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**Simulating the Effects of an Acquisition  
in the Ferry Market**

by

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# *Simulating the Effects of an Acquisition in the Ferry Market<sup>Φ</sup>*

by

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## **Abstract:**

Numerical models have been applied in several merger studies during the last decade. The purpose of this paper is to discuss some modeling issues that have not been addressed in detail in the existing literature on merger simulation. First, we argue that in many instances both the pre- and the post-merger situation differ from the straightforward definition applied in most simulation studies. It is shown that the predictions from merger simulation studies may depend crucially on the definition of the pre- and post-merger alternatives. Second, we argue that the presence of multi-product firms complicates the numerical modeling. The calibration procedure is certainly not as simple as for single-product firms and it may be decisive for the simulation results. An acquisition in the ferry market for the transportation of cars and passengers between Norway and Denmark serves to illustrate the methodological issues.

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## 1. Introduction

The theory of mergers has provided us with detailed knowledge about possible anti-competitive effects of a merger.<sup>1</sup> However, the analysis is often highly stylized and focusing on only one issue at a time. Then the theory of mergers is not very helpful as a tool for examining the overall effect of a merger. For example, would we expect a merger to increase prices by 5% or 25%? Answer to such a question is of vital importance not only to the firms participating in the merger, but also to antitrust authorities that must decide whether they should permit the merger or ban it. The traditional merger analysis, often called structural merger policy, is rarely quantitative.<sup>2</sup> As a response to this shortcoming, it has been suggested to use simulation models in merger analysis.

The basic approach in merger simulation studies is straightforward. The starting point is the present situation. Prices and quantities are observed, and there may be some empirical evidence on price elasticities. Based on such information a numerical model is calibrated so that its solution equals the observed prices and quantities. This is the pre-merger situation. A proposed merger would, if permitted by the antitrust authorities, imply that firms reconsider their price (or quantity) setting. Such a future situation is at present hypothetical, and the numerical model can be used to simulate the post-merger situation (See Willig, 1991). Then the post- and pre-merger situation can be compared, and the simulation study has provided information about the possible price increase following a merger. As pointed out in Werden and Froeb (1996, p.66), 'simple simulations are relatively easy to do and require little information beyond that required to compute market shares'.

We certainly agree that a simulation model can be an important tool in analyzing mergers and acquisitions. As with any tool, however, inappropriate use may cause harm. In this paper we point to two issues that presumably would be of importance in many

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<sup>1</sup>It has also been helpful in determining whether a merger should be permitted by the anti trust authorities without any further examination or not. One approach is to focus on the welfare effects of a merger. Both Farrell and Shapiro (1990) and McAfee and Williams (1992) propose simple sufficiency criteria for when a merger is expected to improve welfare. In both studies, as well as in several other studies, market shares are decisive for whether one should permit a merger without any further examination. Another approach is to check whether the expected reduction in marginal cost is large enough to prevent any price increase following a merger. Both Willig (1991) and Werden (1996) provide a method for determining whether a merger is expected to have price-increasing effects.

<sup>2</sup>Werden and Froeb (1996) criticize the structural merger policy: '... presumptions from market shares are supplemented primarily by the personal impressions and strongly held prior beliefs of enforcement officials, expert witnesses, and judges' (p. 65).

merger simulation studies, but seemingly have been neglected so far. We illustrate our points with a simulation study of an acquisition in a Nordic ferry market.

The first issue is that the definition of which situations to compare may not be as straightforward as described above. Some mergers and acquisitions are triggered by expectations about future competition. For example, the number of mergers and acquisitions increased in the years prior to the establishment of an internal market in the EU in 1992.<sup>3</sup> One interpretation may be that firms merged to prevent a more competitive market in the future. From this perspective, the present situation is irrelevant and it may provide a poor prediction for the future competitive level in the industry if the merger is not implemented. Next, a merger may trigger entry or other mergers. Then also the post-merger situation may be more complicated to describe. We show that the predictions from merger simulation studies may depend crucially on the assumptions concerning the pre-merger as well as the post-merger situation.

Our second point is that despite the fact that many industries have multi-product firms, this feature is not encompassed in the existing merger simulation studies, which largely considers one-product firms. We show that the existence of multi-product firms can be of great importance for the results from simulation studies. The reason for this is that multi-product firms complicate the calibration procedure. In such a setting one could easily end up with unrealistically calibrated parameter values, which subsequently may produce meaningless results.

Quantifying the effects of a merger dates back to Williamson (1968). He used a simple numerical example to illustrate that even a modest cost reduction following a merger could outweigh the dead weight loss associated with a price increase. But it was not until the 90s that merger simulation studies were introduced.<sup>4</sup> Perhaps the most active researchers in this area are Gregory J. Werden and Luke M. Froeb. They have, either alone or jointly with other co-authors, published numerous simulation studies.<sup>5</sup> As far as we know, neither their nor others' merger simulation studies have elaborated on any of the two issues we have raised. One exception is Werden and Froeb (1998), who have analyzed the post-merger situation in more detail than other studies have done. They consider whether entry in the post-merger situation could prevent or reverse

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<sup>3</sup>See Allen, Gasiorok, and Smith (1998).

<sup>4</sup>One earlier contribution, though, is Baker and Bresnahan (1985). They calculated the price effects of several mergers in the US beer market.

anticompetitive effects from mergers. They find that it is unlikely that a merger will induce entry.

The article is organized as follows. In Section 2 we describe the industry in question, the ferry market for transportation of cars and passengers between Norway and Denmark. The case we focus on, an acquisition that took place in 1996, is discussed in Section 3. In particular, we elaborate on the possible market outcomes that may emerge subsequent to a decision by Color Line to acquire Larvik Scandi Line versus the market outcome that may emerge if no acquisition had been made. In Section 4 we proceed by calibrating a numerical model for this particular industry, with a particular emphasis on the problems associated with modeling multi-product firms. The model is then used to simulate market outcomes. Section 6 contains some concluding remarks.

## **2. The industry**

Our case concerns Color Line's acquisition of Larvik Line, which is one among several lines sailing between Norwegian and foreign ports, mainly in Northern Denmark. Figure 1 displays the sailing-pattern of the lines from Southern and Eastern Norway in 1995. There are two neighboring segments in the market: lines from Western Norway to England, but also one line to Denmark, and there are lines from Western Sweden to Denmark. Based on a co-integration analysis of all Norwegian lines, Steen and Sjørgard (1999) concluded that the lines to and from Western Norway made up a separate segment of the market. We do not know of a similar analysis regarding the relationship between Norwegian and Swedish lines to Denmark. For Norwegians living to the southeast of Oslo, Stena Line's sailing to and from Göteborg obviously provides an alternative to the lines to and from Moss or Oslo. As our focus is on the operations on the western side of the Oslo-fjord, however, we will assume that these Swedish lines have such a small influence upon the operations of lines in our segment that they can be disregarded. Hence we shall restrict our attention to the lines operating out of Southeastern Norway.

*[Figure 1 approximately here – see page 31]*

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<sup>5</sup>See, for example, Crooke et al. (1997), Froeb and Werden (1992), Werden and Froeb (1994, 1996, 1998).

We observed some changes in the sailings in 1996. Stena Line replaced the route Oslo-Moss-Frederikshavn with a direct sailing from Oslo to Frederikshavn. Larvik Line responded by replacing its sailing from Larvik to Fredrikshavn with the sailing Larvik-Moss-Frederikshavn. Seven lines were operated by four companies in summer 1996 (see Table 1 for details). Color Line operated three sailings; Larvik Scandi Line operated Larvik Line's and Scandi Line's sailings; Stena Line and DFDS operated one sailing each. These companies are still operating, although the ownership of one line was changed when Larvik Scandi Line (LSL) sold its Larvik Line (LL) to Color Line (CL) by the end of 1996. From then on Color Line operated four sailings, its three original lines and the line owned by Larvik Line.<sup>6</sup>

**Table 1. Companies and lines prior to the acquisition in 1996.**

Line <sup>1</sup>	Company	Port: from – to	Sailing time (hours)	Market share
CLOK	Color Line	Oslo – Kiel	19.5	0.09
CLOH	Color Line	Oslo – Hirtshals	12.5	0.09
CLKH	Color Line	Kristiansand – Hirtshals	4.5	0.22
LSLF	Larvik Line <sup>2</sup>	Larvik – Frederikshavn-Moss	--	0.24
LSSS	Scandi Line <sup>2</sup>	Sandefjord – Strømstad	2.5	0.12
STOF	Stena Line	Oslo – Frederikshavn	12.5	0.11
DFOØ	DFDS	Oslo – København	16.25	0.13

<sup>1</sup> The two first letters denote company and the latter two denote ports (from – to).

<sup>2</sup> Owned by Larvik Scandi Line

Note that none of the lines sail between the same pair of ports. Although 5 lines sail between Norway and Denmark, there are geographical differences. Presumably, a passenger living to the north or east of Oslo would prefer lines from Oslo or Moss, while those living to the south or west of Oslo would prefer lines from Larvik or Kristiansand. This observation provides a basis for product differentiation. Being on board these ferries, it is hard to spot any basis for differentiation, although companies may try to do so. Since there are no directly parallel lines, lines are probably not very close substitutes.

