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MERGERS WITH QUALITY DIFFERENTIATED GOODS ”

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Abstract

We consider the impact of merger on the equilibrium price and quality of products. Consumer demand for both products depends not only on own price and quality, but also on the price and quality of the other product. We consider both the case in which the merging firms produce gross complements, and the case in which the firms produce gross substitutes. In both cases, merger may lower or increase both product price and quality. In the case in which firms produce complementary products, it may happen that firms both lower price and increase product quality when merged. This happens when the cross quality elasticities of demand and the cross price elasticities of demand are equal in magnitude. Surprisingly, we also find that there are situations under which merger between firms producing substitutes increases welfare. For example, it is possible that merger between firms producing gross complements may result in higher product quality but lower social welfare, and merger between firms producing substitute products may result in lower product quality but higher social welfare.

1 Introduction

In both theory and practice, the assessment of merger is usually based upon comparing the potential anti-competitive effects of merger with the potential efficiency gains of merger. Merger may result in welfare gains because of improvements in management efficiency or realization of scale economies.¹ Since Williamson's (1968) classic analysis, the literature is replete with recent papers analyzing the welfare impacts of mergers, see for example, Willig, Salop and Sherer (1991), J. Baker and Bresnahan (1985), and Farrell and Shapiro (1990). For a recent review of literature on mergers, see Cabral (2003) or Pesendorfer (2003).

In spite of its importance, the analysis of merger has largely ignored the impact of merger on product quality, and the resulting welfare effects of merger. While there is a substantial literature on merger and the quality of *inputs* provided by merging firms, this literature ignores the effects that merger may have on the quality of products actually purchased and consumed by consumers.²

A sizable portion of mergers have occurred in industries in which the impact of merger on product quality is likely to be of central importance: health care, airlines, and financial services are three prominent examples. Indeed, it is commonplace to include some measure of quality in empirical work on the impact of merger.³

Our analysis is aimed at assessing the impact of merger on welfare when firms are free to choose product quality. Our methodology admits some other methodological extensions. In addition to studying the familiar case of horizontal merger in which firms produce substitute products, we also consider the case in which firms produce complementary products. In these two environments, we reassess the conventional wisdom concerning merger

¹See Schmalensee (1987), who also discusses some practical difficulties in assessing these features of merger and the evolution of policy over time.

²See, for example, Bian's and McFetridge's (2000) analysis of the efficiencies defense.

³On merger in health care markets and quality, see Ho and Hamilton (2000) or Gaynor and Haas-Wilson (1999). Carlton, Landes, and Posner (1980) study airline mergers and the impact on service quality, and Berger, Kashyap, Scalise, Gertler, and Friedman (1995) study mergers in the banking and financial services industry. For additional discussion of the practical relevance of quality in merger, see Fisher and Lande (1983, 1989), who note that the effects of a merger on quality, in addition to the impact of merger on product variety and innovation, may be as important as economic efficiencies or cost savings, but are perhaps just as difficult to predict.

and welfare.⁴ Do mergers tend to increase or decrease product qualities when merged, and how are consumers, and social welfare, affected by these changes?⁵

The problem is a rich theoretical one due to the nuances of models in which firms select price and quality. In monopoly models of this sort, it is not obvious how the monopolist's profit maximizing price and quality deviate from socially optimal price and quality. Spence (1975) showed that a monopolist choosing both product quality and price generally sets price above marginal cost, but that the firm may choose a quality that is higher or lower than the welfare maximizing quality. The end result is that the monopolist may choose to produce too much or too little quality, at too high or too low a price.⁶ The effect causing the firm to diverge from welfare-maximizing quality is subtle. The monopolist considers the impact of quality choice on the marginal consumer, while welfare maximization requires consideration of the impact of quality choice on *all* consumers.⁷

In spite of these difficulties, we are able to characterize the conditions under which merger increases price, decreases quality, or both. We find that there are circumstances under which merger increases welfare and that this occurrence is in some sense more likely, but not exclusive to the case in which firms producing complementary products. Ultimately, the impact of merger on welfare depends upon the relative magnitudes of cross price and cross quality demand elasticities. If neither elasticity is too large relative to the other (which occurs when quality and price are equally important to consumers), the merged entity faces conflicting incentives in trying to raise price and reduce product quality, and may therefore both reduce price and raise quality. Interestingly, the converse of this argument applies in the case in which firms produce substitutes: merger is most likely to produce a lose-

⁴The case of horizontal merger between firms producing complements is certainly not as well known as the study of horizontal merger between firms which produce substitutes. Economides and Salop (1992, p. 106) develop an extensive analysis of the complementary merger and summarize the relevant economic principle as follows: "...two independent firms ignore the effect of their independent markups on each other, while the monopolist internalizes this externality."

⁵While we refer throughout to merger between the firms, our analysis would apply equally well to joint ventures.

⁶See Sheshinski (1976) for additional details of the model. Tirole (1988) and Wolfstetter (1999) contain abbreviated expositions of models of this sort.

⁷Spence (1975) characterized this as a divergence between marginal willingness to pay for quality and average willingness to pay for quality.

lose scenario for consumers - higher prices and lower product quality - when cross elasticities are relatively equal in magnitude.

The rest of the paper is organized as follows. In section 2, we present the model and discuss the direct and magnitude of changes in product price and quality due to merger, and the impact of merger on consumers' surplus and welfare. Section 3 concludes.

2 The Model

There are two firms, 1 and 2. Let s_i denote product quality, p_i price, and x_i quantity for $i = 1, 2$. Firms' average and marginal costs of producing a good of quality s_i are $c_i(s_i)$, $c'_i > 0$, $c''_i > 0$. Demand for firm i 's product is

$$x_i^d = x_i(p_i, p_j, s_i, s_j); \quad i, j = 1, 2.$$

Demand is decreasing in own price and increasing in own quality:

$$\frac{\partial x_i^d}{\partial p_i} < 0, \quad \frac{\partial x_i^d}{\partial s_i} > 0.$$

The goods produced by the two firms are (gross) complements if the following conditions hold:

$$\frac{\partial x_i^d}{\partial p_j} < 0, \quad \frac{\partial x_i^d}{\partial s_j} > 0,$$

meaning that as the price of good j rises, the quantity demanded of good i falls, while if the quality of good j rises, the quantity of good i demand falls. If the goods are (gross) substitutes demands functions are characterized instead by

$$\frac{\partial x_i^d}{\partial p_j} > 0, \quad \frac{\partial x_i^d}{\partial s_j} < 0.$$

As the price of good j rises, the quantity demanded of good i increases, while if the quality of good j rises, the quantity demanded of good i falls.⁸

⁸We do not consider the cases in which goods are, for instance, quality complements but quantity substitutes. It is difficult to think of real world examples of these types of goods. However, see Sheshinski (1976).

Let the indicator variable δ take on a value of one if firms are merged, and a value of zero if firms are autonomous. Then, firm i 's profits can be written

$$\begin{aligned}\pi_i = & x_i(p_i, p_j, s_i, s_j)(p_i - c_i(s_i)) + \\ & \delta x_j(p_j, p_i, s_i, s_j)(p_j - c_j(s_j)), \\ & i, j = 1, 2.\end{aligned}\tag{1}$$

Maximization of (1) with respect to price and quality yields, respectively, the first order conditions

$$x_{i,p_i}(p_i - c_i) + x_i + \delta x_{j,p_i}(p_j - c_j) = 0,\tag{2}$$

and

$$x_{i,s_i}(p_i - c_i) + x_i c'_i + \delta x_{j,s_i}(p_j - c_j) = 0.\tag{3}$$

It is evident from comparing equations (2) and (3) that firms choose different quality and price combinations when merged than they would when autonomous. To obtain explicit solutions to the first order conditions (2) and (3), we assume the following:

1. Firms have identical cost and demand functions, and thus can be treated symmetrically in equilibrium.
2. Average costs of producing a given quality s are linear and are given by $c(s) = c + c_s s$ for both firms.
3. Demand functions have the following log-linear form:

$$x_i^d = p_i^{-\epsilon} p_j^{\epsilon_c} s_i^\eta s_j^{\eta_c}.\tag{4}$$

The parameter ϵ is the (absolute value of) own price demand elasticity, while ϵ_c is the cross price elasticity of demand. The parameter η is the elasticity of demand with respect to quality, and η_c is the cross quality elasticity of demand. Then, goods are gross complements if

$$\epsilon_c < 0, \quad \eta_c > 0,$$

while goods are gross substitutes if

$$\epsilon_c > 0, \quad \eta_c < 0.$$

Because monopolists produce in the elastic portion of the demand curve, we require that $\epsilon > 1$. We also require that $\eta > 0$; the elasticity of goods' demand with respect to own quality is positive. For the model to yield meaningful equilibrium prices and qualities, it must also be true that

$$\begin{aligned}\epsilon - \eta - 1 &> 0, \\ \epsilon - \epsilon_c - \eta - \eta_c - 1 &> 0.\end{aligned}$$

