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Horizontal Mergers and Product Quality

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Horizontal Mergers and Product Quality*

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Abstract

Using a spatial competition framework with three ex ante identical firms, we study the effects of a horizontal merger on quality, price and welfare. The merging firms always reduce quality. They also increase prices if demand responsiveness to quality is sufficiently low. The non-merging firm, on the other hand, always responds by increasing both quality and prices. Overall, a merger leads to higher average prices and quality in the market. The welfare implications of a merger are not clear-cut. If the demand responsiveness to quality is sufficiently high, some consumers benefit from the merger and social welfare might also increase.

Keywords: Horizontal mergers; Quality; Spatial Competition

JEL Classification: L13, L15, L41

*This paper builds on a former version of our working paper titled "Hospital mergers: a spatial competition approach", which is currently being substantially revised and focuses exclusively on hospital competition with regulated prices (rather than endogenous prices, which is instead the focus of this paper).

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1 Introduction

It is by now widely recognised that horizontal mergers may affect consumer welfare not only through price changes but also through changes in key non-price characteristics such as product quality. In the recent empirical merger literature, several studies show, based on merger simulations, that quality effects of mergers can be hugely important. For example, Fan (2013) develops a structural model of newspaper markets and show that ignoring adjustments to product characteristics as a result of a merger substantially affects the simulated merger effects. Similar conclusions are reached by Israel et al. (forthcoming) and Tenn et al. (2010) based on merger simulations in the airline and ice cream industries, respectively.[1] In recent antitrust practice, the quality dimension is also frequently mentioned. For example, a feared reduction of service quality was one of the elements determining the European Commission's decision to reject the proposed takeover of Aer Lingus by Ryanair in 2007.[2]

However, the effects of mergers on quality remain an under-researched issue, where the potential theoretical mechanisms are less well understood, which poses a considerable challenge to competition policy practitioners who aim to deal with quality effects in a comprehensive way. This knowledge gap is aptly summarised by the OECD Competition Committee (based on a 2013 roundtable debate) as follows:

> "While the importance of quality is undisputed and issues about quality are mentioned pervasively in competition agency guidelines and court decisions, there is no widely-agreed framework for analysing it which often renders its treatment superficial [.....] the role of quality effects in merger controls, and in particular, trading off between quality and price effects, remains to be one of the most vexatious – and still unresolved – issues." (OECD, 2013, p. 1)

In the present paper we offer a contribution towards filling this knowledge gap by studying the effects of a horizontal merger in a theoretical setting where firms compete on both quality and price. We apply a Salop (1979) spatial competition framework where demand is explicitly derived from individual preferences and depends on price, quality and transportation costs (interpreted either

[1] Tenn et al. (2010) consider promotional effort rather than quality, but these two non-price dimensions have of course huge similarities.

[2] Commission decision of 27 June 2007 in Case No COMP/M.4439 – Ryanair / Aer Lingus I.

as horizontal product differentiation or physical travelling costs). Our starting point is a market configuration with three ex ante identical firms which are symmetrically located on the Salop circle. This framework allows us to carefully analyse the strategic interaction between price and quality decisions – within and across firms. The nature of this strategic interaction determines the effects of a merger between two of the firms in the market. In the benchmark version of the model we assume that a merger only implies a coordination of price and quality decisions between the merging parties. However, we also extend the analysis to consider the case where the merged firm obtains fixed-cost savings by closing one of its plants (or withdrawing one of its products, depending on the interpretation of the model).

Our analysis offers five sets of results. First, whereas the merging firms always reduce quality, the non-merging firm responds by *increasing* quality.[3] The reason is that the outside firm also responds to the merger by increasing prices, and a higher profit margin makes it profitable to increase quality, thus making qualities *net strategic substitutes* among firms. In fact, the quality response by the outside firm is sufficiently strong to ensure an increase in *average* quality (weighted by demand) in the market as a result of the merger.

Second, whereas the non-merging firm always responds to the merger by increasing prices, the merging firms increase prices only if demand responsiveness to quality is sufficiently low. The possibility that prices of merging firms may decrease for high demand responsiveness is at first glance surprising and results from an intricate strategic relationship between price and quality – *within* and *between* firms. A quality reduction by the merging firms is met by a quality increase by the non-merging firm, which in turn dampens the merging firms' incentives to increase prices. If this effect is sufficiently strong – which requires sufficiently quality-elastic demand – the overall effect of the merger is a price reduction by the merging firms.

Third, the non-merging firm always benefits more from the merger than the merging firms. Thus, the well-known 'merger paradox' is present also in our framework with quality competition. Furthermore, a merger is privately profitable unless demand responsiveness to quality is sufficiently high. If demand is very quality-elastic, a merger triggers a quality increase by the non-merging firm that is sufficiently strong to make the merger unprofitable. This is an interesting result considering that

[3] This asymmetric quality effect of a merger is partly mirrored in the results from the simulated effects of a merger in the Minneapolis newspaper market in Fan (2013), where she finds a drop in content quality for the merged newspapers but a quality increase for two out of three competitors.

prices are strategic complements, which tends to make mergers profitable under *Bertrand* competition (with differentiated products).[4]

Fourth, because of the non-uniform effects of a merger on quality and price, the welfare effects are generally ambiguous. We show that consumer utility is reduced on average, although some consumers may actually be better off: if demand is sufficiently quality-elastic, the utility gain of the quality increase outweighs the utility loss of the price increase for consumers who buy from the non-merging firm. Perhaps surprisingly, we also find that a merger might in fact improve social welfare if demand is sufficiently responsive to quality. The reason is that a merger might indirectly lead to savings of (endogenous) fixed quality costs.

Finally, we show that the effects of a merger rely crucially on whether or not the merger involves (plant or product) closure. In the case of closure, a merger leads to higher quality and prices for all firms in the market.