<sup>6</sup>After the acquisition, the line Sandefjord-Strømstad was an independent line, owned by Larvik Scandi Line. Larvik Scandi Line also owned 44.5% of the shares in Color Line after the acquisition. We assume that after the acquisition, Color Line and Larvik Scandi Line do not coordinate their price setting. In September 1998, though, Color Group was established and all four Color Line sailings as well as the Larvik Scandi Line sailings are owned by the new firm. From then on it would be natural to assume that all five routes are coordinated. In what follows, we focus on the case where Color Line coordinates their own four sailings after the acquisition.

Steen and Sjørgard (1999) identified two types of passengers in this market.<sup>7</sup> One type is the 'family' going to Denmark or further south on the Continent for (summer) vacation. They will typically bring a car. The other type is the round-trip passenger who is out for fun, good meals, entertainment and tax-free items on board. He will typically not bring his car. We denote these two types 'vacation' and 'tax-free' passengers, respectively. The vacation type travels mainly during the months June – August, in conjunction with school breaks. He causes a large peak in demand in these months, and because he brings a car, the ship's car-carrying capacity becomes a binding constraint. The other type travels more evenly throughout the year. He does not bring a car and the ships' car-carrying capacity is largely non-binding outside the summer months. Even though the companies try to obtain a better match by modifying their supply and inducing demand through their pricing, there is a very distinct variation in capacity utilization over seasons.

The number of passengers in this market grew fairly steadily at an average of 5.5 % over the period 1984-97. The company and sailing structures were stable from 1990 onwards. Steen and Sjørgard (1999) characterize the situation as peaceful coexistence. Then by the mid 90s new technology became available in terms of fast passenger vessels. In the fall of 1994, LL announced that it would introduce such a vessel next summer. This would halve the travel time between Larvik and Skagen (in Northern Denmark) and presumably attract passengers from both its own line and from CL's line from Kristiansand. Because of technical problems, however, the introduction was cancelled and postponed till 1996.

In January 1995 it became publicly known that CL and LSL had decided to merge. At the same time Nils Olav Sunde started to buy shares in LSL, and by early February he owned 45%. He opposed the merger, and it was cancelled.

Now followed a period where LSL and CL, and at one time also Stena Line, announced intentions of, and also taking initiatives to, expanding operations. Apparently, LSL under its new and more aggressive leadership took the lead and threatened to increase capacities. There were plans and initiatives to increase capacities on existing lines as well as to establish new lines in much more direct competition with others than

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<sup>7</sup>For some analyses it might be relevant to identify other types as well, e.g. conference participants. They tend to flock to the longer routes to Kiel and Copenhagen, which are of marginal importance to the present analysis.



previously.<sup>8</sup> The plans involved both fast passenger vessels and more conventional ferries. Actions and reactions mounted to a threat of massive increase of capacity in the Kristiansand-Larvik region presumably leading to fierce competition. Being the dominant player, CL seemed to realize that such collective expansion of capacity could only hurt all companies and stated publicly that it would not go first. By mid summer 1996 CL had ended up committing itself to expansions and effectively played its cards. In particular, CL had decided to open a new line on October 21 1996 from Langesund to Hirtshals. Langesund is located close to Larvik Line's main harbor in Norway, Larvik, and both Hirtshals and LSL's harbor Fredrikshavn are located in Northern Denmark. Whatever LSL would do next, could probably not attract any further reactions from CL and would only reduce CL's profits.

In early September 1996, Olav Nils Sunde owned 90% of the shares in LSL. On September 25 he proposed to sell the Larvik Line to CL contingent on buying a major share of CL's stock. Within a few days a deal was struck, whereby Sunde through LSL owns 44.5% of the much larger company CL. On October 14, 1996, a few days after the acquisition was formally decided and only one week before its announced opening, CL cancelled the new line from Langesund to Hirtshals. Furthermore, CL split the former LSL sailing Larvik-Fredrikshavn-Moss into two separate lines: Larvik-Fredrikshavn and Moss-Hirtshals, where the former can be viewed as a replacement for the cancelled route.

As seen from Table 1, this acquisition increased CL's already large market share from 0.40 to 0.64 in the overall market (of Eastern and Southern Norway) and effectively changed a duopoly into a monopoly in the transportation between the Kristiansand-Larvik region and Northern Denmark. Norwegian Competition Authorities (NCA) investigated the acquisition, but decided to permit it rather than ban it.

### **3. Market outcomes**

What if CL had decided not to acquire LSL, or NCA had banned the acquisition? Willig (1991) suggested that one could evaluate the consequences of such a decision by

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<sup>8</sup>E.g. Color Line announced in January 1996 the introduction of two fast ferries operating Langesund – Frederikshavn – Gotenburg by May 1. The first leg would almost overlap the Larvik Line, and the second leg would enter 'Swedish' waters and thus Stena Line's territory. Stena Line announced in April that it would introduce by mid June a fast vessel sailing between Kristiansand and Hirtshals, a complete overlap with Color Line's sailing. A few weeks later there were rumors that Larvik Scandi Line also would

comparing the pre- and post-acquisition industry structure. Apparently, this is a clear-cut proposition. Applied to the actual acquisition, one would describe the shift in coordination of existing lines. In the pre-acquisition industry, CL coordinates the first three lines (of Table 1), LSL coordinates the next two, and two companies have one line each. In a post-acquisition situation, CL coordinates the first four lines, while LSI and the other two companies have one line each. Figure 2 displays a sequence of decisions starting at node I with Color Line's decision leading to nodes II or III. Willig's proposal is to compare outcome 1 and 7 in Figure 2.

We suggest, however, that the alternatives may not always be evident.<sup>9</sup> Consider again our case. The pre-acquisition industry structure may not provide the relevant description of a future situation following a no acquisition decision. Presumably CL and LSI would continue as rivals. Prior to the acquisition, CL had threatened to establish a new line parallel to LSL's sailing to Denmark, and vice versa.<sup>10</sup> Both firms had also in other ways as well threatened to increase their capacities, and CL for example had negotiated a contract for additional capacity. If these threats were executed, and technically they could be implemented within months, more intense rivalry could emerge. That would definitely be different from the pre-acquisition situation. As illustrated in Figure 2, a no acquisition decision may trigger a prisoner's dilemma outcome. The firms would jointly lose from a capacity expansion, but it could be individually rational to expand capacity. If so, the outcome in the no acquisition scenario would be outcome 4 in Figure 2.

Could such an intense rivalry prevail? The companies had managed to operate for a long period of time in an apparently peaceful coexistence. Probably, they might realize that both would gain from restoring such a situation, e.g. by dropping or rescheduling lines. If so, one might argue that a price war, if any, would be of such short duration that it could be neglected in the analysis, whereby the pre-acquisition structure could provide a relevant description of the outcome after all. Figure 2 represents this possibility as outcome 1. Let us emphasize, however, that although there had been peaceful coexistence

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introduce fast vessels on Kristiansand by mid June. Larvik Scandi Line never stated such plans publicly, but made other announcements that signaled increased supply.

<sup>9</sup>Cotterill and Haller (1997) describe a case where they contend that two firms A and B had cooperated during the last years before A formally acquired B. They suggested that the comparison should be between the cooperative pre merger solution and a solution where A divested of B, thereby reversing the order of Willig's pre and post merger situations.

<sup>10</sup>See Steen and Sjørgard (1999), Appendix 4.

for several years, two recent changes might cause a break-down: new technology in terms of fast vessels and Sunde, the new and more aggressive leader of LSI.

Let us now consider the potential industrial structure following an acceptance. In its analysis NCA suggested that the acquisition could induce entry by Stena Line.<sup>11</sup> If such entry would take place, whereby the industry moved to node IV of Figure 2, the anti-competitive effects of the acquisition could be dampened or even reversed. This claim is among the issues that a simulation could provide insight into. By including another line in the model one could compute the net contribution to Stena Line from entry and compare that to its fixed costs of entering. Based on such information one could evaluate whether an entry is likely, that is whether the industry would end up in outcome 5 or 6 versus outcome 7.

*[Figure 2 approximately here – see page 32]*

In retrospect, Steen and Sjørgard (1999) observe that such entry did not materialize during the first three years, even though there are indications that prices rose following the acquisition.<sup>12</sup> They suggested that one motivation for Stena Line (in addition to fixed costs) could be an expected retaliation, *e.g.*, in the form of CL entering into SL's territory and thereby reducing SL's profits from those operations.<sup>13</sup> In line with this argument, entry by Stena Line would trigger outcome 5.

## **4. A numerical model**

### **4.1 Market delineation**

Before we can formulate and calibrate a numerical model, we have to make a decision concerning the relevant market. At one stage during its analysis the NCA argued that

'based on [...] present information, [NCA] cannot to a sufficient degree substantiate that this market for passenger transportation by ferries can be isolated from other alternative means of transportation and travel products.' (Referred in Steen and Sjørgard, 1999, p. 72)

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<sup>11</sup> See the quotes from internal documents in the NCA, referred to by Steen and Sjørgard (1999, p. 73).

<sup>12</sup> Steen and Sjørgard (1999, Appendix 4) report several price increases in the period after the acquisition.

<sup>13</sup> Note from Figure 1 that Stena Line sails from Oslo, while Color Lines' largest route departs from Southern Norway. Steen and Sjørgard (1999) argue that if Stena Line introduces a new line from Kristiansand, Color Line could respond by expanding its capacity from Oslo or Moss.