These assumptions guarantee that firms' maximization problems are well defined and produce strictly positive markups when autonomous and when merged, respectively. Solving equation (2) for price gives a locus describing the profit maximizing price for any given quality

$$p_p = \frac{(\epsilon - \delta\epsilon_c)(c + c_s s)}{\epsilon - \delta\epsilon_c - 1}. \quad (5)$$

The subscript p identifies (5) as the locus describing p, s combinations consistent with profit maximizing prices. We may also solve (3) for optimal price, which after some rearranging gives the following equation, describing optimal quality for a given price

$$p_s = c + c_s s + \frac{c_s s}{\eta + \delta\eta_c}. \quad (6)$$

The subscript s identifies locus (6) as that which describes profit maximizing quality consistent with a given price. Thus, our assumptions have allowed us to study the merger problem using the same methodology Spence (1975) applied to studying the quality and price decisions of monopolists. In figure 1, we plot both loci in s, p space, assuming that firms are autonomous so that $\delta = 0$. The point of intersection shows firms' autonomous profit maximizing prices and qualities. Varying the parameter δ between zero and one allows us to see how merger shifts the p_p and the p_s locus.

For some shifts of the two loci, it is obvious that welfare is increased by the merger. For example, if the shifts result in a post merger intersection of the p_p and p_s locus in the lower right hatched box, we may immediately conclude that the merger has increased welfare. This follows from the fact that the merger is an unambiguous gain from the perspective of the consumer; higher quality and lower price.⁹ If however, merger shifts the two loci so that the

⁹Because there is perfect information, it is impossible in our model for merger to decrease profits and make firms worse off. Thus, we may conclude that joint profits are always increased by merger.

new intersection lies to the northwest of the original intersection, the result is an unambiguous loss from the perspective of consumer as prices are higher and quality lower. We must then compare consumers' surplus and firms' joint profits to fully assess the impact of merger.

To gain some insight into how merger alters the picture presented in figure 1, we substitute $\delta = 1$ into (5) and (6) and re-plot the p_p and p_s loci. Figure 2 illustrates some possibilities when goods are complements ($\epsilon_c < 0$, $\eta_c > 0$). Inspection of (5) and (6) indicate that merger shifts both loci to the right (recall that products are complements when $\epsilon_c < 0$ and $\eta_c > 0$). The outward shift of the p_p locus captures the idea that merger allows for the internalization of the negative demand externality a high price imposes on the other firm. Similarly, the p_s locus shifts out because firms internalize the positive demand externality generated by production of quality, and after merger wish to produce a higher quality for any given price.

Figure 2 shows that the internalization of cross demand effects may result in higher quality and price, higher quality and lower price, or lower quality and price. We shall elucidate which cases are likely to occur for different elasticities in the subsequent section.

The impact of merger when firms produce substitute products ($\epsilon_c > 0$, $\eta_c < 0$) is described in figure 3. In this case, merger shifts both loci back. The merged firms now have a tendency to charge higher price and produce a lower quality than before. The result may be higher quality and higher price, lower quality and higher price, or lower quality and lower price. In contrast to the typical analysis of horizontal merger, however, it is only in the case in which quality falls and price rises that a loss in consumers' surplus is obvious.

Under which market conditions might we expect the various scenarios described in figures 2 and 3 to occur? Solving equations (2) and (3) simultaneously for equilibrium prices and qualities as functions of cost parameters, elasticities, and the degree of merger (captured by the indicator variable δ) gives solutions:

$$p' = \frac{c(\epsilon - \delta\epsilon_c)}{\epsilon - \delta\epsilon_c - \eta - \delta\eta_c - 1}, \quad (7)$$

and

$$s' = \frac{c(\eta + \delta\eta_c)}{c_s(\epsilon - \delta\epsilon_c - \eta - \delta\eta_c - 1)}. \quad (8)$$

Let the subscript m distinguish prices and qualities when firms are merged, and the subscript a distinguish prices and qualities when firms are not merged.

Substituting $\delta = 0$ and $\delta = 1$ into (7), we find that the change in price due to merger, Δp , is

$$\Delta p = p_m - p_a = \frac{c(\epsilon_c(1 + \eta) + \eta_c\epsilon)}{(\epsilon - \epsilon_c - \eta - \eta_c - 1)(\epsilon - \eta - 1)}. \quad (9)$$

By substituting $\delta = 0$ and $\delta = 1$ into (8), we find that the change in quality due to merger, Δs , is

$$\Delta s = s_m - s_a = \frac{c((\epsilon - 1)\eta_c + \eta\epsilon_c)}{c_s(\epsilon - \epsilon_c - \eta - \eta_c - 1)(\epsilon - \eta - 1)}. \quad (10)$$

We then may compute the percentage change in price and quality due to merger as:

$$\% \Delta p = \frac{\epsilon_c(1 + \eta) + \eta_c\epsilon}{(\epsilon - \epsilon_c - \eta_c - \eta - 1)\epsilon}, \quad (11)$$

and

$$\% \Delta s = \frac{(\epsilon - 1)\eta_c + \eta\epsilon_c}{(\epsilon - \epsilon_c - \eta_c - \eta - 1)\eta}. \quad (12)$$

Both $\% \Delta p$ or $\% \Delta s$ may be positive or negative for both the case in which goods are complements and the case in which goods are substitutes. The size and direction of the effect depends on the relative magnitudes of the four elasticities $\epsilon, \eta, \epsilon_c$ and η_c . To be a bit more specific, one may arrive at the following:

$$\frac{\partial \% \Delta p}{\partial \epsilon} < 0, \quad \frac{\partial \% \Delta p}{\partial \eta} > 0; \quad \frac{\partial \% \Delta s}{\partial \epsilon} \leq 0, \quad \frac{\partial \% \Delta s}{\partial \eta} \leq 0.$$

Not surprisingly, higher own-price elasticity lessens relative changes in price due to merger. This is because any change in price results in a more profound change in product demand. Similarly, higher own-quality elasticity increases relative changes in price due to merger. Intuitively, this is because firms face strong incentives to improve product quality, and improvements in quality are followed by increases in price. These results do not depend upon whether

or not the products are gross substitutes or gross complements. We also find that:

$$\frac{\partial\% \Delta p}{\partial \eta_c} > 0, \quad \frac{\partial\% \Delta p}{\partial \epsilon_c} > 0; \quad \frac{\partial\% \Delta s}{\partial \eta_c} > 0, \quad \frac{\partial\% \Delta s}{\partial \epsilon_c} > 0.$$

Increases in any of the cross elasticities result in larger percentage changes in price and quality when merger occurs.¹⁰ Figures 4 and 5 aid in describing what these results on the cross quality elasticities mean in practical terms.

Figure 4 plots percentage changes in price and quality as functions of cross price and qualities elasticities for the case in which products are gross complements ($\eta_c > 0, \epsilon_c < 0$). The figure shows how the ultimate result of merger varies with cross price and cross quality elasticities. The upper part of figure 4 plots the percentage change in price and quality as functions of the cross quality elasticity, η_c . This part of the diagram shows that, as the cross quality elasticity of products increases, it becomes more likely that merger increases both price and quality. Similarly, the lower half of the diagram implies that as the cross price elasticity decreases (that is, becomes more negative or increases in absolute value), it is more likely that merger decreases both price and quality.

The intuition behind figure 4 is as follows. If goods are strong quality complements in the sense that η_c is large, prior to merger firms are producing insufficient quality, so that when they merge, the internalization of the cross quality externality results in higher product qualities. The price increase follows from the increase in marginal cost associated with the quality increase. The lower half of the diagram reflects the fact that if goods are strong price complements in the sense that ϵ_c is large in absolute value, the issue of overriding importance to firms when merged is lowering product prices. To achieve a lower price, firms must also lower marginal costs of production. This requires a decrease in product quality.