Besides extending the standard horizontal merger literature by including a quality dimension, our paper is also related to the vast literature on competition and quality, dating back at least to Swan (1970), who compared the incentives of a monopolist and a competitive firm with respect to a particular quality dimension, namely product durability. Much of the subsequent literature consists of papers that apply a vertical differentiation framework, often with firms that offer a range of products with different qualities.[5] Models of price-quality competition in a horizontal differentiation framework are fewer and include, i.a., Economides (1993), Ma and Burgess (1993), Gravelle (1999) and Brekke et al. (2010). Although the effect of competition on quality provision is addressed in some of these papers, there is no explicit merger analysis.[6] In fact, although the analysis in the present paper is based on a model framework with fairly standard ingredients, we are not aware of any other theoretical study that explicitly analyses the effects of a horizontal merger on the price and quality offered by merging and non-merging firms.[7]

[4] See the seminal work by Denecker and Davidson (1985). Assuming Cournot competition, Salant et al. (1983) reported the striking result that mergers are usually not profitable for the merging firms unless sufficiently many firms take part in the merger. See also Perry and Porter (1985) and Farrell and Shapiro (1990).

[5] Some early key contributions to this strand of the literature include Gabszewicz and Thisse (1979, 1980) and Shaked and Sutton (1982, 1983) for the case of single-product firms, and Mussa and Rosen (1979), Gal-Or (1983) and Champsaur and Rochet (1989) for the case of multi-product firms.

[6] There are also a few empirical papers studying the effect of more competition on quality; for example Mazzeo (2003), who finds a positive relationship between competition and quality in the US airline industry; and Matsa (2011) who studies the effect of competition on supermarkets' incentive to provide quality, and finds that competition from Wal-Mart decreases inventory shortfalls by up to 24 percent.

[7] Willig (2011) includes product quality in an analysis of unilateral competitive effects of horizontal mergers ('upward

Despite the obvious importance of the topic, the empirical literature on the effects horizontal mergers on quality is also relatively scarce. Besides the recent papers mentioned earlier, there are also a few studies addressing the quality effects of mergers in hospital markets, where quality is clearly a key issue.[8] However, there is thus far little evidence that hospital mergers have affected quality provision in any substantial way (see, e.g., Ho and Hamilton, 2000; Capps, 2005; and Romano and Balan, 2011).

Our paper is also somewhat related to the literature on horizontal mergers and product choice, which acknowledges that a merger might lead the merging (and possibly non-merging) firms to reposition their products or to change their product line. Theoretical contributions in this strand of the literature include Lommerud and Sørgard (1997), Posada and Straume (2004) and Gandhi et al. (2008), whereas key empirical contributions include Berry and Waldfogel (2001) and Sweeting (2010).

The rest of the paper is organised as follows. In Section 2 we present the benchmark model and derive the pre- and post-merger equilibria. In Section 3 we conduct a welfare analysis focusing on both consumer utility and total welfare. In Section 4 we extend the model to consider the case of closure, where the merged firm closes one of its plants (or stops supplying one of its products). Finally, in Section 5 we summarise our findings and offer some concluding reflections.

2 Model and analysis

Consider a market for a particular good where three firms, denoted by $i = 1, 2, 3$, are equidistantly located on a circle with circumference equal to 1.[9] A total mass of 1 consumers are uniformly distributed on the same circle. As is common practice, we can think of the spatial dimension as reflecting either horizontal product differentiation or geographical distance. Each consumer demands

pricing pressure'), but there is no equilibrium analysis with strategic interaction between merging and non-merging firms.

[8] There also exists a couple of theoretical studies on hospital mergers: Calem, Dor and Rizzo (1999) and Brekke (2004). Among several differences with the present study, an important limitation of these papers is that the analysis is cast in a duopoly setting, implying that a merger leads to a monopolisation of the hospital market. In contrast, an important feature of our merger analysis is how non-merging firms respond to the merger.

[9] The assumption of three instead of n firms is made in order to make the analysis tractable. In a market with n firms there would be ex post differences among the non-merging firms, where the incentives for a non-merging firm with respect to quality and price setting in the post-merger game depend on its relative positioning in space vis-à-vis the merged firms. However, as competition is localised, the strongest responses to a merger will always come from the merging firms' closest neighbours. Therefore, the assumption of three firms is without too much loss of generality.

one unit of the good from the most preferred provider. The net utility of a consumer located at z and buying the good from Firm i, located at x_i, is given by

$$u_{z,x_i} = v + bq_i - p_i - t\left(z - x_i\right)^2, \tag{1}$$

where q_i and p_i are the quality offered and the price charged, respectively, by Firm i; $b > 0$ is the marginal utility of quality; and $t > 0$ is a transportation cost parameter.

Each consumer chooses the preferred firm based on quality, price and transportation costs. The demand facing each firm is therefore a function of its own price and quality, and the prices and qualities of its two competitors. When each consumer makes a utility-maximising choice, the demand for the good offered by Firm i is given by

$$D_i\left(p_i, p_{i-1}, p_{i+1}, q_i, q_{i-1}, q_{i+1}\right) = \frac{1}{3} + \frac{3b\left[\left(q_i - q_{i+1}\right) + \left(q_i - q_{i-1}\right)\right] - 3\left[\left(p_i - p_{i+1}\right) + \left(p_i - p_{i-1}\right)\right]}{2t}. \tag{2}$$

Several of our results rely on the relative size of the parameters b and t. As we can see from (2), a high (low) value of b relative to t implies a high (low) *demand responsiveness to quality*, and we will subsequently use this terminology when describing the relative size of b and t.

