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Equilibrium mergers in a composite good industry with efficiencies

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Abstract

This paper studies equilibrium merging behavior in composite good industries. Component producers face the option to either merge with a similar component producer (horizontal merger) or a complementary one (complementary merger) of a composite good. Focusing only on strategic reasons, complementary mergers arise at equilibrium only when composite goods are very differentiated while horizontal mergers otherwise. Next, when efficiencies are considered, the level of marginal cost saving required for a horizontal merger in a composite industry to result in a non- increase in the upward price pressure index (UPPI) is greater as compared with the one in a regular industry. This result can be used by antitrust authorities to be more demanding when dealing with horizontal mergers in composite goods industries.

Keywords: composite goods, substitutes, complements, horizontal merger, complementary merger, efficiency effects, UPPI, diversion ratio.

JEL classifications: L13, L41

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1 Introduction

Consumers derive utility from consumption of different sort of goods, some of them are consumed separately and others used in combinations instead. There are combinations in which individual components provide utility as well, such as a flight and a hotel booking; while in others utility is only derived when both components are used simultaneously, such as mobile phones and mobile phone services, hardware and software, printers and ink cartridges or an e-book file and a device to read it. Industries involved in those products are significant for developed economies. For example the mobile phones market valued at Retail Selling Price is worth 16,702 millions of dollars in North America and 37,765 millions of dollars in Western Europe in 2011. Consumer expenditure on telecommunications services is about 247,855 millions of dollars in North America and 242,323 millions of dollars in Western Europe in 2012.[1] Industries developing those products are typically concentrated and firms are in constant search for increased profitability. Then, interesting questions raise: is it more profitable for a component producer to merge with a substitute or with a complement component producer? What will authorities do? What's the role of efficiencies in these scenarios?

Note that the above question is interesting and also pertinent. The second merger in deal value importance in 2012 is between *Starburst II Inc* (dependent from the Japanese firm *Softbank Corp*, the acquirer) and *Sprint Nextel Corporation* (the target) and amounts to 36,956 millions of dollars.[2] Both firms offer wireless networks and mobile communication services. The proposed merger is therefore between substitute component producers, while *Starburst II Inc* had potentially the option to merge with a mobile phone producer such as the Japanese firm *Kyocera*, that is, with a complement component producer. Then, it is relevant to understand which are the reasons behind the *Starburst* decision.

The main purpose of the paper is to analyze the equilibrium merging behavior in composite good industries, that is when firms face the option to either merge with a competitor that is producing a similar component (same type) or a complementary component (different type) of a composite good. The first type of merger will be denoted *horizontal merger*, while the second one *complementary merger*.[3] Mergers are useful devices to

[1] Data from Passport GMID by Euromonitor.

[2] Data from Zephyr Annual M&A Report 2012, published by BvD.

[3] Both types of merger are different from vertical mergers, which entail expanding forward or backward

restructure industries[4] and one of the most scrutinized firms' decisions by competition authorities. During 2012 the FTC has actively used litigation to block proposed mergers and unwind allegedly anticompetitive consummated mergers, for instance in December 2012 the FTC filed a complaint seeking to deter *Integrated Device Technology's* acquisition of *PLX Technology* in the hardware industry. Similarly, the recent DOJ's challenge to the *Anheuser-Busch InBev/Grupo Modelo* transaction in the beer industry. Regarding the European Commission, over the past three years, the rate at which notified mergers initiate a Phase II investigation has almost tripled, from 1.19% in 2010 to 3.53% in 2012. Finally, 2012 witnessed the third (*UPS*'s acquisition of *TNT Express*) fourth (the proposed takeover of *Aer Lingus* by *Ryanair*) and fifth (the merger between *Deutsche Börse* and *NYSE*) merger prohibition since 2007.

However, while complementary mergers are pleasantly received, horizontal ones are usually considered harmful for consumers and society.[5] Thus our second purpose in the paper is to provide some guidance to competition authorities to better understand the effects of horizontal mergers in composite good industries. In doing so, we will draw comparisons on the UPPI (upward price pressure index) resulting from horizontal mergers in the composite industry analyzed and those derived from regular industries. Also on how synergies resulting from horizontal mergers affect the UPPI depending on the good considered.[6]

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in the chain of distribution, toward the source of raw materials or toward the ultimate consumer. Settings where complements are different inputs in a product chain and assembled by the producers describe vertically related firms. But only one (the downstream end of the chain) has direct access to consumers. In our case such a vertical relation does not exist.