Figure 4 also provides some initial clues into the welfare impact of merger when the products are complementary. We can, for example, say that an unambiguous welfare increase is possible for balanced cross price and cross quality elasticities. The vertical dashed lines on each diagram demarcate an area in which the percentage change in quality is positive while the percentage change in price is negative. This is a win-win situation from the perspective

¹⁰A clarification: since it is the case for complements that $\epsilon_c < 0$, it may help to think of the percentage change in price or quality getting larger as the *absolute value* of the cross price elasticity gets smaller.

of consumers; it may occur when cross quality and cross price elasticities are neither too large or too small so that firms have balanced incentives to both lower price and increase quality when merged. Since in these cases merger unambiguously increases consumers' surplus, it must also increase social welfare.

Figure 5 displays the case in which the firms produce substitute products ($\eta_c < 0, \epsilon_c > 0$); this case is the most similar to the horizontal merger commonly analyzed in the literature. The lower portion of Figure 5 indicates that as the cross quality elasticity grows more negative, firms are more likely to both reduce quality and price when merged. This somewhat surprising result occurs because reduction in competition associated with horizontal merger allows firms to produce lower product quality when merged. Thus, the merger produces downward pressure on price due to lower marginal production costs, and this pressure may override the incentives firms have to increase price when merged. The area between the vertical dashed lines on figure 5 delineate a region in which the desire of the merged entity to ease competition by reducing qualities and increase prices results in a lose-lose situation for consumers, because for these elasticities, firms lower increase prices yet lower quality after merger. In these cases, we must therefore resort to comparison of profits gained and surplus lost to assess whether or not merger increases or decreases welfare.

The chief lesson that we may draw from these diagrams is that allowing firms to vary product quality may result in very different outcomes than in the usual model in which quality is (implicitly) taken as given. In contrast to the conventional wisdom, it is entirely possible that merging firms producing gross complements might increase their prices and firms producing gross substitutes might decrease their prices. We now turn to investigating in more detail the implications of these results for consumers' surplus and total societal welfare.

2.1 Consumer surplus, demand and welfare

In this section we develop a more thorough assessment of the relationship between price, quality, and merger. Our assessment is based upon computing thresholds for percentage changes in price. We compute *the highest percentage price change a consumer would be willing to accept, given a percentage change in quality*. We may then take the change in quality induced by merger, and compare the acceptable price change with the price change

that actually occurs when the firms merge. An advantage of our methodology (beyond tractability) is that it is also flexible in that it allows us to take into account a variety of different types of consumer preferences.

A first challenge is developing a simple representation of consumer preferences capturing the most relevant features of the problem. Capturing the essential reason Spence (1975) found firms' quality choices diverge from welfare-maximizing choices - the difference between marginal and total consumer valuation of quality - is difficult. Consumers' surplus may be written:

$$CS = \int_{p_1}^{\infty} x_1(\tilde{p}_1, p_2, s_1, s_2) d\tilde{p}_1 + \int_{p_2}^{\infty} x_2(\tilde{p}_2, p_1, s_2, s_1) d\tilde{p}_2, \quad (13)$$

and social welfare is

$$W = CS + \pi_1 + \pi_2. \quad (14)$$

Substituting (13) and (1) into (14) and differentiating with respect to price and quality (respectively) yields, respectively, the conditions describing welfare maximizing prices and quality:

$$W_{i,p_i} = \frac{x_{i,p_i}(p_i - c_i) + x_{j,p_i}(p_j - c_j) + \int_{p_2}^{\infty} x_{j,p_i} d\tilde{p}_j}{x_{i,p_i}(p_i - c_i) + x_{j,p_i}(p_j - c_j) + \int_{p_2}^{\infty} x_{j,p_i} d\tilde{p}_j} = 0. \quad (15)$$

$$W_{i,s_i} = \frac{x_{i,p_i}(p_i - c_i) + x_i c_i' + x_{j,s_i}(p_j - c_j) + \int_{p_i}^{\infty} x_{i,s_i} d\tilde{p}_i + \int_{p_j}^{\infty} x_{j,s_i} d\tilde{p}_j}{x_{i,p_i}(p_i - c_i) + x_i c_i' + x_{j,s_i}(p_j - c_j) + \int_{p_i}^{\infty} x_{i,s_i} d\tilde{p}_i + \int_{p_j}^{\infty} x_{j,s_i} d\tilde{p}_j} = 0. \quad (16)$$

Expressions (15) and (16) differ from (3) and (2) regardless of whether or not $\delta = 1$ or $\delta = 0$. Whether autonomous or merged, firms do not generally produce socially desirable quality or charge socially desirable prices. The divergence between profit maximizing and welfare maximizing behavior can be attributed to three factors:

1. *Mark-up pricing*: Firms have a degree of market power and thus charge a price greater than marginal cost.
2. *The importance of total consumer valuation of quality*: Firms consider the impact of quality on the marginal consumer, while welfare maximization requires consideration of the impact of quality changes on all consumers.

3. *Demand interdependency*: The quality and price of one product influences the demand for the other product.

These sources of divergence can be roughly related to the first-order conditions describing welfare maximizing quality and price choices term by term. Compare first equation (15) with equation (2). An x_i term is present in equation (2) that is absent in equation (15). This reflects the standard markup over marginal cost. In the case in which $\delta = 1$ (the firms are merged) the condition for welfare maximizing price under merger, equation (15), contains the additional term $\int_{p_2}^{\infty} x_{j,p_i} d\tilde{p}_j$. The fact that this term is omitted in the determination of merged firms' optimal price is due to the fact that the firm neglects the impact of price decisions on the *total surplus* consumers realize in consuming the related product. This can be seen as a combination of *the importance of total quality valuation* and *demand interdependency* from our list above.

Compare now the conditions describing profit maximizing and welfare maximizing quality: (3) and (16), respectively. Two integral terms appear in (16) that do not appear in (3). This disparity is due to *the importance of total quality valuation*, which is perhaps the most unfamiliar of the firms' incentive problems. As Spence (1975, p. 420) writes, "This aspect of market failure has very little to do with monopoly. It is, rather, a result of the fact that price signals carry marginal information, while averages or totals are required in locating the optimum." When choosing qualities, firms consider how demand is impacted by quality at the margin, but do not consider how quality influences the utility of all consumers.

In consideration of this last source of divergence from welfare-maximizing quality choice, we wish to adopt functional forms for demand that do allow for some divergence in average and marginal utility. Most demand functions that allow this divergence are difficult to work with.¹¹ We employ a simple device to capture this feature of the model: a log-linear demand function that allows for a discrete change in shape at some point:

$$\begin{aligned} x_i(p_i, p_j, s_i, s_j) &= \bar{p}^{-\epsilon+k\epsilon} p_i^{-k\epsilon} s^\eta p_j^{\epsilon c} s_j^{\eta c}, & p_i \geq \bar{p} \\ &= p_i^{-\epsilon} s^\eta p_j^{\epsilon c} s_j^{\eta c}, & p_i < \bar{p}. \end{aligned}$$

¹¹Linear or log-linear demand functions do not allow a difference between marginal and average willingness to pay for quality. The most popular alternative, employed by Spence (1975) and also Dixit (1979), is to employ a function such as $d = p^{\epsilon(s)} s^\eta$, so that price elasticity is constant for any given quality, yet varies with quality. For our purposes, this function is still too difficult to use.

The log-linear demand function (17) allows for a change in willingness to pay for the good at the point \bar{p} , but otherwise retains all characteristics of the demand function used in the previous section. It shall allow us to track the divergence in average and marginal valuation using the sole parameter k . Figure 6 shows the shape of the demand function and how it changes for differing values of k . For $k = 1$, marginal and average quality valuation are the same. In this case the demand function has no kink. If $k > 1$, the demand function flattens out above the kink, implying that the average willingness to pay for quality of is less than marginal willingness to pay. Thus, in this case, by focusing on the marginal consumer, firms overstate the impact of quality on consumers' surplus. If $k < 1$, the average willingness to pay for quality is greater than willingness to pay of the marginal consumer. In this case, firms understate the impact of quality by focusing on only the marginal consumer.