All firm are assumed to have *ex ante* identical costs. The cost function of Firm i is given by

$$C_i\left(q_i, D_i\right) = cq_iD_i + \frac{k}{2}q_i^2 + F, \tag{3}$$

where $c \in (0, b)$, $k > 0$ and $F > 0$. Notice that there are both variable and fixed costs of quality provision, implying that quality and output are cost substitutes ($\partial^2 C_i / \partial q_i \partial D_i > 0$). This is a reasonable assumption that is consistent with constant returns to scale when the cost per unit is increasing with the quality of the good. The restriction $c < b$ is made to ensure interior solutions with strictly positive equilibrium quality levels in all versions of the game considered. Each firm is assumed to maximise profits, given by

$$\pi_i = \left(p_i - cq_i\right)D_i - \frac{k}{2}q_i^2 - F. \tag{4}$$

2.1 The pre-merger game

We look for the Nash equilibrium of a game where price and quality choices are made simultaneously.[10] Firm i chooses q_i and p_i to maximise (4). The first-order conditions for optimal quality and price, respectively, are given by[11]

$$\frac{\partial \pi_i}{\partial q_i} = \frac{3\left(b+c\right)p_i - \left(6bc+kt\right)q_i}{t} + \frac{3c\Sigma_{j\neq i}\left(bq_j - p_j\right)}{2t} - \frac{c}{3} = 0 \tag{5}$$

and

$$\frac{\partial \pi_i}{\partial p_i} = \frac{1}{3} + \frac{3\left(b+c\right)q_i - 6p_i}{t} + \frac{3\Sigma_{j\neq i}\left(p_j - bq_j\right)}{2t} = 0. \tag{6}$$

It is instructive to analyse the strategic interaction between the quality and price decisions, both *within* each firm and *between* firms, as this is crucial for understanding the merger effects on prices and qualities which will be derived below. From (5), the best-quality-response function of Firm i is given by

$$q_i\left(p_i, p_j, q_j\right) = \frac{3\left(b+c\right)p_i}{\left(6bc+kt\right)} + \frac{3c\Sigma_{j\neq i}\left(bq_j - p_j\right)}{2\left(6bc+kt\right)} - \frac{ct}{3\left(6bc+kt\right)}, \tag{7}$$

whereas the best-price-response function is given by

$$p_i\left(q_i, q_j, p_j\right) = \frac{\left(b+c\right)q_i}{2} + \frac{\Sigma_{j\neq i}\left(p_j - bq_j\right)}{4} + \frac{t}{18}. \tag{8}$$

We see that both qualities and prices are *gross strategic complements* between competing firms; i.e., $\partial q_i/\partial q_j > 0$ for given prices and $\partial p_i/\partial p_j > 0$ for given qualities.

The (gross) strategic complementarity between qualities is explained as follows. If a firm increases its quality, the competing firms lose demand, which in turn reduces their marginal cost of quality provision. These firms will therefore respond by increasing their quality. Notice that this strategic complementarity is caused by the presence of variable quality costs. In contrast, if there are only

[10] In the Appendix, we show that our main results are qualitatively similar if we instead assume that quality and price decisions are made sequentially.

[11] The second-order conditions are

$$\frac{\partial^2 \pi_i}{\partial q_i^2} = -\left(\frac{6bc+kt}{t}\right) < 0, \ \frac{\partial^2 \pi_i}{\partial p_i^2} = -\frac{6}{t} < 0$$

and

$$\left(\frac{\partial^2 \pi_i}{\partial p_i^2}\right)\left(\frac{\partial^2 \pi_i}{\partial q_i^2}\right) - \left(\frac{\partial^2 \pi_i}{\partial q_i \partial p_i}\right)^2 = 3\left(\frac{2kt - 3\left(b-c\right)^2}{t^2}\right) > 0,$$

which are satisfied if $t > \frac{3}{2k}\left(b-c\right)^2$.

fixed costs of quality provision (i.e., if $c = 0$), the firms' optimal quality choices are strategically independent.

The strategic complementarity of the firms' pricing decisions is standard. All else equal, a unilateral price increase by one firm leads to higher demand for the competing firms. Their marginal revenues (measured as a function of output) are consequently reduced and they will optimally respond by increasing their prices as well.

However, the strategic relationships described above are *partial* in the sense that one of the choice variables (price or quality) is taken to be fixed. How do quality and price decisions interact strategically? From (7) and (8) we see that *quality and price are strategic complements within firms*; i.e., $\partial q_i/\partial p_i > 0$ and $\partial p_i/\partial q_i > 0$. Abstracting from any strategic responses by competing firms, a price increase has two effects on incentives for quality provision. It increases the firm's profit margin and also reduces the marginal cost of quality provision through lower demand. Both effects contribute to a higher optimal level of quality. Vice versa, a higher quality level leads to higher demand and also increases marginal production costs, and both effects contribute to a higher optimal price.

On the other hand, *quality and price are strategic substitutes between firms*; i.e., $\partial q_i/\partial p_j < 0$ and $\partial p_i/\partial q_j > 0$. All else equal, a unilateral price increase by one firm leads to higher demand for competing firms. As a result, their marginal costs of quality provision increase and they will optimally respond by reducing their qualities. Similarly, if a firm increases its quality, competing firms will have lower demand and their profits are therefore maximised, all else equal, at a lower price.

We can internalise the strategic relationship between quality and price within each firm by simultaneously solving (7)-(8) with respect to q_i and p_i, yielding

$$p_i\left(p_j, q_j\right) = \frac{\left(kt + 3c\left(b - c\right)\right)\left(2t + 9\Sigma_{j \neq i}\left(p_j - bq_j\right)\right)}{18\left(2kt - 3\left(b - c\right)^2\right)} \tag{9}$$

and

$$q_i\left(p_j, q_j\right) = \frac{\left(b - c\right)\left(2t + 9\Sigma_{j \neq i}\left(p_j - bq_j\right)\right)}{6\left(2kt - 3\left(b - c\right)^2\right)}. \tag{10}$$

Whereas the strategic complementarity between prices remains, we see that the strategic relationship between qualities changes when we take the optimal price adjustments into account. In other words,

qualities are net strategic substitutes; i.e., $\partial q_i/\partial q_j < 0$ when p_i is optimally adjusted.[12] As explained above, the direct (gross) effect of higher quality by a firm is that rival firms will increase their qualities and lower their prices. However, as quality and price are strategic complements within each firm, a lower price implies that the quality should be optimally adjusted downwards. This indirect effect outweighs the direct effect, making qualities net strategic substitutes.[13]