In line with such a broad market definition, which would include e.g. railway and hotels, there would be no reason whatsoever for CL or any other ferry company to respond to other ferry companies' actions. The many examples of strategic interaction between ferry companies are inconsistent with such a broad definition of the relevant market. The substantial change in line structure that CL's announced just after the acquisition was decided, e.g. the cancellation of the opening of a new route from Langesund, is also inconsistent with this view of the relevant market. Thus, we will assume that companies outside the ferry market are not part of the relevant market.

Based on the location of the various lines (see the map in Figure 1), Hotelling's model suggests a basis for product differentiation. A traveler will experience different transportation costs for joining up to and coming off these lines. Geography or distance will be our basis for product differentiation. Being on board these ferries, it is hard to spot any other basis for differentiation. Essentially, they provide the same services and items. Steen and Sjørgard (1999) concluded that the eastern and southern ferry market out of Norway represents one integrated market where lines compete. They did not rule out the possibility, however, of some regional segmentation, e.g. that lines from Larvik and Kristiansand make up one segment and lines from Oslo and Moss another. Judging from the distances between ports, it seems less likely that the market is more finely segmented, e.g. to the extent that lines from different ports represent *unrelated* segments, although this seems to be the conclusion of the Norwegian Competition Authorities.<sup>14</sup> Our modeling allows a mixture of the two end points: Lines are neither symmetric substitutes for each other nor isolated markets, rather they have different degrees of closeness.

So far we have concentrated our discussion entirely to Norwegian ports. Destinations also count in a traveler's choice among lines, and of course travel plans for foreigners visiting Norway add to demand. Figure 1 shows that 4 out of 7 lines are destined for Northern Denmark, namely the ports Hirtshals and Frederikshavn. From a destination point of view, these lines should be close substitutes for all kinds of travelers. On the other hand, one would think that the line crossing the Oslo-fjord, taking cars and passengers between Norway and Sweden, is a poor substitute for these five lines. Also, one would think that the two lines from Oslo to Copenhagen and Kiel (in Germany)

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<sup>14</sup>In an internal document, dated December 18 1996, NCA concluded that the relevant market was either the total leisure segment (including the hotel industry) or each ferry route (see p. 20 in the internal document).

would be more distant substitutes to the five lines destined for Northern Denmark, while the two may be fairly close substitutes to each other and form a separate segment.

## 4.2 Decision variables

There are at least two issues here. One is whether we should consider the company or the line (product) as the unit of the analysis. The other issue is the familiar price or quantity question. The above discussion of product differentiation has largely settled the first issue. Aggregating Color Line's three different lines into a company-wide activity level, would eliminate the geographical structure and hence our basis for differentiation. We would think that for our purpose a roughly calibrated demand system for seven lines would be superior to an estimated demand system for four companies.<sup>15</sup> That is, model structure is probably the most important part of the empirical description in our case.

We can either use price setting (Bertrand) or quantity setting (Cournot). According to Kreps and Scheinkman (1983), a quantity setting model can be interpreted as if firms compete on capacities. Although capacity seems to be important in this industry, the previous discussion has indicated that capacity is quite flexible. Ships can be moved from one line to another, and companies can rent additional ships. When capacities are not binding, it has been argued that a price-setting model is a better choice than a quantity setting model (Tirole, 1988, p. 223-4). We have therefore chosen to use a price setting model.<sup>16</sup> This is in line with the assumption used in most other merger simulation studies.<sup>17</sup>

## 4.3 Model formulation.

Assume that there are  $n$  products and  $m$  firms in the market. Let  $i$  and  $f$  denote product respectively company, and let  $I(f)$  denote the set of indices for products operated by company  $f$ . Although there may be some economies of scope in this industry, we think they are small and shall assume a very simple cost structure, namely line specific and

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<sup>15</sup>Without data for estimating a system of demand functions, the choice is rather self evident.

<sup>16</sup>Mathiesen (2000) employed both price and quantity models for his analysis of this acquisition. He found that the quantity model produced somewhat larger price and quantity changes than did the price model.

<sup>17</sup>Willig (1991) suggested the price-setting oligopoly model for merger analyses, and the studies by Froeb and Werden employ price-setting models. Borenstein and Bushnell (1999) and Borenstein *et al.* (1999), however, use a homogeneous product Cournot-model.

constant variable costs and firm specific fixed costs. This seems to be customary in such analyses. Let

$p_i$	denote the price of product $i$ , $i=1, \dots, n$ ,
$x_i = x_i(p_1, \dots, p_n)$	denote the demand for product $i$ as a function of all prices,
$C_i(x_i) = c_i x_i$	denote the cost function for operating line $i$ ,
$F_f$	denote the fixed costs of company $f$ , and
$\Pi_f = \sum_{i \in I(f)} (p_i x_i - C_i(x_i)) - F_f$	denote the profit of company $f$ operating lines $i \in I(f)$ .

The first order condition for optimal price for firm  $f$ 's product  $i$  is<sup>18</sup>:

$$(1) \quad \partial \Pi_f / \partial p_i = x_i + \sum_{j \in I(f)} (p_j - c_j) (\partial x_j / \partial p_i) = 0, \quad i \in I(f)$$

If  $f$  denotes a one-product company, so that the summation contains only one term, the optimal price balances the marginal increase in income on the  $x_i$  units sold and the lost contribution from the reduced sales;  $(p_i - c_i) \partial x_i / \partial p_i < 0$ . For a multi-product company, the summation contains a negative own-price effect as well as a positive cross-price effect ( $\partial x_j / \partial p_i > 0$ ) from all its products  $j$ ,  $j \neq i$ . The increase of price  $i$  augments demand for product  $j$ , bringing additional contribution  $(p_j - c_j)$ , which alleviates the loss of contribution on product  $i$ . This model therefore predicts that product  $i$  will be priced higher within the portfolio of a multi-product company than by a single-product company.<sup>19</sup> The summation running over all its products thus coordinates the company's price setting.

We shall assume that demand for product  $i$  is described by a linear function<sup>20</sup>:

$$(2) \quad x_i = d_i + \sum_j a_{ij} p_j, \quad i=1, \dots, n.$$

Thus the first-order condition (1) becomes

$$(1') \quad \partial \Pi_f / \partial p_i = x_i + \sum_{j \in I(f)} (p_j - c_j) a_{ji} = 0, \quad i \in I(f)$$

<sup>18</sup> By writing an equality, we assume that product  $i$  is supplied to the market. That is, we assume  $P_i' > c_i$ , where  $P_i'$  chokes demand for product  $i$  and solves  $0 = x_i(p_1^*, \dots, P_i', \dots, p_n^*)$ , where  $p_i^*$  denotes the optimal price for product  $j \neq i$ .

<sup>19</sup> This is the same argument as for the price increase on the products of a merged company.

#### 4.4 Calibration

We do not have an estimated demand system or any cost functions for the ferry market. Hence, we shall have to calibrate the entire model. We think many researchers are in this position and we therefore consider some issues related to calibration. In merger analysis the demand system gets virtually all the attention.<sup>21</sup> Marginal costs are assumed constant over the relevant range of volume changes, and only their values remain to be stipulated. The following seems to be a widely used procedure for calibration<sup>22</sup>:

- i) Pick some point  $(P_i, X_i)$ ,  $i=1, \dots, n$ ,<sup>23</sup> for the calibration of demand functions. This is often taken to be the most recent observation of these variables.
- ii) Assume a (sufficient) set of parameters in order to establish a demand system.
- iii) Using the above-mentioned parameters, compute the marginal cost parameter from the first order condition.

#### 4.5 Calibration of demand

In a partial equilibrium context such as ours, it is necessary to distinguish between two kinds of competition in the marketplace: The competition internal to the market, *i.e.*, between the firms in the (relevant) market, and that external to the market. The demand for  $n$  differentiated products in a non-segmented market can thus be characterized by two parameters, one representing the external and one representing the internal competition. Cf. Werden and Froeb (1994) who calibrate Logit demand functions by specifying two parameters  $\beta$  and  $\varepsilon$ .  $\beta$  is a scale parameter for cross-price elasticities and represents internal competition.  $\varepsilon$  is interpreted as ‘the elasticity of the inside good’ and represents what we call the external competition. Consider a one-percent increase in the prices of all products in the relevant market and define

$$(3) \quad \varepsilon_i \equiv \sum_j \varepsilon_{ij}$$

---

<sup>20</sup> Crooke et al. (1997) simulate mergers with four different demand functions, and show that the linear function provides the smallest changes in prices and quantities resulting from the merger. The differences between predictions from the linear and the Logit-function, were rather small.

<sup>21</sup> See Cotterill and Haller (1997), Cotterill *et al.* (2000), Nevo (1998), Werden and Froeb (1994).

<sup>22</sup> See Willig (1991) and Werden and Froeb (1994) in merger analysis and for example Smith and Venables (1988) in the international trade literature.