Because the positioning of the kink in demand is arbitrary, we might as well position it to greatest advantage. It is most useful to position the kink at the pre-merger price, and assume that firms ignore the possibility of the kink when choosing price and quality and that it does not effect firms' profits. In figure 6, if p_1 is the pre merger price, we position the kink at p_1 . In the appendix, we show that performing these operations lead us to the following expression describing an iso-consumer surplus line:

$$dCS = \frac{dp}{p}(-(\epsilon k - 1) + \epsilon_c) + (\eta + \eta_c)\frac{ds}{s} = 0, \quad (17)$$

We may solve (17) as follows, using as before $\% \Delta p$ and $\% \Delta s$ to denote percentage changes in prices and qualities:

$$\% \Delta p^* = \frac{\eta + \eta_c}{\epsilon k - 1 - \epsilon_c} \% \Delta s \quad (18)$$

Equation (18) describes a relationship between percentage changes in quality and percentage changes in prices such that consumer welfare is unchanged, given the change in the shape of the demand curve. Using this expression, we can assess whether or not merger increases or decreases consumers' surplus. If we insert a value for $\% \Delta s$ into (18) we obtain *the price change which leaves consumers indifferent between pre and post merger prices and qualities*. That is, we obtain the price change that consumers are willing to tolerate, given the change in quality induced by merger. It follows that any percentage price

increase greater than this standard reduces consumer welfare, while any price increase lower than this increases consumer welfare.

In similar fashion, in the appendix we also derive an iso-social welfare line that describes *the price change given the change in quality due to merger that would leave social welfare unchanged*. This line is described by the equation:

$$dSW = \frac{dp}{p}(\epsilon\epsilon_c - (\epsilon k - 1)(\epsilon + \epsilon_c)) + (\epsilon(\eta + \eta_c) + \eta_c(\epsilon k - 1))\frac{ds}{s} = 0. \quad (19)$$

Rearranging gives the following expression:

$$\% \Delta p^{**} = \frac{\epsilon(\eta + \eta_c) + \eta_c(\epsilon k - 1)}{(\epsilon k - 1)(\epsilon + \epsilon_c) - \epsilon\epsilon_c} \% \Delta s \quad (20)$$

In figure 7 we plot the acceptable price increases from the perspective of consumers (labelled $\Delta CS = 0$), and the acceptable price increases from a social welfare perspective ($\Delta SW = 0$) given that $k = 1$, so there is no divergence between the marginal willingness to pay for quality and the average willingness to pay for quality. The change in quality is omitted to avoid cluttering the diagrams unnecessarily; the reader may refer to figures 4 and 5 to see associated percentage changes in quality. The figure shows, as the previous figures did, that increasing the cross quality elasticity of the products generally results in greater percentage changes in price when merger occurs (because quality has improved; see figure 4).

For all points up to the vertical dotted line, which marks the point at which the $\Delta SW = 0$ line intersects the $\% \Delta p$ line, welfare is improved by merger. This is because for all other points on the diagram, the actual price change provoked by merger is below the constant welfare price change, meaning that prices either increase less or fall more than the minimum needed to hold welfare constant. This result is interesting in that it implies that a relatively large cross quality demand elasticity may result in merger decreasing welfare, even though intuition might suggest that in a case when firms have strong incentives to upgrade quality when merged, welfare should increase when firms merge.

The lower half of figure 7 plots the same three percentage changes as functions of the cross price elasticity is allowed to vary. Figure 7 indicates that as the cross price elasticity gets larger (becomes more negative) and goods become stronger price complements, the likelihood that merger increases welfare increases. This is true because firms have a strong incentive to lower prices when merged.

This analysis reveals an interesting fact about mergers in which goods are complementary and product quality may change due to merger. One may conclude that it is most likely that, given there is no divergence in marginal and total willingness to pay for quality, merger may result in a decrease in welfare when goods are complements if the cross quality demand elasticity is large, and the cross price elasticity is small. To review, the intuition is as follows. When the cross quality elasticity of demand is large, firms have an incentive to greatly increase quality when merged; this also leads to a corresponding increase in prices. If the cross price elasticity is sufficiently small, the price increase resulting from the change in the quality may be large enough to swamp the welfare gains due to the quality change.

Perhaps the chief lesson provided by the diagram is that increases in product quality associated with merger do not necessarily indicate that a merger has increased welfare. Indeed, it is possible that merger may result in reduction of product quality, but that this will result in higher welfare due to the associated fall in prices. It is also possible that merger may decrease welfare when product quality increases. This is because the increase in price associated with higher product quality offsets the benefits consumers realize from higher product quality.

How does this picture change when some divergence between average and marginal willingness to pay for quality is allowed? Recall that in our specification described by (19) a higher k means that average valuation of quality is lower than marginal valuation of quality. Figure 8 plots the percentage change in price and the constant welfare price changes for different values of k . As k gets larger, the constant welfare line flattens out. Not surprisingly, when the “average” consumer places lower value on quality, consumers are, *ceteris paribus*, less willing to tolerate price increases. This effectively expands the range for which mergers decrease welfare. The opposite is true if $k < 1$, the average consumer benefits more than the marginal consumer from an increase in quality. Thus, consumers in general are more willing to tolerate price increases. As the $k < 1$ line on Figure 8 indicates, it is possible that this effect can be strong enough to result in any merger between firms producing complementary products increasing welfare.

Figure 9 shows the essential aspects of merger when goods are substitutes and k is allowed to vary. The distinguishing feature of Figure 9 is that the welfare constant price change now generally lies below the actual price change, meaning that merger usually results in price changes given quality changes, that reduce welfare. However, in tandem the upper and lower

portion of figure 9 reveal that, unlike the typical case of horizontal merger, merger between firms producing substitute products that may vary product quality can produce welfare increases. This outcome may occur when the cross quality elasticity is relatively large (in this case negative), and the cross price elasticity is relatively small. In this case, firms do not face a strong incentive to increase price and decrease quality when merged. It is possible then, that a simultaneous drop in quality and price occurs which decreases welfare. Thus, there are cases of horizontal merger which increase welfare, but they correspond to falling quality and prices.

If k is allowed to vary for the case of substitutes, the results do not change profoundly and are roughly as expected. Smaller k implies a greater average willingness to pay for quality changes than marginal willingness to pay. The effect is most pronounced for the case in which quality falls, where previously a welfare increase had been possible. Here, the resulting quality drop means that consumers must be compensated by a larger price drop, rendering an improvement in welfare less likely.

3 Conclusions

This paper has examined the impact of merger in situations in which firms are free to choose both product qualities and prices. We show that, contrary to the standard case of horizontal merger in which product quality is given, merger between firms producing gross complements may decrease welfare, and mergers between firms producing substitute products (the classic horizontal merger case) may increase welfare. When the cross quality elasticity of demand is high, and the cross price elasticity of demand is low, merger between firms producing complementary products may induce *quality and price increases that reduce welfare*. Similarly, in the case in which firms produce substitute products, welfare may induce *quality and price declines that increase welfare*. We also find that in some cases welfare and quality move in opposite directions. For example, in the case in which firms produce gross complements, it is possible that firms increase quality when merged, but that this change lowers consumer welfare. Additionally, in the case in which firms produce substitutes, it is possible that firms decrease quality, but that this change increases consumer welfare.

Our results have some important implications for policy when quality choice is important. Our results suggest that one must exercise caution in

assessing arguments that merger should be allowed to occur because the merged entity will produce higher quality products.

There are many ways in which one might extend our analysis. First, one might wish to include in our model some of the other reasons for merger considered in the literature: an obvious idea is to include in the analysis the possibility that merger increases efficiency in some way, so that the merged entity faces lower production costs than the independent firms. This would lead to an assessment of merger which combined our analysis of merger with the classic "efficiency" analysis of merger. Another way in which others might build upon our model is by introducing an asymmetry in the quality and price dependency between firms.