[4] The number of mergers and acquisitions in 2012 reached 19,600 in Western Europe and 14,800 in the US and Canada. Despite the worldwide economic crisis, the number of deals is still relevant (Zephyr Annual M&A Report 2012, published by BvD).

[5] Nevertheless, horizontal mergers are frequently proposed and accepted by antitrust authorities. For example, a merger between two of the six major publishing companies, *Random House* and *Penguin Group (Pearson)* has been recently announced. It will reach a turnover of €3,000 million. The new firm, Penguin Random House, has been approved by antitrust authorities from US, New Zealand, Australia, EU, Canada, South Africa and China, all of them without conditions.

[6] Upward price pressure indices have recently been incorporated in merger analysis by Professors Joseph Farrell and Carl Shapiro to evaluate potential unilateral effects. In fact, the US Horizontal Merger Guidelines issued in 2010 by the USDOJ and FTC are considering UPPI thresholds instead of the 35 percent combined markets share threshold to assess unilateral effects of horizontal mergers.

To answer the above questions, we will present the simplest model that allows firms to choose the type of merger. Then, consider an industry of composite goods formed by two components, A and B. There are four independent firms, two of them produce varieties of component A while the other two firms produce varieties of its complementary component B. Components' compatibility results in four composite goods in the market. We assume consumers choose components to create their own composite goods and get utility, since consuming separate components is useless. Therefore, composite goods compete as imperfect substitutes, but at the same time, different type components are complements while same type components are substitutes. One of the four firms, the proponent firm chooses between merging with a substitute component producer, with a complementary component producer or remaining alone. Focusing on strategic effects, we find that a complementary merger is privately preferred only when composite goods are very differentiated, the horizontal merger is chosen otherwise.[7] Therefore *horizontal mergers are more suitable tools rather than complementary ones to increase business profits.* The Cournot effect is dominated by the competition effect. Regarding policy implications we reach two interesting ones: i) *when only strategic effects are reckoned, proposed complementary mergers have to be always cleared while proposed horizontal mergers must be always forbidden by antitrust authorities.* And ii) *merger proposals different from the equilibrium ones are sufficient conditions for antitrust agencies to infer substantial efficiencies not considered that justify those proposals.*

If firms do the same activity, it seems natural to consider costs savings after a merger due to the similarity in production of both components.[8] Those efficiencies are obtained from the rationalization of production, economies of scale, technological progress (know-

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However, market shares can be informative about diversion ratios. Antitrust authorities take into account several instruments to evaluate the effects of a merger, not only diversion ratios and market shares, but also merger simulations and qualitative analysis of the elements that determine prices and aspects not captured by other means, as is stated in Kühn, Albæk, and De la Mano (2011) for the DG Competition in EU.

[7] Both mergers are qualitatively different, not only by the component combinations, but also because the complementary merger allows more pricing strategies (pure bundling and mixed bundling).

[8] In the empirical paper by Gayle and Le (2013) two real mergers between airline companies are studied. They found evidence of fixed and marginal cost savings in both cases. In another industry, Harrison (2011) found that hospital mergers involved cost savings, which are greater the first post-merger year than the following ones.

how, R&D), purchasing economies or savings in factor prices.[9] When efficiency gains are sufficiently large to extend the benefits to consumers, antitrust authorities allow for the proposed horizontal merger. Thus, which is this minimum required efficiency in a composite good industry? In order to answer this question the level of marginal cost saving that results in a non-increase in the upward price pressure index is computed. We find that *a greater marginal cost saving is required for a horizontal merger in a composite good industry not to increase prices as compared with a horizontal merger in a regular good industry*. The above result is interesting for antitrust authorities since it advises them to be more demanding when dealing with horizontal mergers in composite goods industries. We would like to note that this difference is rooted to the higher diversion ratio and margin that arises in composite good industries.