Simultaneously solving the three pairs of best-response functions given by (9)-(10), the symmetric Nash equilibrium in the *pre-merger* game is characterised by the following qualities and prices:

$$q_i^* = \frac{b-c}{3k}, \tag{11}$$

$$p_i^* = \frac{t}{9} + \frac{c\,(b-c)}{3k}. \tag{12}$$

The corresponding profits are

$$\pi_i^* = \frac{t}{27} - \frac{(b-c)^2}{18k} - F. \tag{13}$$

2.2 The post-merger game

Consider a merger between two of the firms. In the *post-merger* game, the outside firm chooses quality and price, denoted q_o and p_o, to maximise its profits, whereas the merger participants choose quality and price for each of the merged firms' products (or at each of the merged firms' plants), denoted q_m and p_m, to maximise the sum of the two firms' profits. In the asymmetric Nash equilibrium, qualities and prices are given by

$$q_m^* = \frac{(b-c)\left(5kt - 9\,(b-c)^2\right)}{9k\left(2kt - 3\,(b-c)^2\right)} \tag{14}$$

and

$$p_m^* = \frac{\left(5kt - 9\,(b-c)^2\right)(2kt + 3c\,(b-c))}{27k\left(2kt - 3\,(b-c)^2\right)} \tag{15}$$

[12] Notice that this relationship holds also without cost substitutability ($c = 0$).

[13] In a similar type of spatial competition model, Barros and Martinez-Giralt (2002) also find that qualities are strategic substitutes under price-quality competition. In a three-firm vertical differentiation model with quality-then-price competition, Scarpa (1998) finds that quality competition is characterised by strategic complementarity between some firms and strategic substitutability between others.

for each of the merged firms, and

$$q_o^* = \frac{(b-c)\left(8kt - 9(b-c)^2\right)}{9k\left(2kt - 3(b-c)^2\right)} \tag{16}$$

and

$$p_o^* = \frac{(kt + 3c(b-c))\left(8kt - 9(b-c)^2\right)}{27k\left(2kt - 3(b-c)^2\right)} \tag{17}$$

for the outside firm. Equilibrium profits for the outsider and each of the merged firms, respectively, are given by

$$\pi_o^* = \frac{\left(8kt - 9(b-c)^2\right)^2}{486k\left(2kt - 3(b-c)^2\right)} - F \tag{18}$$

and

$$\pi_m^* = \frac{\left(4kt - 3(b-c)^2\right)\left(5kt - 9(b-c)^2\right)^2}{486k\left(2kt - 3(b-c)^2\right)^2} - F. \tag{19}$$

Before analysing the effects of a merger on qualities and prices, let us first derive a condition for merger profitability. A straightforward comparison of (19) and (13) yields:

Lemma 1 *A merger is profitable for the participants if*

$$t > \frac{9(b-c)^2}{4k},$$

and unprofitable otherwise.

This result is perhaps surprising. It is easily shown that a merger is always profitable when quality is the only competition variable or when price is the only competition variable (which is a standard result from the merger literature, the seminal paper being Deneckere and Davidson, 1985). However, a merger might not be profitable when competition occurs simultaneously along both dimensions. The intuition for this result will be discussed below, after deriving the equilibrium price and quality responses to the merger.

For the remainder of the analysis, we will assume that the condition in Lemma 1 is satisfied; i.e., we restrict attention to profitable mergers only. This condition, along with the condition $b > c$, also ensures existence and uniqueness of both Nash equilibria (before and after the merger).

Proposition 1 *A merger leads to*

(i) lower quality offered by the merged firms, higher quality offered by the outside firm, and higher average quality in the market;

(ii) higher (lower) prices charged by the merged firms if the demand responsiveness to quality is sufficiently low (high), a higher price charged by the outside firm, and a higher average price in the market;

(iii) smaller market shares for the merged firms.

A key observation is that the effect of a merger on quality is not uniform across all firms in the market. A merger leads to lower quality offered by the merging firms, but *higher* quality offered by the firm not taking part in the merger. Similarly, the price responses to a merger might also be qualitatively different across merging and non-merging firms. Perhaps counterintuitively, a merger might lead to a *price reduction* for the merging firms.

In order to sort out the intuition behind these results, which are not straightforward, we need to keep in mind the strategic relationships between qualities and prices – within and across firms – which we previously analysed in detail. When two firms merge they have an incentive to internalise the negative competition externality that existed between them in the pre-merger game. All else equal, they can increase their joint profits by increasing the price and reducing the quality provided. Such price and quality adjustments will trigger a response from the outside firm, which in turn triggers feedback effects on the merging firms' optimal quality and price decisions. As qualities are net strategic substitutes whereas prices are net strategic complements across firms, the direct response of the non-merging firm is to increase both the quality and the price. The net strategic substitutability of qualities explains why a merger may lead to higher quality – but only for non-merging firms. Furthermore, the increase in quality and market share for the non-merging firm implies that the (volume-weighted) *average quality* in the market goes up as a result of the merger. In other words, the 'average consumer' enjoys a higher quality in this market as a result of the merger.

The *feedback effects* of higher price and quality by the outside firm are in general ambiguous with respect to the pricing decision of the merged firms. As prices are strategic complements across firms, the price response of the outside firm will reinforce the initial price increase by the merger participants. However, from (9) we see that $\partial p_i/\partial q_j < 0$. Thus, the positive quality response by

the outside firm will counteract the initial price increase by the merged entity. If this particular feedback effect is sufficiently strong, it might outweigh the merged firms' initial incentive to raise prices, implying that a merger might lead to lower prices at the merged firms. This will happen if the demand responsiveness to quality is sufficiently high.[14] However, even if a merger might lead to lower prices charged by the merged firms, the net effect of the quality and price responses to the merger implies a loss of market share for the merger participants. Regardless of the sign of the price effect for the merged firms, the increase in price and market share for the non-merging firm also implies that the merger leads to an increase in the (volume-weighted) *average market price*.

The intricate strategic relationships between the optimal price and quality decisions also explain the profitability result in Lemma 1. The possibility of unprofitable mergers arises from the fact that qualities are net strategic substitutes. If demand responds sufficiently strongly to quality changes, the positive quality response by the outside firm is sufficiently strong to make the merger unprofitable for the participants.[15] It is also easily confirmed that the 'merger paradox' applies here, i.e., a merger is more profitable for the firm not taking part in the merger.

3 Welfare

In this section we analyse the welfare effects of the merger, applying two different criteria: (i) the effect on consumer utility only, and (ii) the effect on social welfare, defined as the sum of total consumer utility and total profits.