Appendix - Derivation of Iso Surplus Lines

In this appendix, we describe the derivation of an iso consumers' surplus line when the demand function is discontinuous. The demand functions are taken to be given as the following

$$\begin{aligned} x_i(p_i, p_j, s_i, s_j) &= \bar{p}_i^{-\epsilon_i + k_i \epsilon_i} p_i^{-k_i \epsilon_i} s_i^{\eta_i} p_j^{\epsilon_{ij}} s_j^{\eta_{ij}}, & p_i \geq \bar{p}_i \\ &= p_i^{-\epsilon_i} s_i^{\eta_i} p_j^{\epsilon_{ij}} s_j^{\eta_{ij}}, & p_i < \bar{p}_i. \end{aligned}$$

The demand functions leads to the following expression for consumers' surplus:

$$\begin{aligned} CS &= (\bar{p}_1^{-\epsilon_1 + 1} (\frac{1}{\epsilon_1 k_1 - 1} - \frac{1}{\epsilon_1 - 1}) + \frac{1}{\epsilon_1 - 1} \bar{p}_1^{-\epsilon_1 + 1}) s_1^{\eta_1} s_2^{\eta_{12}} p_2^{\epsilon_{12}} + \\ & (\bar{p}_2^{-\epsilon_2 + 1} (\frac{1}{\epsilon_2 k_2 - 1} - \frac{1}{\epsilon_2 - 1}) + \frac{1}{\epsilon_2 - 1} \bar{p}_2^{-\epsilon_2 + 1}) s_1^{\eta_2} s_2^{\eta_{21}} p_1^{\epsilon_{21}}. \end{aligned}$$

Taking the total differential of CS with respect to p and s , applying symmetry, and allowing \bar{p} to approach p , the price which shall be used in forming calculations, we arrive at the following expression describing the price and quality combinations between which the consumer is indifferent:

$$dCS = \frac{dp}{p} (-(\epsilon k - 1) + \epsilon_c) + (\eta + \eta_c) \frac{ds}{s} = 0$$

To test whether or not $dCS > 0$ after merger, we can employ the price and quality changes, Δ_p in (9) and Δ_s in (10), respectively, as estimates of dp and ds in (17). The term is converted into percentage change terms by substituting in either p_m, s_m or p_a, s_a for p and s . We shall generally use the price and quality combination with the larger price in the above. If we did not do this, the point at which the demand curve changed slope would have to enter into firms' decision making process.

Alternatively, we can develop an iso welfare line by applying the same methodology, but this time to the expression:

$$SW = CS + x_1(p_1 - c_1(s_1)) + x_2(p_2 - c_2(s_2)),$$

where we use the specified demand functions given in (4). Taking the total differential of SW with respect to prices and qualities, applying symmetry,

letting \bar{p} approach p , substituting in the equilibrium prices and qualities described by (7) and (8), and making cancellations gives the following expression describing an iso-welfare line:

$$dSW = \frac{dp}{p}(\epsilon\epsilon_c - (\epsilon k - 1)(\epsilon + \epsilon_c)) + (\epsilon(\eta + \eta_c) + \eta_c(\epsilon k - 1))\frac{ds}{s} = 0.$$

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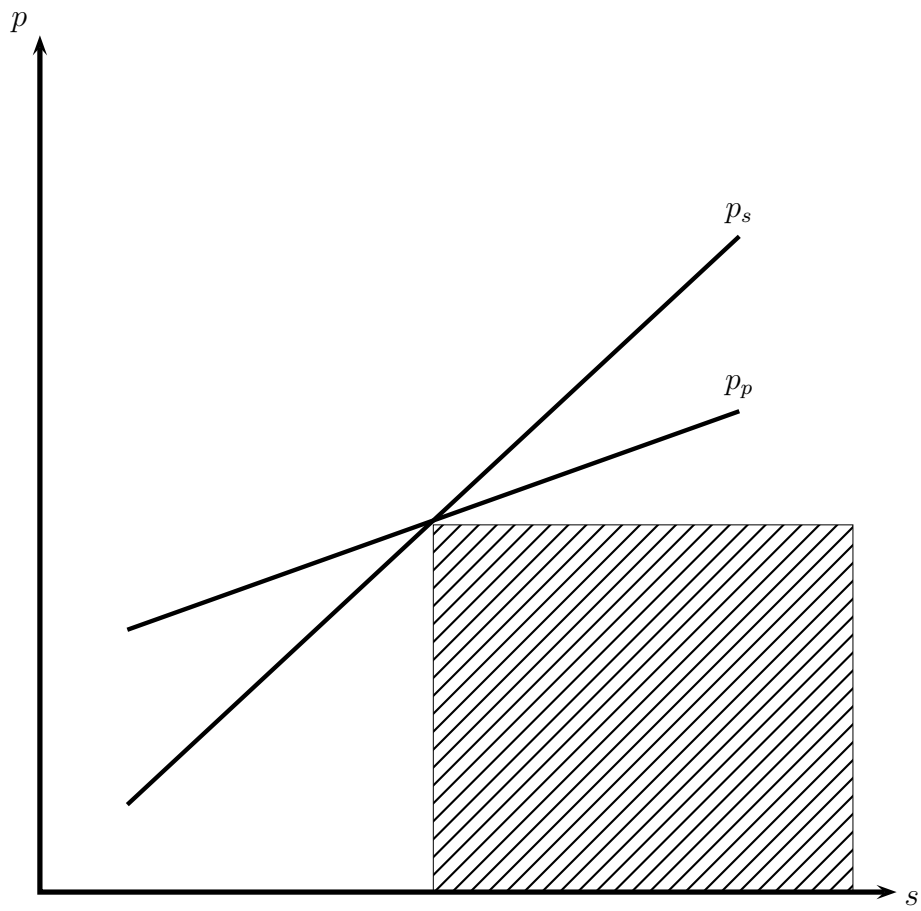