<sup>23</sup> Upper-case symbols denote observed or given values for model parameters.

where  $\varepsilon_{ij} = (\partial x_i / \partial p_j) / (p_j / x_i)$ ,  $i, j = 1, \dots, n$ , denotes the partial price elasticity. Assume that we have a symmetric setting whereby external elasticities are equal ( $\varepsilon_i = \varepsilon'$ ,  $i = 1, \dots, n$ ) and cross-price elasticities are equal ( $\varepsilon_{ij} = \beta'$  for  $j \neq i$ ,  $i, j = 1, \dots, n$ ). The own-price elasticity for product  $i$  can then be computed from (3) as

$$\varepsilon_{ii} = \varepsilon_i - \sum_{j \neq i} \varepsilon_{ij} = \varepsilon' - (n-1)\beta',$$

that is, as the sum of the external and internal elasticity (competition) in the market.

We adapt this procedure to the calibration of the linear functions. First stipulate

$$(4) \quad \varepsilon_i = \varepsilon' \text{ for all } i, \quad \varepsilon_{ij} = \beta' \text{ for all } j \neq i, \text{ and compute } \varepsilon_{ii} = \varepsilon' - (n-1)\beta', \quad i = 1, \dots, n.$$

Then compute demand parameters based on elasticities ( $\varepsilon_{ij}$ ) and observed values ( $X_i, P_i$ )

$$(5.1) \quad a_{ij} = \varepsilon_{ij} (X_j / P_j) \text{ for } i, j = 1, \dots, n \text{ and}$$

$$(5.2) \quad d_i = X_i - \sum_j a_{ij} P_j \text{ for } i = 1, \dots, n.$$

The linear demand system given by (2) and (5) has the stipulated elasticities at the observed prices and higher elasticities for higher prices.

#### 4.6 Calibration of marginal cost

Applying the above-mentioned three-step routine to a single-product company illustrates why it is so popular. Consider (1')

$$(6) \quad \begin{aligned} \partial \Pi / \partial p_i &= x_i + a_{ii} (p_i - c_i) \\ &= x_i + (\varepsilon_{ii} X_i / P_i) (p_i - c_i) \\ &= X_i [1 + \varepsilon_{ii} (P_i - c_i) / P_i] = 0, \end{aligned}$$

where the first substitution is for a calibrated demand parameter ( $a_{ii} = \varepsilon_{ii} X_i / P_i$ , see (5.1)), and the second substitution is the requirement that the benchmark values ( $P_i, X_i$ ) be solutions to the model. We observe that (6) holds for all values  $X_i$ , which implies



$$(6') \quad (P_i - c_i)/P_i = -(1/\varepsilon_{ii}).$$

This says that at the optimum the Lerner-index shall equal the inverse of the own-price elasticity. This well-known equilibrium condition applied to the parameters of the model makes one of the three parameters ( $P_i$ ,  $c_i$ ,  $\varepsilon_{ii}$ ) dependent upon the other two. Thus, if we require that i) the optimal price  $p_i^* = P_i$  and ii) the own-price elasticity of demand  $\varepsilon_{ii} = \varepsilon'_{ii}$ , the marginal cost is determined (residually) as

$$(6'') \quad c_i = P_i(1+1/\varepsilon'_{ii}).$$

When  $f$  is a multi-product company, the analogous of (6) is derived as

$$\begin{aligned} \partial \Pi_f / \partial p_i &= x_i + \sum_{j \in I(f)} (p_j - c_j) a_{ji} \\ &= x_i + \sum_{j \in I(f)} (p_j - c_j) (\varepsilon_{ji} X_j / P_i) \\ (7) \quad &= X_i + \sum_{j \in I(f)} (P_j - c_j) (\varepsilon_{ji} X_j / P_i) = 0. \end{aligned}$$

This is a system of equations that must be solved simultaneously in order to obtain the  $c_i$ 's. Observe that both in (6) and (7),  $c_i$  is computed residually so that all uncertainty about demand parameters and noise in observations, e.g. that  $(P_i, X_i)$  may not be an equilibrium, is translated into parameter  $c_i$ .

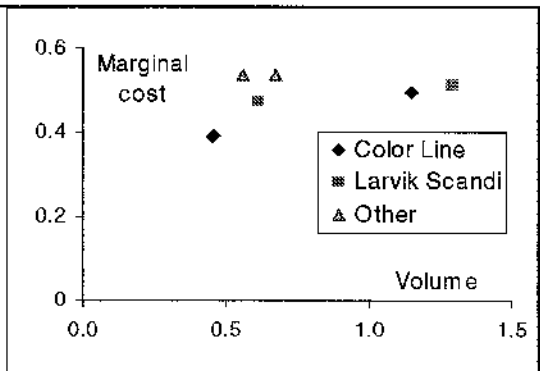
Let us illustrate the dangers of the preceding calibration procedure.<sup>24</sup> Consider a market of 7 products with ownership structure and volumes as in our ferry market and shown in columns two respectively three of Table 2. Note that we let route four be a route between Larvik and Frederikshavn, excluding the route Moss-Frederikshavn since it has only a market share of 4 %. Calibrate a linear demand system to observed volumes and prices  $P_i = 0.75$ ,  $i=1, \dots, 7$ . Assume that all cross-price elasticities are equal ( $\beta'$ ) and that the external elasticity  $\varepsilon_i = \varepsilon'_i = -0.5$ . Own-price elasticities are  $\varepsilon_{ii} = \varepsilon' - (n-1)\beta'$ . The last four columns of Table 2 show computed marginal costs for different values of the cross-price elasticity ( $\beta'$ ) ( $e_{ij}$  in the first row) and the corresponding own-price elasticity ( $e_{ii}$  in

<sup>24</sup>Werden and Froeb (1994) hint at this problem when suggesting that products, for which the routine may compute negative marginal costs, should be left out of the model.

the second row). Lines STOF and DFOØ get equal marginal costs independent of their volumes (see (6')). The other five products being part of either of two portfolios have marginal costs varying with their volumes. (See (7).)

**Table 2. Calibrated marginal cost for different values of cross-price elasticities.**

		$e_{ij}$	0.1	0.3	0.5	0.7
		$e_{ii}$	-1.1	-2.3	-3.5	-4.8
Line	Comp. Vol.		mc	mc	mc	mc
CLOK	A	0.46	-0.19	0.23	0.39	0.48
CLOH	A	0.46	-0.19	0.23	0.39	0.48
CLKH	A	1.15	0.00	0.37	0.49	0.56
LLLF	B	1.29	0.03	0.39	0.51	0.57
STOF	C	0.56	0.07	0.42	0.54	0.59
DFOØ	D	0.67	0.07	0.42	0.54	0.59
SCSS	B	0.62	-0.05	0.34	0.48	0.54



There are several features about how these numbers come out that we certainly do not like. First, we see that for low cross-price elasticities (values below 0.15), the marginal costs of some of company A's products are negative. Next, even when  $\beta' = 0.5$ , the computed marginal costs of company A differ too much across lines to be appreciated when these lines represent products that are horizontally differentiated and presumably fairly similar. Furthermore, these computed marginal costs are positively related to market shares (volumes), which also is contrary to intuition. (The Figure displays the case where  $\beta' = 0.5$ ). The only feature that does not seem undesirable is the fact that marginal costs of companies with larger portfolios are smaller.

The motivation for computing  $c_i$  residually is the claim that the outside researcher seldom has access to information on costs. Thus, the routine provides a convenient route around a data problem. But unless he has data to estimate a demand system, the researcher would usually know as much (or little) about costs as he knows about demand parameters. After all, cost information is regularly provided to the financial market. Furthermore, the depth of insight into the operations of an industry that the researcher would need in order to construct a reasonably structured model, would certainly give him some feel for the level of marginal costs as well. We therefore suggest that the calibration routine should be based upon 'what do we know and how well?' For example, one might be better off computing some elasticity parameter residually. In both cases, however, one piece of information, either on marginal cost or elasticities, is thrown away. In a situation

of little and vague information, a better procedure would be to discard no information, but rather use all pieces of evidence to calibrate the parameters of the model.<sup>25</sup>

Unfortunately, we do not have such a procedure available.

#### 4.7 Changes to the market structure

By definition, the static modeling methodology does not consider structural changes like new products or relocation of old ones, entrants, etc. Expanding our analysis in order to get further insight into the economies of potential responses to an acquisition, one would like to model structural changes like new lines. Within the homogeneous product Cournot model this is simple, just add a new supplier. Except for possibly different costs, a newcomer competes on equal basis with the incumbents, and the equilibrium is a function of the number of suppliers and their costs. Nothing is done to demand, it remains the same.

When products are differentiated there is demand for each variant supplied to the market and firms can cut into demand for competitors' products by under-pricing. A newcomer has to be assigned a demand, and in doing so, the researcher has to determine how large share of a given market the newcomer could potentially capture (at equal price, say). He has to calibrate demand confronting the newcomer and recalibrate demand for incumbents. This calibration involves several decisions and there does not seem to be a well-defined procedure for doing this. The following simple example illustrates one way of extending a model and it also clarifies some questions that have to be answered.