In order to derive an expression for total consumer utility, notice that Firm i's demand function, given by (2), can alternatively be expressed as

$$D_i\left(p_i, p_{i-1}, p_{i+1}, q_i, q_{i-1}, q_{i+1}\right) = \widehat{x}_i^{i+1}\left(p_i, p_{i+1}, q_i, q_{i+1}\right) + \widehat{x}_i^{i-1}\left(p_i, p_{i-1}, q_i, q_{i-1}\right), \tag{20}$$

[14] From (9), the feedback effect of higher quality by Firm j on the optimal price of Firm i is given by

$$\frac{\partial p_i}{\partial q_j} = -\frac{\left(kt + 3c\left(b-c\right)\right)b}{2\left(2kt - 3\left(b-c\right)^2\right)} < 0.$$

We see that the magnitude (in absolute value) of this effect is increasing in b.

[15] From (10),

$$\frac{\partial q_i}{\partial q_j} = -\frac{3\left(b-c\right)b}{2\left(2kt - 3\left(b-c\right)^2\right)}.$$

The magnitude (in absolute value) of this effect is increasing in b.

where

$$\widehat{x}_i^{i+1} = \frac{1}{6} + \frac{3\left(b\left(q_i - q_{i+1}\right) - \left(p_i - p_{i+1}\right)\right)}{2t} \tag{21}$$

is the location (measured *clockwise* from Firm i) of the consumer who is indifferent between Firm i and Firm $i+1$, and

$$\widehat{x}_i^{i-1} = \frac{1}{6} + \frac{3\left(b\left(q_i - q_{i-1}\right) - \left(p_i - p_{i-1}\right)\right)}{2t} \tag{22}$$

is the location (measured *anticlockwise* from firm i) of the consumer who is indifferent between Firm i and Firm $i-1$. With a slight abuse of notation, total consumer utility is then given by[16]

$$U = \sum_{i=1}^{3} \left(\int_0^{\widehat{x}_i^{i+1}} \left(v + bq_i - p_i - ts\right) ds + \int_0^{\widehat{x}_i^{i-1}} \left(v + bq_i - p_i - ts\right) ds \right). \tag{23}$$

Social welfare also includes profits and is given by

$$W = U + \sum_{i=1}^{3} \pi_i, \tag{24}$$

which can be re-written as

$$W = \sum_{i=1}^{3} \left(\int_0^{\widehat{x}_i^{i+1}} \left(v + bq_i - ts\right) ds + \int_0^{\widehat{x}_i^{i-1}} \left(v + bq_i - ts\right) ds - cq_i D_i - \frac{k}{2} q_i^2 \right) - 3F. \tag{25}$$

Applying the equilibrium expressions derived in the previous section, total consumer utility and social welfare in the pre-merger equilibrium are given by, respectively,

$$U\left(q_i^*, p_i^*\right) = v - \left(\frac{13kt - 36\left(b - c\right)^2}{108k} \right) \tag{26}$$

and

$$W\left(q_i^*, p_i^*\right) = v - \left(\frac{kt - 18\left(b - c\right)^2}{108k} \right), \tag{27}$$

whereas the corresponding expressions in the post-merger equilibrium are

$$U\left(q_m^*, p_m^*, q_o^*, p_o^*\right) = v - \left(\frac{kt\left(5589\left(b - c\right)^4 + 4kt\left(175kt - 873\left(b - c\right)^2\right)\right) - 2916\left(b - c\right)^6}{972k\left(2kt - 3\left(b - c\right)^2\right)^2} \right) \tag{28}$$

[16] Notice that, if $i = 1$, then $i - 1 = 3$, and if $i = 3$, then $i + 1 = 1$.

and

$$W\left(q_m^*, p_m^*, q_o^*, p_o^*\right) = v - \left(\frac{kt\left(2025\left(b-c\right)^4 + 4kt\left(11kt - 198\left(b-c\right)^2\right)\right) - 1458\left(b-c\right)^6}{972k\left(2kt - 3\left(b-c\right)^2\right)^2} \right). \quad (29)$$

The welfare implications of a merger are summarised as follows:

Proposition 2 *A merger leads to*

(i) lower total consumer utility;

(ii) higher utility for more than a third of all consumers in the market if the demand responsiveness to quality is sufficiently high;

(ii) higher social welfare if the demand responsiveness to quality is sufficiently high; otherwise, welfare drops.

If we consider total consumer utility, or the utility of the 'average consumer' in the market, a merger has three different effects: (i) the average quality goes up, which is positive; (ii) the average price also goes up, which is negative; and (iii) total transportation costs go up (because of the asymmetry of the post-merger equilibrium), which is also negative. In our model, the second and third effects always outweigh the first effect, implying that a merger has a negative effect on total consumer utility. However, some consumers in the market might still benefit from the merger. The consumers buying from the non-merging firm benefit from higher quality as a result of the merger. If the demand responsiveness to quality is sufficiently high, the quality response of the outside firm is sufficiently strong to make these consumers enjoy a net benefit from the merger in spite of the corresponding price increase. As these net benefits also apply (due to continuity) to some of the consumers who switch firms as a result of the merger, more than a third of the consumers in the market might potentially benefit from the merger.

Perhaps the most surprising result of our analysis is that a purely anti-competitive merger (i.e., a merger with no direct cost synergies) might improve social welfare. This will be the case if demand responds sufficiently strongly to quality changes. The intuition behind this apparently counterintuitive result is the following. Social welfare depends on a trade-off between consumer benefits of quality and two types of costs: (i) transportation costs and (ii) the cost of quality provision. Interestingly, social welfare is not necessarily maximised with symmetric supply of quality across all firms in the

market. The reason is that there are fixed costs of quality provision (given by the term $(k/2)q_i^2$ in the cost function). Starting from a situation with symmetric quality provision, the costs of providing a given level of average quality can be reduced by increasing the quality at some firm(s) and reducing it at others, and having more consumers buy from the high-quality firm(s). In fact, the costs of providing a given level of average quality are minimised if there is only one firm offering this quality level, whereas all other firms offer zero quality (at zero costs) and have zero demand. If there are no transportation costs, such an outcome would clearly maximise social welfare for any given average quality level (including the socially optimal one).