Figure 1: Firms' profit maximizing p and s

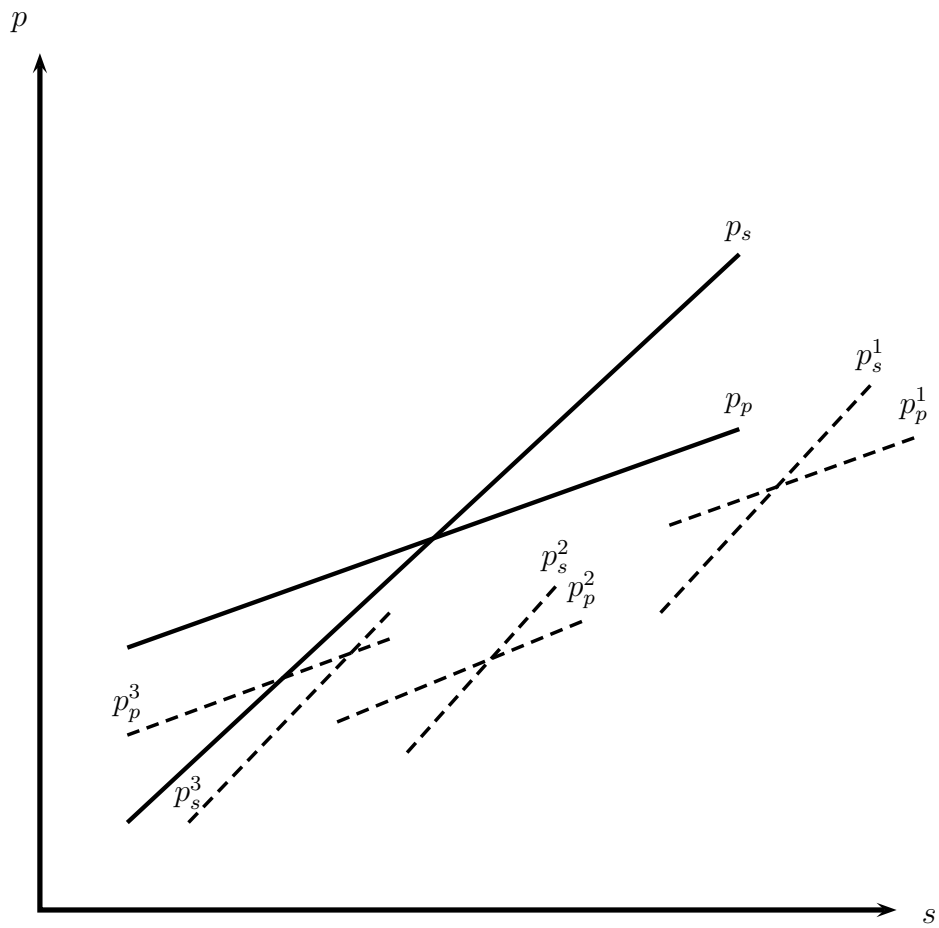


Figure 2: Illustration of the potential outcomes of merger: complements

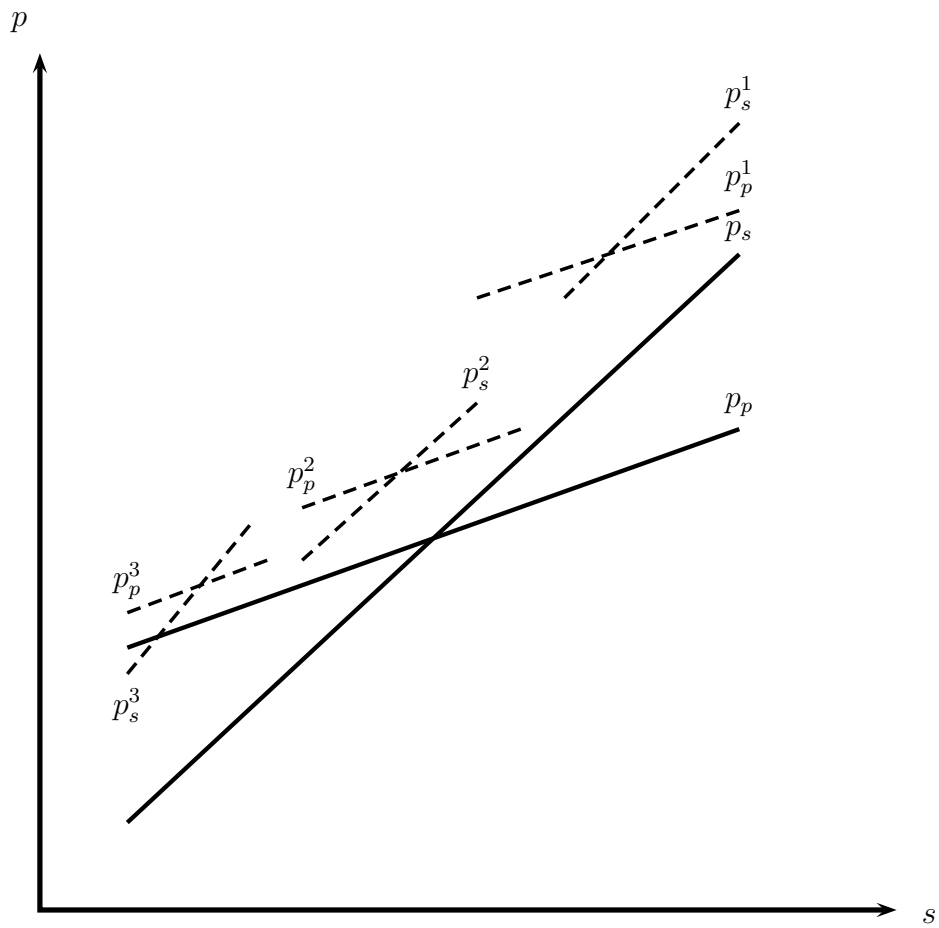


Figure 3: Illustration of the potential impact of merger: substitutes

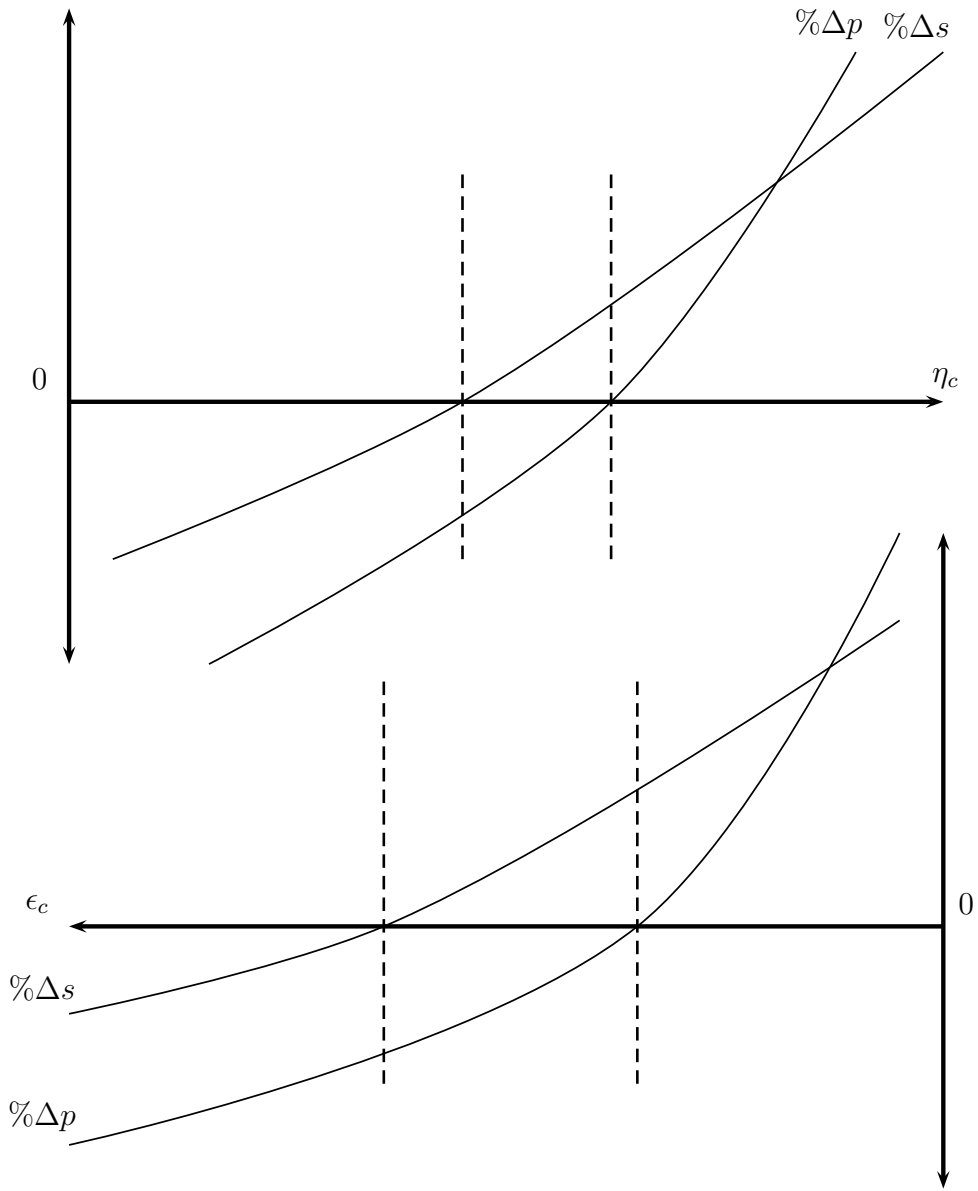


Figure 4: Percentage changes in quality and price due to merger as functions of cross quality and cross price elasticities: complements.