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#### Extending the demand-system to account for a new product

Consider an industry with two one-product suppliers charging prices  $p_1=p_2=1$ , selling  $x_1=x_2=2.4$ . Assume that demand is characterized by an external elasticity  $\varepsilon' = -1$  and a cross-price elasticity of  $\varepsilon_{12} = \varepsilon_{21} = 1$ , whereby the own-price elasticity  $\varepsilon_{ii} = -2$ ,  $i=1,2$ . Using (5) and  $P_i=1$ ,  $X_i=2.4$ ,  $i=1,2$ , calibrated demand is

$$x_i = 4.8 - 4.8p_i + 2.4p_j, \quad i,j=1,2.$$

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<sup>25</sup>One possibility is to specify an ideal parameter set (a point) and an objective function for the distance between this ideal and the calibrated parameter point. Then one could minimize the objective function

Consistent with the own-price elasticity, marginal cost  $c_i = 0.5$ . (See (6'').)

Suppose now that a newcomer introduces a third product and positions it close to product 2, while it is equally close (or distant) to product 1 as is product 2. We assume that at equal price the new product will take 50% of the customers of product number 2, while product number 1 maintains its volume at equal prices.<sup>26</sup> Hence, we assign individual reference volumes  $X_1=2.4$ ,  $X_2=X_3=1.2$ , and use  $P_i=1$ ,  $i=1, \dots, 3$ , as reference prices.

Subsequent to entry each product has two competitors, whereby elasticities may change from the pre entry situation. We shall assume that external elasticities  $\varepsilon_i = -1$ ,  $i=1, \dots, 3$ , that  $\varepsilon_{12} = \varepsilon_{21} = \varepsilon_{13} = \varepsilon_{31} = 1$ , and that  $\varepsilon_{23} = \varepsilon_{32} = \beta$ . The higher the  $\beta$ , the closer substitutes products are. If  $\beta=1$ , the own-price elasticity  $\varepsilon_{ii} = -3$ ,  $i=1, 2, 3$ , and signals increased competition. Using (5), calibrated demand subsequent to entry is

$$\begin{aligned} x_1 &= 4.8 - 7.2p_1 + \sum_{j \neq 1} 2.4p_j \\ x_i &= 2.4 - 3.6p_i + \sum_{j \neq i} 1.2p_j \quad i=2,3. \end{aligned}$$

We shall assume that marginal cost is unchanged and that the newcomer has  $c_3 = 0.5$  as the incumbents.<sup>27</sup>

Now we compute the post entry Nash-equilibrium which has  $p_i = 0.875$  and  $x_1 = 2.7$ ,  $x_2=x_3=1.35$ . The increased competition, as evidenced by increased own-price elasticity, compels each supplier to reduce his price. (See (6').) Because of reduced prices, there is an increase in total consumption; prices are reduced by 12.5% and volumes are up by 12.5% (being consistent with the external price elasticity of  $-1$ ).

Let us increase  $\beta$  and compute the corresponding equilibrium. Figure 3 shows how prices depend upon the value of  $\beta$ . As products 2 and 3 become closer substitutes, their optimal prices are reduced. If they were perfect substitutes, these prices would equal marginal cost (0.5) in the equilibrium. We see from the figure that even at a cross-price elasticity of 100, price is above marginal cost.

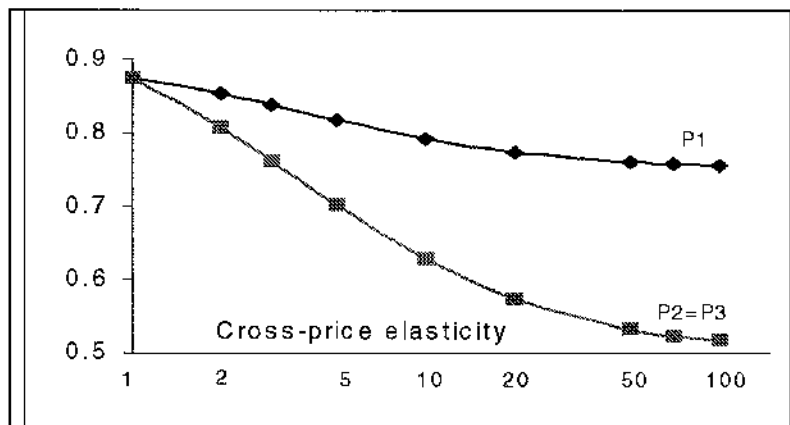
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subject to the constraint that calibrated parameters satisfy the first order conditions with  $(P_i, X_i)$ .

<sup>26</sup> A new product might expand the market if three imperfect substitutes cover a wider spectrum than the two. To account for such expansion, one could possibly increase the reference volumes.

<sup>27</sup> If mc was recalibrated (to  $(1+1/(-3))=0.67$ ), the Nash-solution would be  $p_i = P_i=1$ , i.e., as the reference.

**Figure 3. Optimal pricing as a function of closeness.**



The figure also makes clear the relationship to product number one. Because products 2 and 3 are imperfect substitutes to product number 1, they steal customers and thereby force producer 1 to reduce his price as well. Because of his product's distance to these two, as evidenced by the (fixed) cross-price elasticity of 1, he follows only some of the price reduction.

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## 5. Simulations

In this chapter we illustrate the previous issues by computing equilibria for a few of the outcomes in Figure 2. Furthermore we illustrate the sensitivity of these equilibria to the chosen structure of the model and to the values of some central parameters.

### 5.1 The standard pre and post acquisition analysis

The standard merger analysis is to compare outcomes 1 and 7 in Figure 2. Mathiesen (2000) conducted such an analysis simulating the acquisition of the Larvik Line by Color Line using four different models: a 5-company model with quantity or price as decision variable and an 8-line price-setting model of a non-segmented or a segmented market. We will focus on the line as the unit of operation and regard price as decision variable. Furthermore, we will assume that the market is segmented. We follow Mathiesen (2000) and categorize lines into three segments:

Northern Denmark. (Four<sup>28</sup> lines)  
 Across the Oslofjord. (One line)  
 Lines to Kiel and Copenhagen. (Two lines)

The calibration of parameters can be done in different ways. The question is, does it matter? Next, if it matters, how does it matter? We have employed routines that differ in the way we arrive at estimates of marginal costs ( $c_i$ ) and external elasticities ( $\varepsilon_i$ ), and whether we calibrate using the first order conditions (FOC) or not, *i.e.*, (6') and (7). We consider the following three alternatives:

- (a) Stipulate demand parameters ( $\varepsilon_i$  and  $\varepsilon_{ij}$ ), and calibrate  $c_i$  from FOC<sup>29</sup>.
- (b) Stipulate  $c_i$  and cross-price elasticities ( $\varepsilon_{ij}$ ), and calibrate  $\varepsilon_i$  from FOC<sup>30</sup>.
- (c) Stipulate demand parameters ( $\varepsilon_i$  and  $\varepsilon_{ij}$ ) and marginal costs ( $c_i$ ), ignoring the FOC.

One feature of the first two procedures is the fact that the corresponding Nash equilibria have  $p_i^* = P_i$ , *i.e.*, the solution to the model equals the benchmark observation. It is reassuring to have this check that the coding of the model and the data handling are done correctly. The third procedure would only by chance satisfy this criterion. For an analysis, however, one will typically rely on *percentage changes* between the pre and post merger equilibria, whereby the *levels* of computed prices and volumes may not be that important.

Problems with the first procedure are commented upon above (see Table 2.) In order to obtain positive marginal costs, we have to be careful not to stipulate too low values of price elasticities. Of course, external and cross-price elasticities close to zero would imply that each line comes close to having a monopoly contradicting the flavor of the analysis. Hence, it seems reasonable to stipulate 'high' elasticities. The positive correlation between calibrated mc-values and market shares prevails, however.

<sup>28</sup> Mathiesen (2000) considered sailing on Moss as a separate line. This line has a small volume. Werden and Froeb (1994) suggested dropping small products from the analysis. Our experience with and without this line in the model supports their advice. Both calibration (of marginal cost or price elasticity) and simulation are severely affected by the presence of this line. This applies not only to the values for this line itself, but also other lines as both calibration and computation of equilibria imply solving simultaneous equations. Solutions without this line are indeed more stable and without non-reliable features than solutions with. Hence our analysis is conducted without this line as a separate unit.

<sup>29</sup> Observe that own-price elasticities follow from:  $\varepsilon_i = \varepsilon_i - \sum_{j \neq i} \varepsilon_{ij}$ .

<sup>30</sup> The rationale for this routine is taken from (6'). In the case of multi-product firms, it may be too simple.

The second procedure may run into another type of problem. Computing the external elasticities (and thereby own-price elasticities) from first-order conditions ((6') or (7)) does not guarantee that the sum of partial elasticities ( $\sum_j \varepsilon_{ij} \equiv \varepsilon_i$ ) is negative.<sup>31</sup> Hence, a general price-increase (following a merger) may increase demand.<sup>32</sup> It seems that using high cross-price elasticities provokes this incident, which could be a problem when modeling a case where (some) products are close substitutes and there is no obvious external competition.<sup>33</sup>

For the present analysis a data set was constructed with cross-price elasticities  $\varepsilon_{ij} = 0.6$  and  $\varepsilon_{ij} = 0.2$  for lines in the same segment respectively in different segments. In cases (a) and (c), the external elasticity  $\varepsilon_i = -1$ , for all  $i$ . In case (b) the external elasticities ( $\varepsilon_i$ ) are calibrated from the FOCs (see Table 3, column 3.) The volume-weighted average is -0.92, which is on the order of the value of  $\varepsilon_i$  in cases (a) and (c), while the individual values vary quite a lot.