The received literature

Analysis of merging incentives started with Salant, Switzer and Reynolds (SSR) (1983) where exogenous mergers not including enough members could be unprofitable for the participants while outsiders were better off, if only strategic effects are considered, with substitute goods and quantity competition.[10] Gaudet and Salant (1992) extend SSR's analysis to complementary goods and price competition, getting the same conclusions about merger profitability but opposite welfare outcome. Beggs (1994) studies merging decisions in a setting of two groups with two firms each, where products are complements within the group but substitutes across groups and no compatibility is assumed. Complementary product firms usually prefer acting independently instead of merging. Economides and Salop (1992) analyze price effects derived from different exogenous market structures in an industry with two brands for each compatible component and no bundling strategies. Effects on prices show that different market structures internalize vertical and horizontal externalities. Choi (2008) takes Economides and Salop's framework to study strategic motives to engage only in complementary mergers allowing for mixed bundling, which is the optimal post-merger price strategy where the bundle price is lower while component prices are higher.[11] Our contribution to the merger literature

[9] For an exhaustive analysis about efficiency gains from mergers see Röller et al (2001).

[10] In Deneckere and Davidson (1985) every merger is profitable, due to upward-sloping reaction functions. Kamien and Zang (1990) develop a two-stage game of endogenous mergers in a market with homogenous products, finding that full monopolization of an industry is not the usual result.

[11] In the case consumers also obtain utility by consuming the components separately, Flores-Fillol and

hinges on the case in which consumers assemble the components of composite goods and only joint consumption yields utility. We wish to move a step forward by addressing the incentives to merge when two types of merger are possible in the same industry: among same type component producers or among different type ones.

The binomial mergers-efficiency effects is considered since Perry and Porter (1985) who state that incentives to merge depend on two effects: price increases and output decreases. Allowing for a larger merged firm (with lower marginal cost) than previous independent firms, the output reduction is softer than in SSR. Farrell and Shapiro (1990) present internal efficiencies where firms have different costs, showing that economies of scale or learning effects needed for a merger to decrease prices are greater the larger are the market shares of the merging firms and the less elastic is industry demand.[12] More recent papers focus on dynamic models of endogenous mergers, as Motta and Vasconcelos (2005) and Vasconcelos (2010), where a comparison is established between myopic and forward looking antitrust authorities. The former paper shows that if efficiencies are strong, prices might be lower after the merger, even if some firms exit. The efficiency offence argument cannot be sustained with forward looking antitrust authorities, since rival firms will engage in a merger as well. The latter paper focuses on structural remedies in merger control, which are not needed to implement the preferred market structure with forward looking authorities but they are necessary for optimal decisions with myopic ones. Banal-Estañol et al (2008) focus on questioning the realization of efficiencies. If antitrust authorities take them for granted, mistakes are found in both sides: approving welfare-reducing mergers and blocking welfare-enhancing ones. Closer to our model is Motta (2004), who finds a sufficient level of efficiency gains for a horizontal merger to be beneficial for consumers when firms choose prices in a static framework. We extend it by analyzing a composite good industry with differentiated goods finding the required synergy which implies a non-

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Moner-Colonques (2011) find that merging is a dominant strategy with soft competition and incentives to merge are higher if component demands are not too important.

[12] An extension to this model and Werden and Froeb's (1998) but allowing for entry is Spector (2003) who found that profitable mergers with no technological synergies are harmful for consumers, regardless of fixed costs or entry conditions. Efficiencies and free-entry are also studied in Cabral (2003), who states that a merger defense based on cost efficiencies changes if post-merger entry is allowed, because there is a more efficient firm, but entry will be less likely since new rivals will face a tougher price competition.

increase in prices and how it compares with a regular good industry.[13]

Next section describes the model and presents the type of merger which is preferable from a private and a social point of view. In Section 3 the model is extended to include efficiencies in marginal cost, the UPPI that corresponds to the Horizontal merger in a composite good industry is provided and compared with the one that would arise if the industry would not be a composite good one. Section 4 concludes.

2 The model

Consider a situation where consumers need to combine two complementary components, A and B, in fixed proportions on a one-to-one basis, to form a composite good because they only get utility by consuming a composite good. The industry consists of four initially independent firms[14], two of them producing A-type components, firms $i = 1, 2$, and the other two producing B-type components, firms $j = 1, 2$. It is assumed that any component of one type is fully compatible with any other component of the different type, that is, there is full compatibility and therefore up to four different composite goods can be consumed, i.e. A_1B_1, A_1B_2, A_2B_1 A_2B_2.