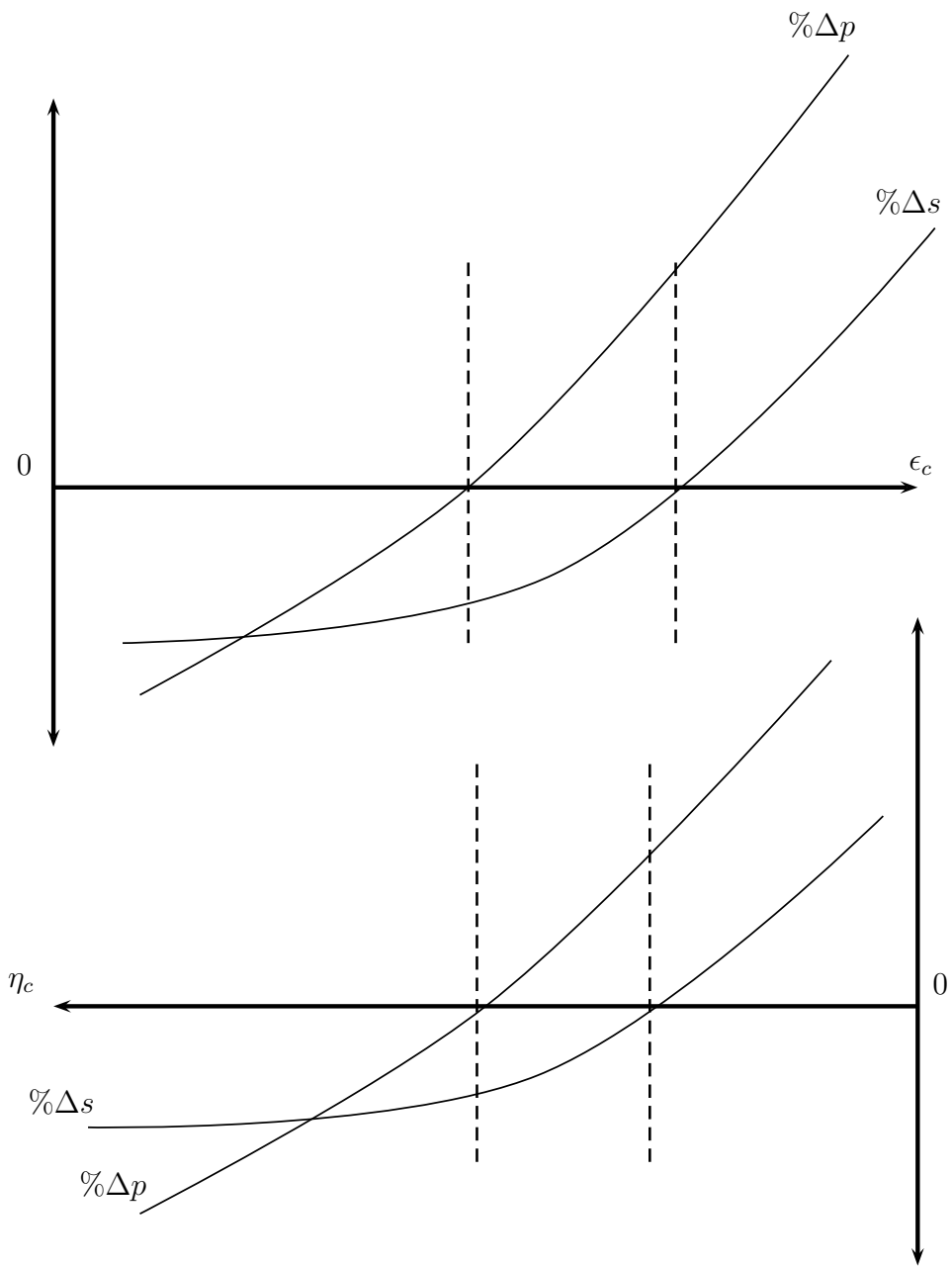


Figure 5: Percentage changes in quality and price due to merger as functions of cross quality and cross price elasticities: substitutes.