**Table 3. Results from calibration of three models.**

Lines	(a)	(b)	(c)		
	$c_i$	$\varepsilon_i$	$C_i$	$p_i$	$x_i$
CLOK	0.39	-1.8	0.57	0.850	0.32
CLOH	0.40	-2.0	0.50	0.807	0.33
CLKH	0.50	-0.6	0.42	0.716	1.39
LALF	0.52	-0.3	0.44	0.716	1.57
STOF	0.53	-0.3	0.50	0.740	0.61
DFOØ	0.46	-1.1	0.54	0.800	0.61
SCSS	0.36	-1.9	0.40	0.778	0.59
Aver/sum	0.467	-0.92	0.467	0.748	5.42

Calibrated marginal costs in case (a) vary and average 0.467. (See column 2.) This is our stipulated value for all producers in case (b), while in case (c) marginal costs also average 0.467, but differ between producers based on differences in sailing hours. (See column 4.) Table 3 also presents the resulting Nash equilibrium of (c) which differs from the

<sup>31</sup> Let  $E \equiv (\varepsilon_{ij})$  denote the matrix of partial price elasticities of the demand system. The first-order condition relates the own-price and some cross-price elasticities in the  $i$ 'th column of  $E$ , while the sum of elasticities (in demand) involves all elasticities in the  $i$ 'th row.

<sup>32</sup> The requirement that this sum be negative, that is, the own-price effect dominates the sum of cross-price effects, relates to the entire demand system and thus has to hold on average. It may be positive for one or a few products, but then the sum of elasticities for other products has to be more negative. (See Kolstad and Mathiesen (1987) for the related question of uniqueness of the Nash-Cournot equilibrium.)

<sup>33</sup> Mathiesen (2000) illustrated the problem in a Bertrand model with differentiated products described by demand with constant price elasticities. For an external elasticity of -0.5, a merger between two (out of four identical) firms caused increased demand (at increased price)!

benchmark, where  $P_i=0.75$  and volumes are shown in Table 2. The average price is almost on target, while the total quantity is about 9% above the benchmark. Individual prices and volumes differ more.

Changes in equilibrium values caused by the acquisition are shown in Table 4 for these three differently calibrated models. Starting at the bottom line, we would say that changes in average price and total volume are almost equal across cases. Observe that model (c) has a different reference than (a) and (b), because its Nash equilibrium is not  $(P_i, X_i)$ . Percentage changes thus mean different absolute changes. Looking at price and volume changes on individual lines, there are slightly larger differences across the three cases.

The overall impression may be that the choice of calibration procedure does not matter that much. Observe, however, that *our preparation of the three cases for comparison uncovered several difficulties one may not be aware of*; e.g. negative or low marginal costs and low, even positive external elasticities. Such parameter values may cause meaningless results. For such reasons, we chose to drop the sailing on Moss from explicit consideration. Hence, calibration matters in the sense that things may go wrong if one is not cautious, and computed results may depend more on the specificity of the calibration routine than on the economics of the case at hand.

It may seem counterintuitive that the price change on line SCSS is negative in post-acquisition solutions. Remember, however, that the holding company LSL divested of its other line (LALF). Hence SCSS' price in the pre-acquisition situation was based on coordination between the two lines SCSS and LALF and resulted in a higher price than would be charged by a one-line company.

Consider now the analysis of the consequences of the acquisition, comparing outcomes 1 and 7 in Figure 2, and let us use the results from all three models. The average price in the 7-line market is up by 5-6%. In the narrower, but possibly more relevant destination market of Northern Denmark (lines 2-5), the *average* price increases by 7-8%. This pattern is as expected, prices increase most in the segment where the acquisition takes place, and price increases are larger for CL's four lines than for the competitors' lines. It is less satisfactory though that the largest price increase for CL appears on the line based in Oslo and not on the LI-line that is actually bought. Coming into a larger portfolio, one would expect this line to get the larger price increase. (Cf. the



discussion in relation to equation (1).) Of course, our segmentation treats lines within a segment symmetrically and thus disregards any geographical pattern.

**Table 4. Percentage price and volume changes following the acquisition**

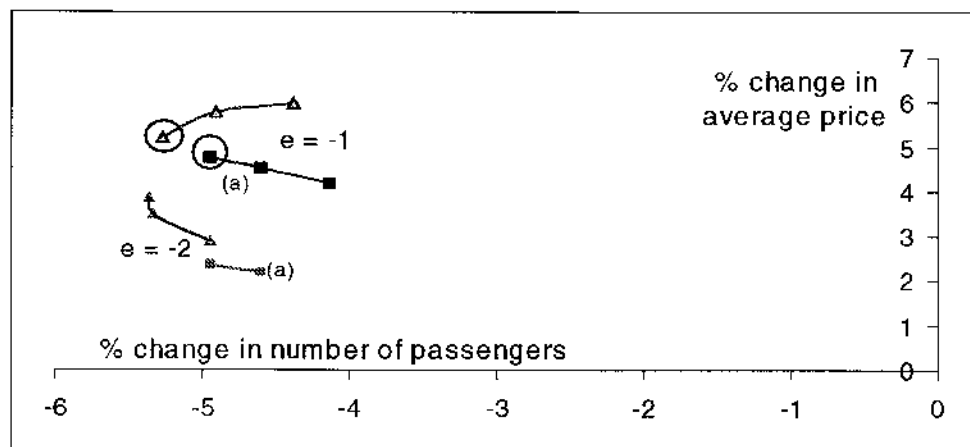
Lines	(a) Calibrate $\epsilon_i$		(b) Calibrate $\epsilon_i$		(c) Ignore FOC	
	% p	% x	% p	% x	% p	% x
CLOK	6	-10	6	-13	7	-18
CLOH	13	-32	13	-40	14	-52
CLKH	6	-7	9	-9	8	-7
LALF	7	-9	10	-9	8	-8
STOF	3	9	4	10	3	9
DFOØ	2	5	2	5	2	6
SCSS	-1	10	-1	12	-2	13
Aver./sum	5	-5	6	-6	5	-5

In order to check the sensitivity of these results to different price elasticities, we have stipulated alternative values, recalibrated parameters according to routines (a) and (c) and computed the equilibria to the corresponding models.<sup>34</sup> In particular, we have considered an alternative external elasticity of -2 and alternative cross-price elasticities of 0.3 / 0.9 and 0.4 / 1.2. In total we have thus calibrated models and computed the corresponding equilibria for six different sets of price elasticities spanning a fairly wide and possibly the relevant range of values.

The values of the percentage changes in average price and total number of customers are displayed in Figure 4 as four graphs. The two graphs with square symbols represent calibration (a), the graphs with triangles represent calibration (c), the upper two graphs represent  $\epsilon_i = -1$ , and the lower two graphs represent  $\epsilon_i = -2$ . Finally, the cross-price elasticities increase from left to right for the upper two graphs, being 0.2 or 0.6 in the left end and 0.4 or 1.2 in the right end, while directions are reversed on the lower two graphs. The solutions of Table 4 are encircled.

<sup>34</sup>Routine (b) failed in this exercise. First, the computed solution in Table 4 falls almost outside the chart in Figure 4. Next, the price and volume changes are 15% respectively -1% for cross-price elasticities of 0.3 and 0.9, and 50% respectively +41% for elasticities of 0.4 and 1.2. The latter result is clearly meaningless, and the middle one also provides little insight into the economic realities of the acquisition, but suggests a lesson to the analyst. With differentiated product and multi-product firms, calibration of the parameters of the demand system is a delicate undertaking.

**Figure 4. Price and volume changes following the acquisition for different price elasticities and calibration procedures**



A higher external elasticity implies more intense competition from the outside market restricting price increases. Solutions therefore shift downwards with increased external elasticity, while they shift almost horizontally with increased cross-price elasticities.

In our view, the numbers from these different runs show a surprisingly small dispersion. Supposing that the chosen parameter values span the relevant range, these solutions provide a fairly robust prediction of an average price increase of 3-5% and a total volume reduction of 4-5%.

## 5.2 More intense rivalry following no acquisition

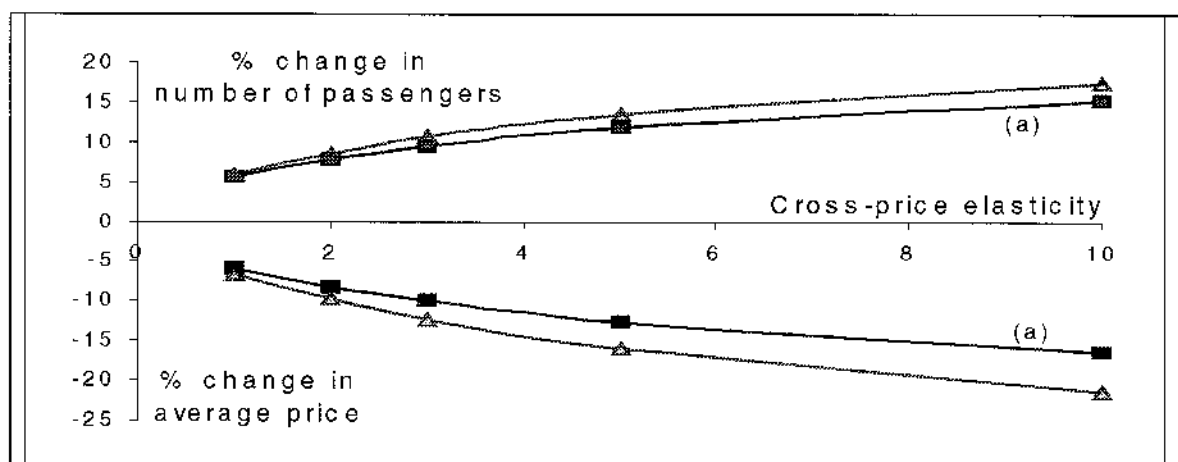
Let us now consider outcome 4 of Figure 2, and compare it with outcome 1. We will assume that CL and LSI, in line with their announcements (or threats) establish new lines that closely parallel those of their competitor. That is, CL starts sailing from the Larvik area to Northern Denmark and LSL responds (immediately) by opening a line between Kristiansand and Northern Denmark. Observe that both companies had taken steps to acquire the necessary capacities. In order to avoid modeling and numerical difficulties, we maintain the assumption that lines are judged imperfect substitutes, although the parallel lines are considered much closer substitutes to their respective competitors than existing lines are to each other.