Note that the underlying market is one where both substitute and complement components are strategically linked, but consumers only choose among substitute composite goods. The quantity consumed of composite good A_iB_j is denoted by X_{ij} where subscript ij, with $ij = 11, 12, 21, 22$, refers to the four composite goods mentioned above. The price of component A_i is denoted by p_i while the price of component B_j is denoted by q_j where $i, j = 1, 2$. Therefore, composite good or system ij is available at price $s_{ij} = p_i + q_j$. The system of demand functions is obtained considering a representative consumer product differentiation model, with the following utility function: $U = y + \alpha \sum_{\forall ij} X_{ij} - \frac{\beta}{2} \sum_{\forall ij} X_{ij}^2 - \gamma(X_{11}X_{12} + X_{11}X_{21} + X_{11}X_{22} + X_{12}X_{21} + X_{12}X_{22} + X_{21}X_{22})$, where $\alpha, \beta, \gamma > 0$ are the demand parameters in the model and y is the quantity of numeraire good consumed. Utility maximization under the following budget constraint, $I = y + \sum_{\forall ij} s_{ij}X_{ij}$ leads to

[13] Another interesting contribution is that of Mialon (2013), she considers which is the most profitable way for a firm to bundle her own product with a complementary one, either by proposing a complementary merger or by forming a strategic alliance. Different price strategies (mixed bundling, pure bundling and no bundling) are compared, although efficiencies are not considered.

[14] For a general analysis of a composite good industry but with n producers of each type, see Pardo-García (2012).

the next system of inverse demand functions, $s_{ij} = \alpha - \beta X_{ij} - \gamma\left(X_{ii} + X_{ji} + X_{jj}\right)$, where $ij, ii, ji, jj = 11, 12, 21, 22$, with $ij \neq ii \neq ji \neq jj$. Finally, by inverting the above system, the next system of demand functions is reached,

$$X_{ij} = \frac{\alpha(\beta-\gamma)-(\beta+2\gamma)s_{ij}+\gamma(s_{ii}+s_{ji}+s_{jj})}{(\beta-\gamma)(\beta+3\gamma)}, \tag{1}$$

where $ij, ii, ji, jj = 11, 12, 21, 22$, and $ij \neq ii \neq ji \neq jj$.

Note that composite goods are imperfect substitutes, own effects in demand are negative and greater, in absolute value, than cross effects if condition $\beta > \gamma$ holds. This condition is standard and simply says that an increase of the same amount in all prices will imply a decrease in demand. Finally, as parameter γ approaches β, composite goods become more similar (less differentiated) to consumers and in the extreme case where γ equals zero all goods become independent.

Regarding component production costs, and to simplify the model as much as possible, it is assumed that marginal costs are constant, common and equal to c. Firms profits are, therefore, $\pi_{A_i} = (p_i - c)(X_{i1} + X_{i2})$, and $\pi_{B_j} = (q_j - c)(X_{1j} + X_{2j})$, for all $i, j = 1, 2$.

Without loss of generality, along the merger proposal A_1 is arbitrarily chosen to be the proposer, that is, the firm deciding whom to merge with. The other part, the respondent, can either accept or reject it. If a proposed merger is profitable as a whole, any respondent will undoubtedly accept it, since the proposer will offer the same profits earned the previous period plus an epsilon to the respondent. Only mergers that will be accepted at equilibrium will be proposed.

Initial situation: Independent ownership (I)

Each firm is identified with a single component and its strategic behavior affects the marketing of two composite goods. Firms are assumed to maximize profits by choosing corresponding prices and due to the assumed symmetry in the market, equilibrium prices of every component are the same, as well as composite goods outputs and firms' profits. The initial situation equilibrium (component prices, composite good outputs and firm's profits), denoted by superscript I, reads $p_i^I = q_j^I = q^I = p^I = \frac{\alpha(\beta-\gamma)+c(\beta+\gamma)}{(3\beta-\gamma)};\ \forall i, j,\ X_{ij}^I = X^I = \frac{(\alpha-2c)(\beta+\gamma)}{(3\beta-\gamma)(\beta+3\gamma)}; \forall ij;$. Quantities are nonnegative as it is assumed that $\alpha \geq 2c$ thus profits are also positive and read $\pi_{A_i}^I = \pi_{B_j}^I = \pi^I = \frac{2(\alpha-2c)^2(\beta-\gamma)(\beta+\gamma)}{(3\beta-\gamma)^2(\beta+3\gamma)};\ \forall i, j.$