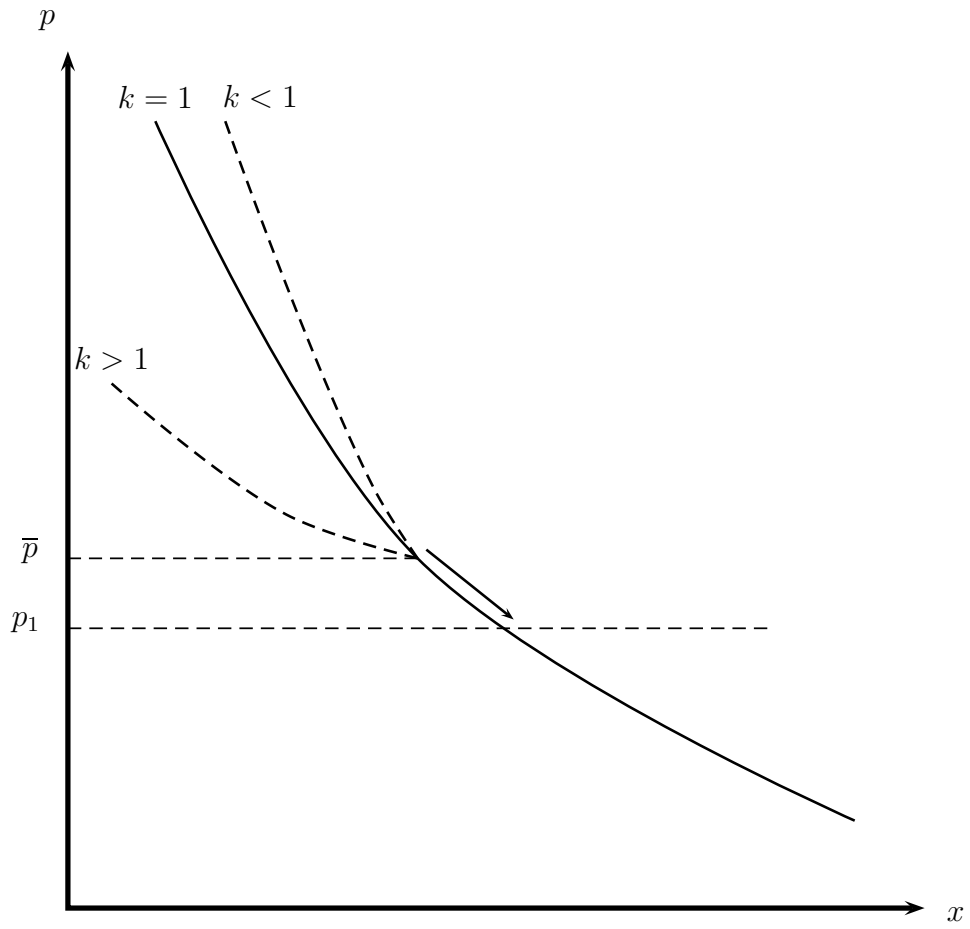


Figure 6: Consumer preferences for varying k

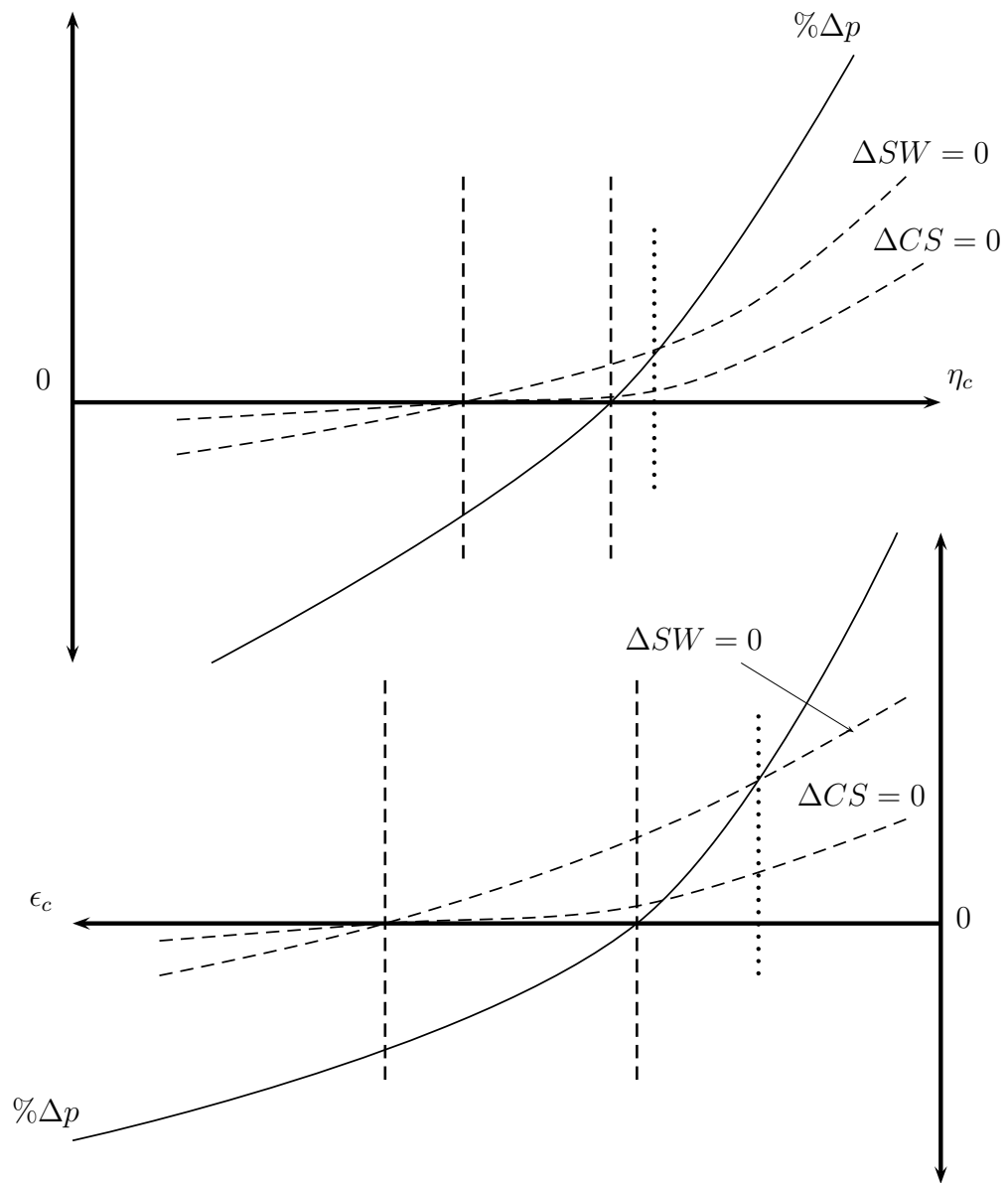


Figure 7: Acceptable percentage change in prices as functions of elasticity

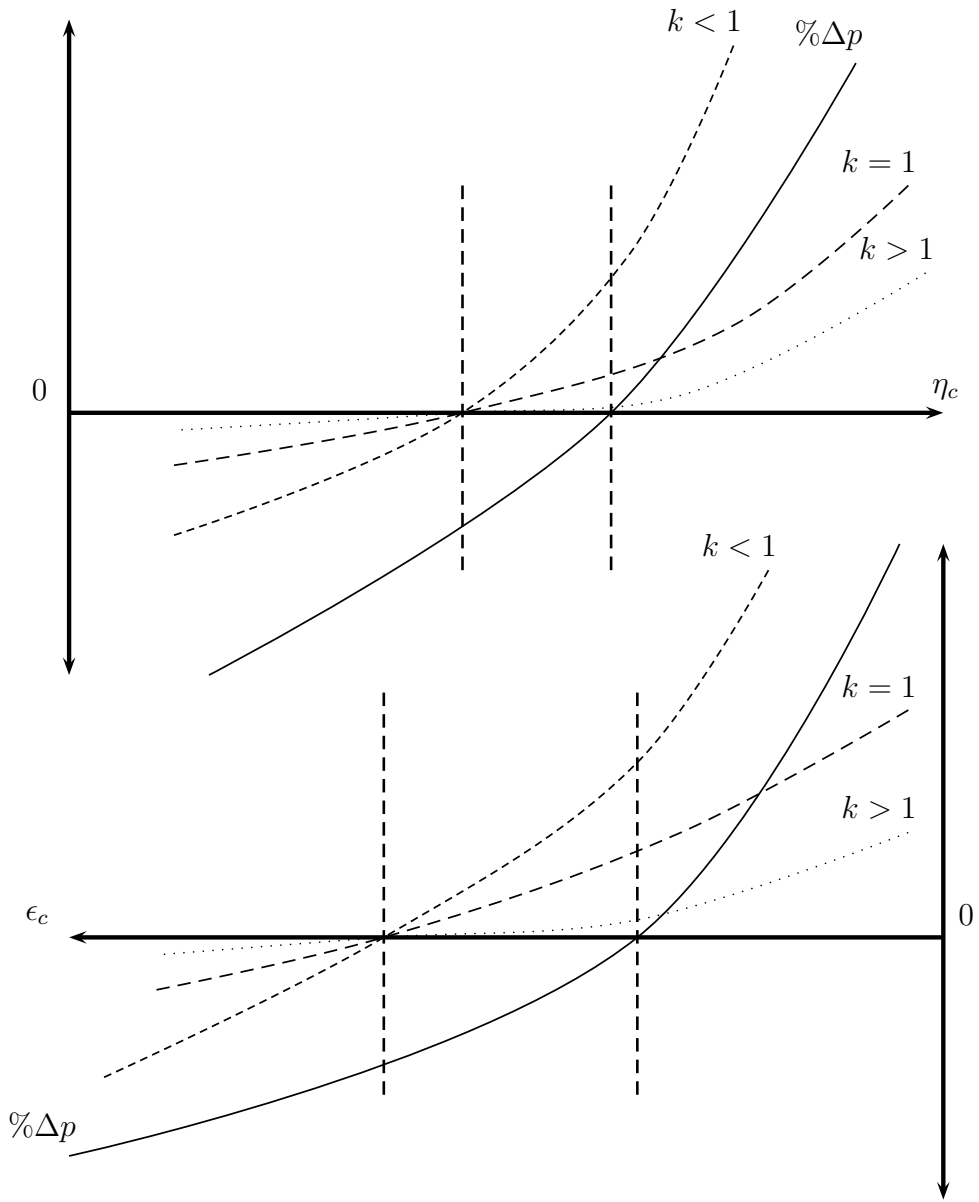


Figure 8: Percentage change in price due to merger, with equal welfare percentage changes in price: case of complements

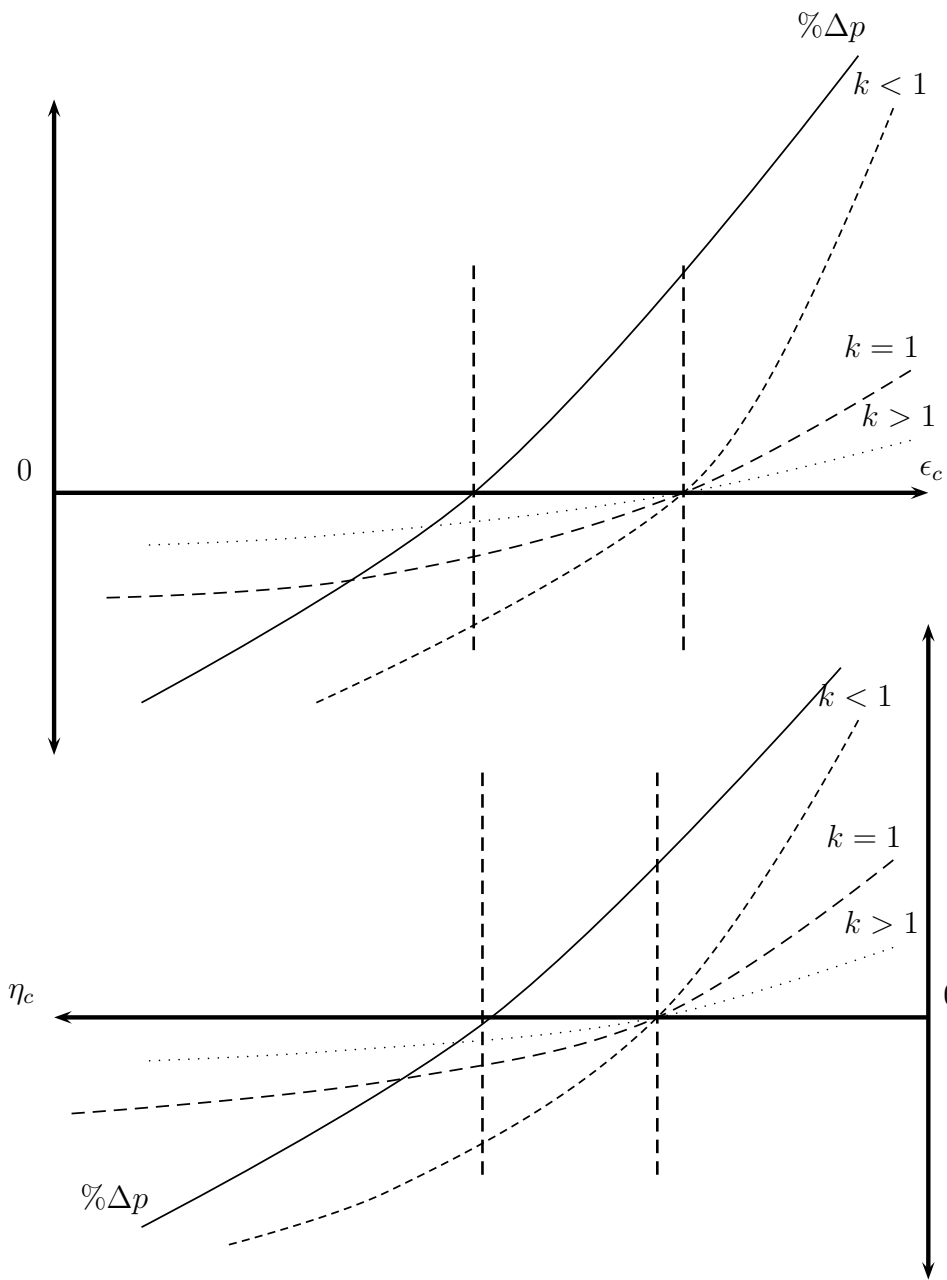


Figure 9: Percentage change in price due to merger, with equal welfare percentage changes in price: case of substitutes