In order to establish a demand system for outcome 4, we have to assess the effects of the new lines on demand for each individual line (see the example in section 4.7.). First, assume that at equal price a new line will capture half the number of benchmark customers of the parallel incumbent line, but no customers from other lines. Next, assume

that these new lines do not expand the market, and that external elasticities stay the same,  $\epsilon_i = -1$ . Finally, keep cross-price elasticities of 0.2 and 0.6 between existing lines, while the cross-price elasticity ( $\epsilon_{Nj}$ ) between a new line and its parallel competitor is stipulated higher. Marginal costs are kept as in section 5.1 for existing lines, and a new line is assigned the same marginal cost as its parallel competitor. We have constructed the model in two ways according to the calibration-routines (a) and (c) of section 5.1.

Figure 5 shows how average price and total number of customers in outcome 1 compared to outcome 4 depend upon the value of the cross-price elasticity ( $\epsilon_{Nj}$ ). As expected, without any expansion of demand new lines increase the competition and cause reduced prices. As parallel lines are becoming closer competitors (implied by the higher cross-price elasticity) the average price is reduced. The question is what is an empirically sound value for this cross-price elasticity. For the scenarios below we used a value of 3, or five times the elasticity between other lines within the Northern Denmark segment.

**Figure 5. Percentage changes in average price (P) and total number of passengers (X) for different values of cross-price elasticity between new and parallel lines**



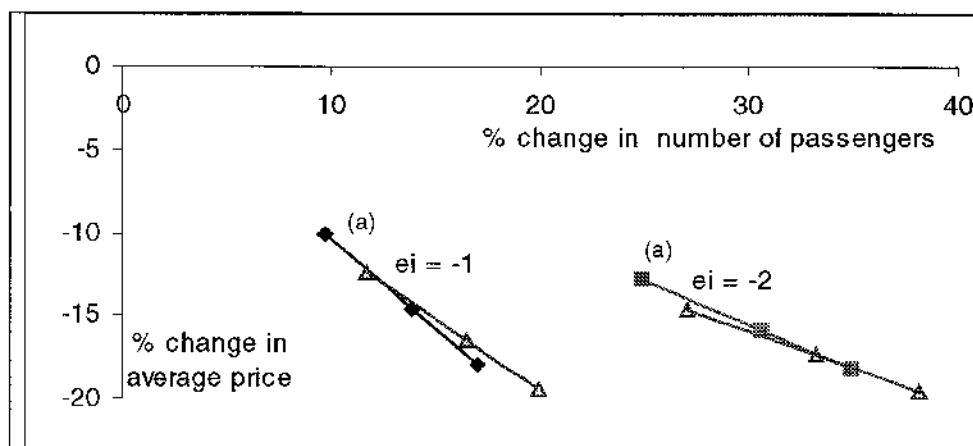
Comparing outcomes 1 and 4 of Figure 2, Table 5 shows percentage price and volume changes caused by the introduction of the two new lines. Cases (a) and (c) provide roughly the same picture, although changes are larger for (c). Increased competition spills over to all participants in the segment of Northern Denmark and to other segments. The average price in the ferry-market declines by 10-12 %, while the average price in the segment of Northern Denmark is reduced by 11-13%. Also, individual price changes are largest in this segment and for the two close competitors, Color Line and LSL.

**Table 5. Percentage changes in prices and number of passengers caused by two new parallel lines.**

Lines	a) Calibrate $c_i$		c) Ignore FOC	
	%P	%X	%P	%X
CLOK	-8	5	-8	-3
CLOH	-12	19	-13	10
CLKH	-12	16	-15	18
CLLH	-11	10	-14	14
LLKF	-13	24	-15	23
LALF	-12	17	-14	18
STOF	-8	-2	-6	-22
DFOØ	-6	-2	-6	-7
SCSS	-8	3	-8	3
Sum/aver	-10	10	-12	12

We have performed a similar sensitivity analysis of the robustness of the solutions in Table 5 as in Section 5.1. Figure 6 presents the results. The graphs with squares represent routine (a), the leftmost graphs of both (a) and (c) are based on  $\varepsilon_i = -1$ , and cross-price elasticities increase from left to right. The solutions of Table 5 are encircled.

**Figure 6. Price and volume changes following the introduction of two new lines for different price elasticities and calibration procedures**



The solutions of both models seem reasonable. Price is reduced and volume increased in all solutions; higher cross-price elasticities implying more intense internal competition, yield larger changes, and likewise a higher external elasticity, shifts the graph outwards and amplifies volume changes. Gleaned from the figure, an average price decrease of 15% and a volume increase of 20% are central predictions.

Figure 6 indicates that the introduction of new sailings could result in substantial price cuts, which would result in rather dramatic losses of net revenue. It is natural to

question whether Color Line and Larvik Line would end up in the prisoner's dilemma as illustrated with outcome 4 in Figure 2. Observe, however, that Color Line argued that the fear of intense rivalry on the route Kristiansand – Hirtshals was a motivation for paying such a high price for the acquisition of Larvik Line.<sup>35</sup>

### 5.3 Acquisition followed by an entry of Stena Line

Consider Stena Line's decision problem after the acquisition. Price increases caused by Color Lines' acquisition of Larvik Line (see Table 3) provide an incentive for Stena Line to establish a new line between Kristiansand and Northern Denmark and hence move the industry to node IV in Figure 2. If Stena Line does not establish a new line, the industry ends up in outcome 7.

In order to analyze this case, we have to assess how the added line would affect the demand system. This work would parallel our efforts in the preceding section and presumably it would add nothing in terms of methodological issues.

The net contribution to Stena Line from operating two lines (STOF and the new line from Kristiansand) and not one (STOF), would then be compared to the fixed costs of setting up and running the new line. It is reasonable to assume that if net contribution is insufficient to cover such costs, the line would not be established. We note that Werden and Froeb (1998) found that it is unlikely that a merger would induce entry.

Steen and Sjørgard (1999) suggested that an (implicit) threat of retaliation, whereby Color Line expands its capacity sailing on Oslo, would add to fixed costs and diminish the profitability of Stena Lines' entry. The credibility of a threat of retaliation could also be evaluated after computing the corresponding equilibrium (outcome 5), whereby one could judge which of the outcomes 5-7 that most likely would materialize. The limited price increases in Table 4 (and Figure 4) suggest this might be outcome 7.

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<sup>35</sup> Based on a traditional comparison of outcomes 1 and 7 in Figure 2, independent sources argued that Color Line paid a higher price than necessary. Responding, Color Line explained their price by fear of intense rivalry on its route from Kristiansand (Dagens Næringsliv 4.10.1996).

#### **5.4 Evaluating the game tree.**

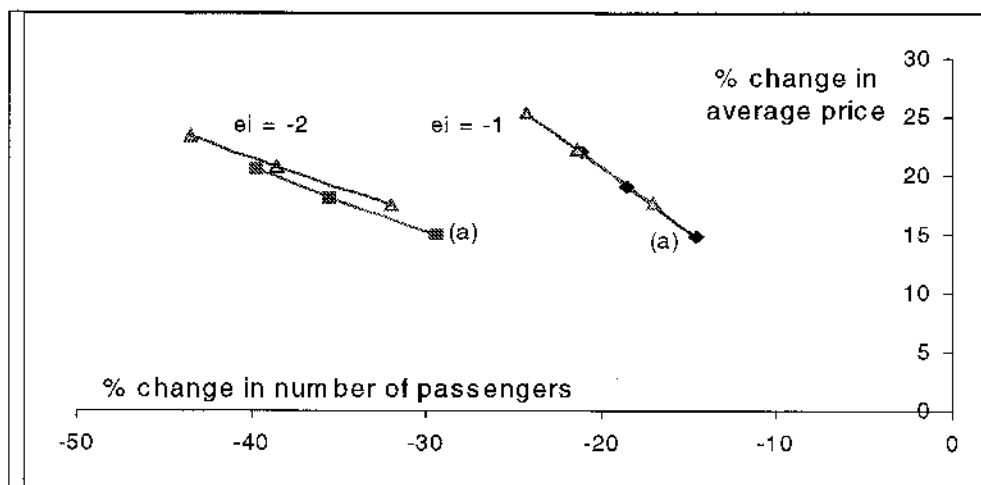
Figure 2 shows how Color Line's decision to acquire Larvik Line or not is followed by possible actions and reactions by market participants. In the preceding sections we have computed solutions to some of the outcomes of this tree.