However, in the presence of transportation costs, the cost savings from a more asymmetric quality provision must be weighed against the increase in total transportation costs that would occur in a more asymmetric outcome. If transportation costs are sufficiently low and the marginal utility of quality is sufficiently high, social welfare can be increased with a more asymmetric quality provision.[17] In our setting, the effect of a merger is precisely to make quality provision more asymmetric. Quality increases at the non-merging firm and more consumers buy from this firm in the post-merger equilibrium. Such a merger can therefore increase social welfare because of increased allocational efficiency with respect to fixed quality costs, if the demand responsiveness to quality is sufficiently high (i.e., if b is sufficiently high relative to t).

4 Extension: Closure

In this section we consider the case where the merged firm decides to close down one of its two plants and allocate all production to the remaining plant (or, depending of the interpretation of the model, the merged firm decides to reduce its product line and offer only one product). Such closure allows the merging parties to realise fixed-cost savings and would be profitable if F is sufficiently large. Thus, the analysis in this extension applies to cases where the realisation of fixed-cost savings is an important motivation for the merger.

In the case of closure, a merger implies that the market structure changes from a symmetric

[17] Notice that the cost savings from a more asymmetric quality provision would increase the socially optimal level of quality. More asymmetric quality provision could therefore increase social welfare if consumers value the higher average quality level to a sufficient degree.

triopoly to a symmetric duopoly.[18] The post-merger demand function for Firm i is given by

$$D_i\left(p_i, p_j, q_i, q_j\right) = \frac{1}{2} + \frac{9\left(b\left(q_i - q_j\right) - \left(p_i - p_j\right)\right)}{4t}; \quad i = m, o; \quad j = m, o; \quad i \neq j, \tag{30}$$

whereas the profit function is given by (4). As a merger with closure is always profitable for sufficiently high values of F, we neglect the issue of merger profitability and focus only on the effects on quality and price.

In the post-merger game, assuming simultaneous decision-making, Firm i chooses p_i and q_i to maximise profits, $i = m, o$. The symmetric Nash-equilibrium outcome of the post-merger game with closure is given by

$$q_m^* = q_o^* = \frac{b - c}{2k}, \tag{31}$$

$$p_m^* = p_o^* = \frac{2t}{9} + \frac{c\left(b - c\right)}{2k}, \tag{32}$$

$$D_m\left(p_m^*, p_o^*, q_m^*, q_o^*\right) = D_o\left(p_m^*, p_o^*, q_m^*, q_o^*\right) = \frac{1}{2}, \tag{33}$$

$$\pi_m^* = \pi_o^* = \frac{t}{9} - \frac{\left(b - c\right)^2}{8k} - F. \tag{34}$$

The effects (on price and quality) of a merger with closure are unambiguous:

Proposition 3 *A merger with closure leads to higher quality and price for both the merging and the non-merging firms.*

The key to understanding the effects of closure is the initial demand response for the remaining firms in the market. All else equal, closure leads to higher demand for the remaining firms. This makes firm-specific demand less elastic and the remaining firms will respond by increasing their prices. The effect of closure on quality provision is determined by two counteracting incentives. One the one hand, a higher price implies a higher profit margin, which stimulates quality provision. On the other hand, the initial demand increase (because of the closure) leads to higher variable quality costs and gives the firms an incentive to reduce their quality provision. Here the former effect dominates, yielding higher equilibrium quality provision as a result of the closure.[19]

[18] The post-merger duopoly is, in a sense, asymmetric in terms of locations. However, with only two firms in the market, the equilibrium outcome in a Salop model will be symmetric regardless of how the firms are located.

[19] This result is also found by Economides (1993) who report an inverse relationship between firm density and

Interestingly, this finding is not consistent with our previous results on merger without closure (cf. Proposition 1), where we found that the merging firms reduce quality whereas the non-merging firm increases quality. In case of closure, the post-merger game is symmetric and all firms have the same incentives for quality provision. Because of the initial demand effect of closure, the positive price response is sufficiently strong to ensure higher quality provision (as price and quality are strategic complements within firms) in the post-merger equilibrium. Thus, an important insight from the analysis in this section is that the effect of a merger on quality provision is likely to depend crucially on whether the merger implies closure or not.

5 Concluding remarks

In this paper we have used a spatial competition framework to study the effects of horizontal mergers when firms compete along two different dimensions: price and quality. We have shown that the effects of a merger are quite involved due to the strategic relationship between quality and price, and we report some quite surprising results. The non-merging firm *increases* quality as a response to the quality reduction by the merging firms, and this effect is sufficiently strong to increase the average quality provision in the market as a result of the merger. This result holds regardless of how strongly demand responds to quality changes. Under the assumption that demand responsiveness to quality is sufficiently high, we obtain some additional surprising results. First, the merging firms might *reduce* prices if the quality increase by the non-merging firms is sufficiently strong. This, in turn, might make the merger *unprofitable*. Finally, the merger might be socially beneficial, even in absence of direct cost synergies.

Despite applying a fairly simple theoretical framework, we believe that our analysis – by pinpointing some key strategic interactions when firms make their price and quality decisions – can help identifying the main mechanisms at play and therefore assist in interpreting results from empirical merger analyses. For example, the incentive (or scope) for price increases by merging firms is crucially linked with the incentive for quality reductions. Thus, if the merger results in lower quality for the merging firms, the corresponding price effects are likely to be softened. The reduction in quality because of a merger is, in turn, linked to the demand responsiveness to quality. If the demand

equilibrium quality in a Salop model with quality and price competition. However, Brekke et al. (2010) show that this result could be reversed if utility is non-linear in income.

responsiveness is low (high), then mergers are likely to lead to large (small) price increases.

Another key implication of our analysis is that quality effects of mergers might be highly asymmetric across merging and non-merging firms. This has further implications for the design and interpretation of empirical merger analyses that attempts to quantify the effect of horizontal mergers on quality. For example, if non-merging firms respond to the merger by increasing their quality, as in our model, including them in the control group is likely to cause an upward bias in the estimates of the (negative) quality effect of a merger.