The Horizontal Merger (H)

Consider a merger between the two producers of the same type of components, e.g. the A_1A_2 merger. The firms not participating in the merger are named as outsiders. The new firm partially internalizes competition among composite goods by monopolizing one type of component in the market. Equilibrium prices and outputs, denoted by superscript H, are the following:

	Prices	Outputs
Merged firm	$p_1^H = p_2^H = p^H = \frac{\alpha(\beta+\gamma)+c(\beta-\gamma)}{(3\beta+\gamma)}$	$X_{ij}^H = X^H = \frac{(\alpha-2c)(\beta+\gamma)}{(3\beta+\gamma)(\beta+3\gamma)}$; $\forall ij.$
Outsiders	$q_1^H = q_2^H = q^H = \frac{\alpha(\beta-\gamma)+c(\beta+3\gamma)}{(3\beta+\gamma)}$	

Components produced by the merged firm have a higher price as compared to the initial situation. The reason is that the marginal benefit is now larger at any price for the new entity, thus leading to a higher equilibrium price which results in a lower equilibrium price of the complementary components (by strategic substitutability among p's and q's). Therefore, as compared with the initial situation, $p^H > p^I = q^I > q^H$. Equilibrium outputs for all composite goods are set at the same level due to the symmetry, since the merged firm produces components for every composite good in the market. Finally, the increase in the $A-$ type component price is greater than the decrease in the $B-$ type one, therefore composite good prices rise (i.e. $s^H > s^I$) while outputs decrease after the merger. Thus consumers are worse off. Firms profits are $\pi_{A_1A_2}^H = \frac{4(\alpha-2c)^2(\beta+\gamma)^2}{(3\beta+\gamma)^2(\beta+3\gamma)}$ and $\pi_{B_1}^H = \pi_{B_2}^H = \frac{2(\alpha-2c)^2(\beta-\gamma)(\beta+\gamma)}{(3\beta+\gamma)^2(\beta+3\gamma)}$.

Several comments are in order. First, the merged firm is better off offering the full range of components rather than restricting them. The reason is that more composite goods in the market allow the merged entity to capture greater share of industry profits, at the expense of outsiders. Second, industry profits after the merger might decrease if composite goods are very differentiated (i.e. for $\frac{\gamma}{\beta} < 2\sqrt{3}-3$), the reason is that outsiders' profits after the merger fall to outweigh the increase in profits of the merged entity. As products become more homogeneous all profits decrease, but the merger entity is able to deal better with the increase in competition since it has more market power than firms only controlling one component.

The Complementary Merger (C)

Consider now a merger between two different type component producers: e.g. the

A_1B_1 merger. The merged firm is able to implement a mixed bundling pricing strategy, that is it selects three prices p_1, q_1 and the bundle price s_b, where at equilibrium, $s_b < p_1 + q_1 = s_{11}$. The demand system must then be reformulated substituting s_{11} for s_b, as now composite good A_1B_1 is only demanded as a bundle, since it offers a discount on price.[15] This implies that the merged firm now gets revenues from directly selling one composite good (i.e. the bundle X_{11}) and from the selling of two components which are combined by consumers to form two mix-and-match composite goods (i.e. X_{12} and X_{21}). The other composite good, X_{22}, is totally controlled by outsiders. However, it turns out that when composite goods are not very differentiated, mixed bundling can be improved upon by the merged entity only focusing on the selling of the bundle and stops selling the components A_1 and B_1 separately (i.e. pure bundling). This leads to the following result:

Result: *The merged entity is better off only selling the bundle when composite goods are not very differentiated (i.e. for* $\frac{\gamma}{\beta} > 0.665$), *otherwise mixed bundling arises at equilibrium.*