In section 5.1, we followed Willig (1991) and conducted the traditional merger analysis by comparing outcomes 1 and 7. Based on a sensitivity analysis with respect to elasticity parameters, we concluded with a prediction of an average price increase of 3-5% in the market and 5-7 % in the segment of Northern Denmark.

In section 5.2, we analyzed the effect of two new lines and hence compared outcomes 1 and 4. Here, our sensitivity analysis suggested predictions of 15 % reduction in average price in the overall market and somewhat more in the particular segment.

In section 5.3 we (summarily) concluded that outcome 7 might be the most likely one following an allowed acquisition. If the capacity-expanding announcements and actions of Color Line and Larvik Scandi Line prior to the acquisition were held credible, CL should thus compare positions 4 and 7, and not 1 and 7. As noted earlier (see note 35), Color Line argued that no acquisition would most likely lead to intense rivalry between Color Line and Larvik Scandi Line on the sailings on Kristiansand. In line with this, we have argued that no acquisition would lead to outcome 4. Figure 7 compares outcomes 4 and 7, showing the difference in percentage changes between Figures 4 and 6. On this background, one would arrive at a prediction not of 3-5% price increase if the acquisition were accepted, but an average price that would be 20 % above what it could be if the acquisition were denied and increased competition followed. The price differences in the relevant segment would be even larger. These numbers are considerably larger than what was obtained from the conventional comparison.

**Figure 7. Comparing acquisition to increased competition**



## 6. Some concluding remarks

A merger or an acquisition is a decision that may affect product prices. It then is of vital importance for the decision that is made by the firms in question, as well as for the anti-trust authorities' decision of whether to permit it or ban it, to quantify the expected price effects. The purpose of this article has been to discuss some difficulties that may arise when we try to predict the price effects of a merger or an acquisition. We argue that it is not always straightforward to determine which alternatives to compare. In Figure 2 we let Color Line decide either to acquire Larvik Line or not, and its decision is followed by conceivable actions and reactions by market participants. The figure gives a broader picture of the relevant setting than the conventional comparison in the literature on merger simulations. Figure 2 suggests a procedure for conducting an analysis of the decision problem.

We constructed models and computed solutions to outcomes in this game tree. As many other analysts, we lacked appropriate data from which to estimate (the functions of) the model and had to calibrate the whole model. This work uncovered methodological issues and difficulties. A model of differentiated products is more difficult to calibrate than models for homogenous products. Imperfect competition and multi-product firms compound the problems by tying the various parameters together in several ways. Finally, it seems that introducing a new product (or an entrant) into this setting requires extremely careful handling. Thus, the calibration of differentiated products' models for

market simulation seems both to offer challenges for the practitioner and to be a separate research topic.

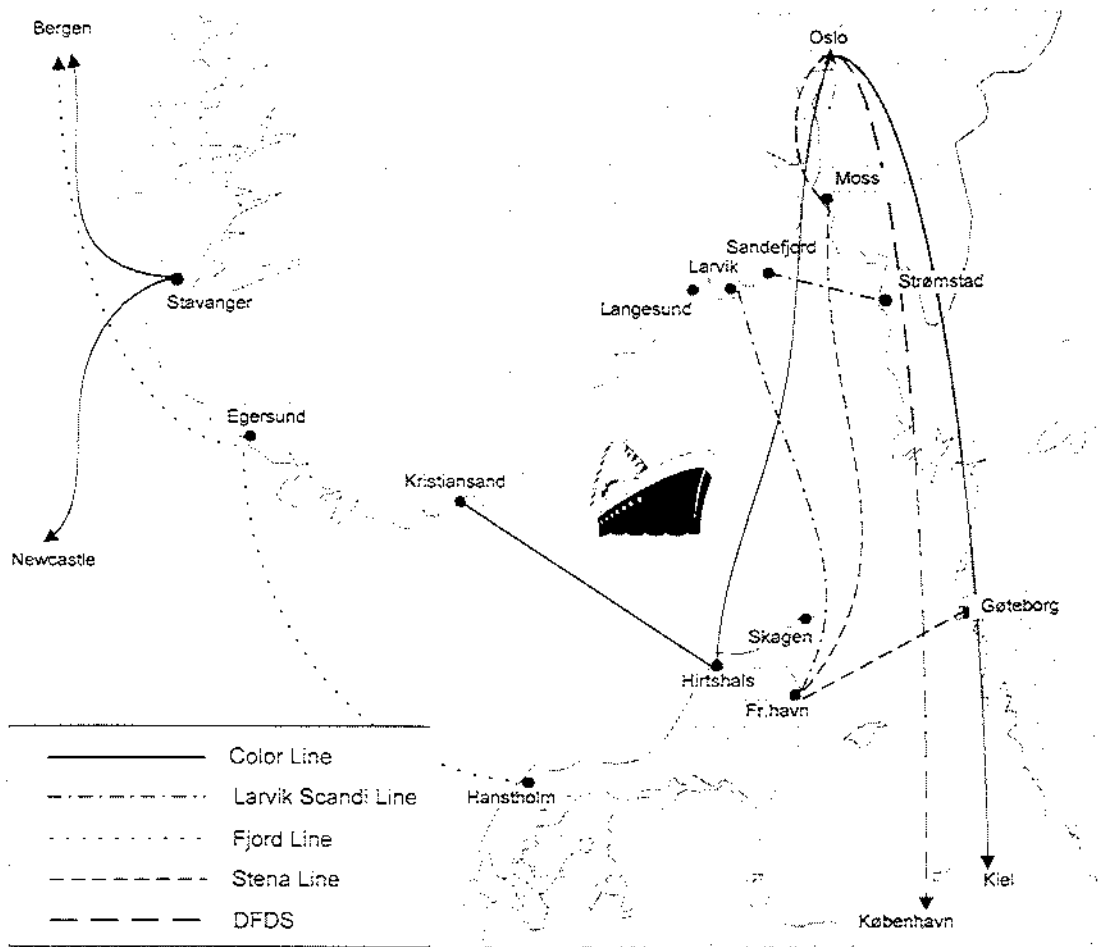
Our simulations illustrate that the conventional way of comparing the effects of a merger may deviate substantially from a comparison, which in our view is more realistic. In this particular case the conventional comparison predicts a rather modest price increase, while our suggested comparison predicts a considerable price effect from the acquisition. Our results have important implications not only for firms' predictions of the effects of a merger or an acquisition, but also for antitrust policy.

## References

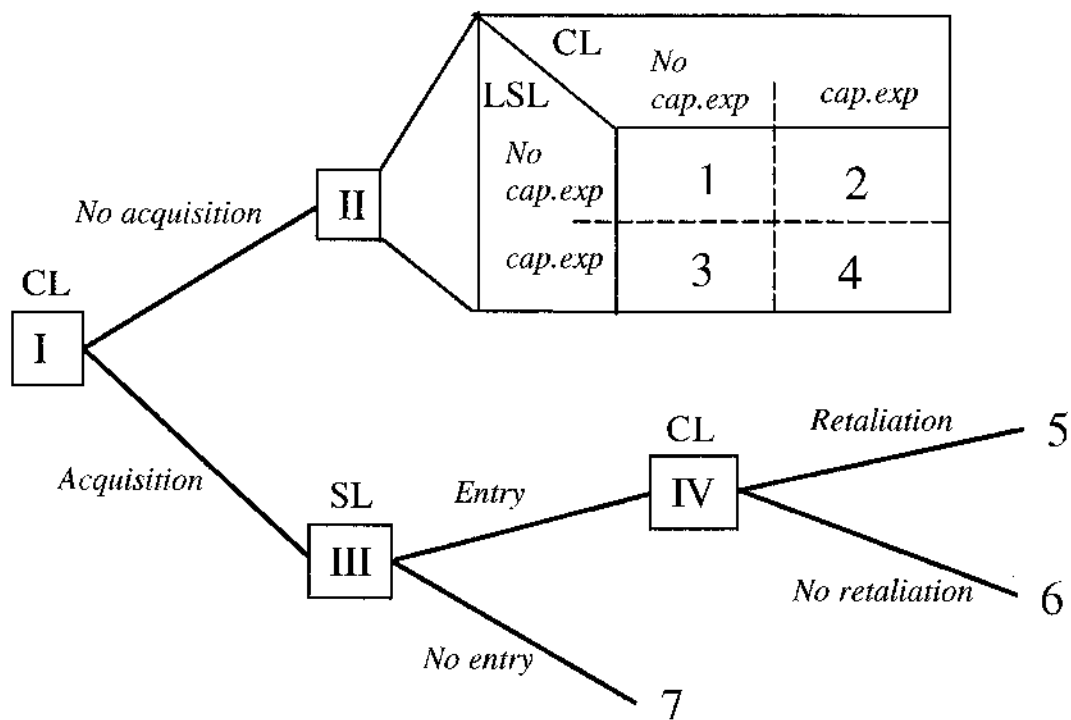
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**Figure 1. Ferry lines to and from Eastern/Southern Norway in 1995**



**Figure 2. The acquisition game**