There are, inevitably, several potential limitations to our analysis. We have conducted the analysis in a spatial competition framework. While this framework lends itself well to incorporating quality as an additional dimension of inter-firm competition, some of its underlying assumptions arguably fit some markets better than others. One such assumption is unit demand, which implies that total demand is fixed and therefore that any merger-induced price increase has no direct effect on total welfare. Thus, it might be argued that our analysis overestimates the scope for welfare-improving mergers. We have also disregarded the possibility of product repositioning (or plant relocation) as a result of the merger. A detailed analysis of how this might affect the quality and price effects of a merger is left for future research.

Appendix

The proofs of all Propositions are offered in Section A.1, whereas the subgame perfect Nash equilibrium with sequential quality and price choices is derived in Section A.2.

A.1. Proofs

Proof of Proposition 1. (i): Comparing (14) and (11) yields

$$q_m^* - q_i^* = -\frac{(b-c)\,t}{9\left(2kt - 3\,(b-c)^2\right)} < 0. \tag{A1}$$

Comparing (16) and (11) yields

$$q_o^* - q_i^* = \frac{2t\,(b-c)}{9\left(2kt - 3\,(b-c)^2\right)} > 0. \tag{A2}$$

The average quality in the market in the post-merger equilibrium is

$$\begin{aligned}\overline{q} \quad &: \quad = 2D_m\left(q_m^*, p_m^*, q_o^*, p_o^*\right) q_m^* + D_o\left(q_m^*, p_m^*, q_o^*, p_o^*\right) q_o^* \\ &= \quad \frac{\left(81\left(b-c\right)^4 + 2kt\left(19kt - 54\left(b-c\right)^2\right)\right)\left(b-c\right)}{27k\left(2kt - 3\left(b-c\right)^2\right)^2}. \end{aligned} \tag{A3}$$

Comparing (A3) and (11) yields

$$\overline{q} - q_i^* = \frac{2kt^2\left(b-c\right)}{27\left(2kt - 3\left(b-c\right)^2\right)^2} > 0. \tag{A4}$$

(ii): Comparing (15) and (12) yields

$$p_m^* - p_i^* = t\left(\frac{4kt - 3\left(3b-2c\right)\left(b-c\right)}{27\left(2kt - 3\left(b-c\right)^2\right)}\right) > (<)\, 0 \quad if \quad t > (<)\, \frac{3\left(3b-2c\right)\left(b-c\right)}{4k}. \tag{A5}$$

Merger profitability requires $t > \frac{9(b-c)^2}{4k}$. As $\frac{3(3b-2c)(b-c)}{4k} - \frac{9(b-c)^2}{4k} = \frac{3c(b-c)}{4k} > 0$, the parameter space defined by $t < \frac{3(3b-2c)(b-c)}{4k}$ is non-empty. Regarding the non-merging firm, comparing (17) and (12) yields

$$p_o^* - p_i^* = \frac{2t\left(kt + 3c\left(b-c\right)\right)}{27\left(2kt - 3\left(b-c\right)^2\right)} > 0. \tag{A6}$$

The average price in the market in the post-merger equilibrium is

$$\begin{aligned}\overline{p} \quad &: \quad = 2D_m\left(q_m^*, p_m^*, q_o^*, p_o^*\right) p_m^* + D_o\left(q_m^*, p_m^*, q_o^*, p_o^*\right) p_o^* \\ &= \quad \frac{729c\left(b-c\right)^5 + kt\left(81\left(5b-17c\right)\left(b-c\right)^3 + 2kt\left(82kt - 9\left(28b-47c\right)\left(b-c\right)\right)\right)}{243k\left(2kt - 3\left(b-c\right)^2\right)^2}. \end{aligned} \tag{A7}$$

Comparing (A7) and (12) yields

$$\overline{p} - p_i^* = \frac{2t\left(81\left(b-c\right)^4 + kt\left(28kt - 9\left(b-c\right)\left(10b-11c\right)\right)\right)}{243\left(2kt - 3\left(b-c\right)^2\right)^2}. \tag{A8}$$

The numerator is monotonically increasing in t for all $t > \frac{9(b-c)^2}{4k}$. Setting t at the lowest level that still guarantees profitable mergers, $t = \frac{9(b-c)^2}{4k}$, the numerator in (A8) reduces to

$\frac{729b(b-c)^3(b-c)^2}{8k} > 0$. Thus, $\overline{p} > p_i^*$. (iii): Inserting the equilibrium values of qualities and prices into (2) and comparing the pre- and post-merger equilibria, yields

$$D_m\left(q_m^*, p_m^*, q_o^*, p_o^*\right) - D_i\left(q_i^*, p_i^*\right) = -\frac{tk}{9\left(2kt - (b-c)^2\right)} < 0. \tag{A9}$$

Q.E.D.

Proof of Proposition 2. (i): Comparing (26) and (28) yields

$$U\left(q_m^*, p_m^*, q_o^*, p_o^*\right) - U\left(q_i^*, p_i^*\right) = -2t\left(\frac{kt\left(29kt - 99\left(b-c\right)^2\right) + 81\left(b-c\right)^4}{243\left(2kt - 3\left(b-c\right)^2\right)^2}\right). \tag{A10}$$

The sign of (A10) is determined by the sign of the numerator, which is monotonically increasing in t for $t > \frac{9(b-c)^2}{4k}$. Setting $t = \frac{9(b-c)^2}{4k}$, the numerator is $\frac{81(b-c)^4}{16} > 0$. Thus, $U\left(q_m^*, p_m^*, q_o^*, p_o^*\right) < U\left(q_i^*, p_i^*\right)$ for all parameter configurations that yield profitable mergers. (ii): Consumers buying from the non-merging firm in the pre-merger equilibrium (these consumers constitute one third of the market) can potentially benefit from the merger due to higher quality (if the quality increase outweighs the utility loss of higher prices). The individual utility effect of the merger for each of these consumers is

$$\Delta u := b\left(q_o^* - q_i^*\right) - \left(p_o^* - p_i^*\right) = -\frac{2t\left(kt - 3\left(b-c\right)^2\right)}{27\left(2kt - 3\left(b-c\right)^2\right)} < (>) \quad if \quad t > (<)\,\frac{3\left(b-c\right)^2}{k}. \tag{A11}$$

