, we notice from column 2 that the results from the OLS estimator carrries over. Further, since the variance may increase as a function of route size, we used a Cook-Weisberg test for heteroscedasticity. The H_0 of constant variance is rejected for the OLS specification and a robust estimator utilized to estimate the variance-covariance matrix. Further, since *PAS* is expected to be an endogenous variable, the 2SLS instrument estimator was used. All three estimators, *i.e.*, OLS, 2SLS and 2SLS/robust, show very similar results supporting our general specification.

day (see Table A1 in the Appendix).

The most important result from Table 1 is that the interaction term *REG94*MON* is negative and has a significant impact. This shows that deregulation led to increased capacity for the routes shifting from monopoly to duopoly routes in excess of the increased demand for airline services (the reference groups). Hence, deregulation led to more intense rivalry. However, we cannot use these results to conclude whether the post-regulation regime is a competitive or semicollusive regime. Hence, now we turn to our second model to test hypothesis 2.

Test of hypothesis 2: Competition vs. Semicollusion

Table 2 presents results from estimating Model (II) for all 11 routes where the aim now is to distinguish between semicollusion and competition.

Table 2 here

The within estimator provides support for the OLS results also for this model. The same test for heteroscedasticity was undertaken and a constant variance rejected. Hence, a robust estimator was used. Further, the 2SLS estimator was used since PAS is expected to be endogenous. The four specifications show a very a similar and stable pattern in explaining the variation in total capacity. The control variables have the expected signs and are significantly different from zero.

The interaction term between the variable for deregulation, *REG94*, and the size of the market, *LARGE*, is positive and has a significant impact. It shows that market size matters for the Norwegian airlines' investment in total capacity following a deregulation: Capacity is more sensitive to changes in demand in a large than in a small market. Hence, we are able to distinguish between a semicollusive and competitive regime. Since investment in total capacity following deregulation is predicted from theory to be dependent on market size only when semicollusion characterises the relationship among firms, our results reject a competitive regime.

The four largest routes are all duopoly routes. In order to ensure that the positive relationship between market size and investment in capacity found in model (II) is *not* driven by routes going from monopoly to duopoly (a deregulation effect), but rather is a "pure" size effect, we now estimate model (II) only for the duopoly routes. These results are presented in Table 3.

Table 3 here

The results of Model (II) only for the duopoly routes are parallel to what we found when estimating Model (II) for all routes. Even though the size effect is less significant now – with the exception of the fixed effect estimator where it is not significant at conventional levels -we still find size to have a positive effect on capacity; the interaction term REG94*LARGE is positive in all three models in Table 3.[16] The effect is significant at all conventional levels for the IV-specification. Moreover, the significance level is within 90 percent in both remaining cases (90 percent for the OLS and 93 percent for the IV/robust regressions, respectively).[17]

[16]For the fixed effect estimator the sign of the parameters points in the right direction, but since we are limiting the variation in the data dramatically using the within estimator for only the duopoly routes it is probably to ask too much of the data to expect it to be significant.
[17]An additional explanation for the lower significance in these models, might be that we have considerable fewer observations and thereby less variance.

Hence, even when we only include the duopoly routes we can reject the competitive regime. We found that our results are consistent with a semicollusion regime.[18]

5. *Some concluding remarks*

The purpose of this paper has been to test the effect of the deregulation in the Norwegian airline industry in 1994. Did the two established firms, SAS and Braathens, compete after deregulation? If yes, did they compete on capacity, on price, or both? First, we find that it was a significant increase in capacity on the duopoly routes following deregulation. Hence, we reject our hypothesis that deregulation resulted in collusion on both prices and capacity. Second, we find that a marginal change in demand had a larger effect on large than on small duopoly routes in the period after deregulation. This is consistent with a semicollusive regime, where the firms collude on prices and compete on capacities, and not consistent with a competitive regime where they compete along both dimensions.

Casual observation lends support to what we here have found. Lian (1996) suggests that there is no fierce price competition in the business segment. A representative for Braathens, the public relation manager Audun Tjomsland, explained the lack of fierce price competition in the following way:

> *'The two Norwegian firms on Norwegian routes, Braathens and SAS, are of equal size and can follow each other during a price war. A firm starting a price-war will quickly be followed by the rival firm, so the firm that starts a war will have an advantage only a day or two. Accordingly, the firms are reluctant to trigger a price war' (our translation) [Bergens Tidende, 31/7/95]*

[18] As noted in footnote 14, the possible bias due to low-price sale of idle seats in the leisure segment actually enforce our results. When our models suggest an increase in capacity even when we control for *all* passengers, this implies that our results are even more robust.

Moreover, other statements suggest that the two firms did compete intensely along other dimesions, among others capacity. For example, Braathens explained its poor result in the first quarter of 1996 in the following way:

> *'Braathens explains this [poor result] with an increased competition. The firm has increased its capacity, but it has not helped much. The growth results in an increase in employment and other costs of production (our translation) [Dagens Næringsliv, 10/5/96]*

A few months earlier, SAS had announced several new initiatives:

> *'Among the initiatives are recruitment on the ground and in the cabin, adjustment of time-scheduling of flights, an increase in capacity amounting to 400.000 seats annually, better food on business class between Norway and other countries, .. (our translation) [Bergens Tidende, 9/3/96].*

It is of interest to note that none of them mention price cuts. Hence, these statements are consistent with what we have found: Collusion on prices and competition on capacities. Although the phrase semicollusion is seldom used, we find numerous examples of this phenomenon in real life.[19] So we find indications that this is just another example of such a phenomenon, which illustrates that such a nature of competition should be taken into consideration as one possible scenario when discussing the possible effects of deregulating a particular industry.

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[19]Price collusion led to intense rivalry on advertising in the American cigarette industry [see Scherer (1980), p. 388-389], the installing of excess capacity in the German [see Scherer (1980), p. 370] as well as the US cement industry [see Scherer and Ross (1990), p. 674], and to excess capacity in ocean shipping [see Scherer and Ross (1990), p. 674]. The existence of cartels in the domestic Japanese market, where quotas were allocated according to relative capacity, led to excess capacity in many Japanese industries during the 50s and 60s [see Matsui (1989)]. The price cartel in the Norwegian cement market led to the installment of excess capacity in the Norwegian cement industry in the 50s and 60s, which showed up as a large increase in exports [see Steen and Sørgard (1998)].

Appendix - 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 A1:

Table A1 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

**/ <u>*Routes 11 and 12*</u>

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). To adjust for this effect, the following are done:

- 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, the capacity 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 A2 summarises the municipals, and their airport region codes.

Table A2 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	Samnan-ger	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	5 - Bergen	9 - Trondheim
2 - Kristiansand	6 - Ålesund	10 - Bodø
3 - Stavanger	7 - Molde	11 - Tromsø
4 - Haugesund	8 - Kristiansund	

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							
$\bar{R}^2$	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							
$\bar{R}^2$	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							
$\bar{R}^2$	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*

Available on request to the authors

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

Available on request to the authors

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