If $\Delta u > 0$, the merger will also increase the utility of some consumers who switch from the merged firms to the outside firm as a result of the merger, and who are located sufficiently close to the consumers who were indifferent between a merged and a non-merged firm in the pre-merger equilibrium. (iii) Comparing (27) and (29) yields

$$W\left(q_m^*, p_m^*, q_o^*, p_o^*\right) - W\left(q_i^*, p_i^*\right) = -\frac{\left(2kt - 9\left(b-c\right)^2\right)kt^2}{243\left(2kt - 3\left(b-c\right)^2\right)^2} < (>)\,0 \quad if \quad t > (<)\,\frac{9\left(b-c\right)^2}{2k}. \tag{A12}$$

Thus, $W\left(q_m^*, p_m^*, q_o^*, p_o^*\right) > W\left(q_i^*, p_i^*\right)$ if b is sufficiently large relative to t. *Q.E.D.*

Proof of Proposition 3. Comparing (11)-(12) and (31)-(32) yields

$$q_m^* - q_i^* = q_o^* - q_i^* = \frac{b-c}{6k} > 0 \tag{A13}$$

and

$$p_m^* - p_i^* = p_o^* - p_i^* = \frac{t}{9} + \frac{c\,(b-c)}{6k} > 0. \tag{A14}$$

Q.E.D.

A.2. Sequential choices of quality and price

Here we show that the price and quality effects of a firm merger reported in Section 2 are qualitatively similar if quality and price decisions are made sequentially instead of simultaneously. Consider the following two-stage game:

1. Each firm chooses its quality.

2. Each firm chooses its price, observing the qualities chosen in the previous stage.

In the pre-merger game, the optimal price chosen by Firm i at the second stage of the game is given by

$$p_i\,(q_i, q_j) = \frac{t}{9} + \frac{1}{5}\left((2b+3c)\,q_i - \sum_{j\neq i}(b-c)\,q_j\right). \tag{A15}$$

In the first-stage of the game, each firm chooses its optimal quality level to maximise profits, anticipating the prices that will subsequently be chosen. In the subgame perfect Nash equilibrium, prices and qualities are given by

$$p_i^* = \frac{t}{9} + \frac{4c\,(b-c)}{15k} \tag{A16}$$

and

$$q_i^* = \frac{4\,(b-c)}{15k}. \tag{A17}$$

As in the simultaneous-move game, an interior solution requires $b > c$.

In the post-merger game, the optimal prices set at the second stage by the each of the merged firms and the outside firm are given by, respectively,

$$p_m(q_m, q_o) = \frac{5t}{27} + \frac{(5b+7c)}{12}q_m - \frac{(b-c)}{3}q_o, \tag{A18}$$

$$p_o(q_m, q_o) = \frac{4t}{27} - \frac{(b-c)}{6}q_m + \frac{(b+2c)}{3}q_o. \tag{A19}$$

In the subgame perfect Nash equilibrium, prices and qualities are given by

$$p_m^* = \frac{\left(5kt - 6(b-c)^2\right)(kt + c(b-c))}{27k\left(kt - (b-c)^2\right)}, \tag{A20}$$

$$p_o^* = \frac{\left(4kt - 3(b-c)^2\right)(kt + 2c(b-c))}{27k\left(kt - (b-c)^2\right)}, \tag{A21}$$

$$q_m^* = \frac{(b-c)\left(5kt - 6(b-c)^2\right)}{27k\left(kt - (b-c)^2\right)}, \tag{A22}$$

$$q_o^* = \frac{2(b-c)\left(4kt - 3(b-c)^2\right)}{27k\left(kt - (b-c)^2\right)}. \tag{A23}$$

Equilibrium existence requires

$$t > \frac{6(b-c)^2}{5k}.$$

Comparing (11) and (A22)-(A23), the effects of the merger on equilibrium quality provided by the merged and non-merged firms, respectively, are given by

$$q_m^* - q_i^* = -\frac{(b-c)\left(11kt - 6(b-c)^2\right)}{135k\left(kt - (b-c)^2\right)} < 0 \tag{A24}$$

and

$$q_o^* - q_i^* = \frac{2(b-c)\left(2kt + 3(b-c)^2\right)}{135k\left(kt - (b-c)^2\right)} > 0. \tag{A25}$$

Comparing (12) and (A20)-(A21), the effects of the merger on equilibrium prices set by the merged and non-merged firms, respectively, are

$$p_m^* - p_i^* = \frac{6c\left(b-c\right)^3 + kt\left(10kt - \left(15b-4c\right)\left(b-c\right)\right)}{135k\left(kt - \left(b-c\right)^2\right)} \tag{A26}$$

and

$$p_o^* - p_i^* = \frac{6c\left(b-c\right)^3 + kt\left(5kt + 4c\left(b-c\right)\right)}{135k\left(kt - \left(b-c\right)^2\right)} > 0. \tag{A27}$$

The sign of (A26) is determined by the sign of the numerator and it is easy to see that the sign is negative if b is sufficiently high relative to t. It remains to show that the sign is ambiguous for parameter configurations that are compatible with equilibrium existence. Notice that the numerator is monotonically increasing in t. Setting t equal to the lower bound, $t = \frac{6(b-c)^2}{5k}$, the numerator in (A26) reduces to $-\frac{18(b+c)(b-c)^3}{5} < 0$. Thus, $p_m^* > (<) p_i^*$ if b is sufficiently low (high) relative to t.

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02/14 January, **Alexander W. Cappelen, Bjørn-Atle Reme, Erik Ø. Sørensen,** and **Bertil Tungodden, "**Leadership and incentives".

03/14 January, **Ingvild Almås, Alexander W. Cappelen, Kjell G. Salvanes, Erik Ø. Sørensen**, and **Bertil Tungodden**, "Willingness to Compete: Family Matters".

04/14 February, **Kurt R. Brekke**, Luigi Siciliani, and Odd Runde Straume, "Horizontal Mergers and Product Quality".

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