The reason is that close substitutability among composite goods imposes at equilibrium too high component prices in order to keep the bundle appealing, thus ending up in a situation where it is better not to serve the mix-and-match markets. Equilibrium prices and outputs, where superscript C denotes complementary merger are:

Prices

Merged firm	$s_b^C = \begin{cases} \frac{\alpha(\beta-\gamma)(3\beta+5\gamma)+2(\beta+\gamma)(3\beta+\gamma)c}{2(3\beta^2+3\beta\gamma-2\gamma^2)} & \text{if } \frac{\gamma}{\beta} < 0.665 \\ \frac{\alpha(\beta-\gamma)(3\beta+2\gamma)+2\beta(3\beta+\gamma)c}{2(3\beta^2-\gamma^2)} & \text{if } \frac{\gamma}{\beta} > 0.665 \end{cases}$ $p_1^C = q_1^C = \begin{cases} \frac{\alpha(\beta+2\gamma)(\beta-\gamma)+(\beta^2+\beta\gamma+2\gamma^2)c}{(3\beta^2+3\beta\gamma-2\gamma^2)} & \text{if } \frac{\gamma}{\beta} < 0.665 \\ \text{not defined} & \text{if } \frac{\gamma}{\beta} > 0.665 \end{cases}$
Outsiders	$p_2^C = q_2^C = \begin{cases} \frac{\alpha(\beta-\gamma)(\beta+\gamma)+\beta(\beta+3\gamma)c}{(3\beta^2+3\beta\gamma-2\gamma^2)} & \text{if } \frac{\gamma}{\beta} < 0.665 \\ \frac{\alpha(\beta-\gamma)(2\beta+\gamma)+2\beta(\beta+\gamma)c}{2(3\beta^2-\gamma^2)} & \text{if } \frac{\gamma}{\beta} > 0.665 \end{cases}$

[15] As noted by Tirole (2005): "buying the bundle is really the only feasible option if the prices of the individual products are high".

Outputs

Merged firm	$X_{11}^C = \begin{cases} \frac{(\alpha-2c)(3\beta+\gamma)(\beta+2\gamma)}{2(\beta+3\gamma)(3\beta^2+3\beta\gamma-2\gamma^2)} & \text{if } \frac{\gamma}{\beta} < 0.665 \\ \frac{(\alpha-2c)(3\beta+2\gamma)\beta}{2(\beta+\gamma)(3\beta^2-\gamma^2)} & \text{if } \frac{\gamma}{\beta} > 0.665 \end{cases}$
Outsiders	$X_{22}^C = \begin{cases} \frac{(\alpha-2c)(2\beta^2+5\beta\gamma+5\gamma^2)}{2(\beta+3\gamma)(3\beta^2+3\beta\gamma-2\gamma^2)} & \text{if } \frac{\gamma}{\beta} < 0.665 \\ \frac{(\alpha-2c)(2\beta+\gamma)\beta}{2(\beta+\gamma)(3\beta^2-\gamma^2)} & \text{if } \frac{\gamma}{\beta} > 0.665 \end{cases}$
Mix-and-match	$X_{12}^C = X_{21}^C = \begin{cases} \frac{(\alpha-2c)(2\beta^2+3\beta\gamma-\gamma^2)}{2(\beta+3\gamma)(3\beta^2+3\beta\gamma-2\gamma^2)} & \text{if } \frac{\gamma}{\beta} < 0.665 \\ \text{not defined} & \text{if } \frac{\gamma}{\beta} > 0.665 \end{cases}$

In the case of mixed bundling, outsider component prices decrease, while prices of the components produced by the new entity are higher as compared with the initial situation. Therefore, $p_1^C = q_1^C > p_2^C = q_2^C$. Both, the bundle price s_b^C and outsiders' composite good prices, are lower as compared with the initial situation. However, mix-and-match composite goods increase their price. Thus, the general presumption that mergers between complements lead to lower prices is not completely true. This happens because the merged firm increases its single components prices to benefit its bundle demand, $p_1^C + q_1^C > s_b^C$, in detriment to mix-and-match system's demands. If we compare prices of composite goods in the market after the merger, we find that the bundle price is always the lowest one: $s_{12}^C = s_{21}^C > s^I > s_{22}^C > s_b^C$. As a consequence the output's ranking is $X_{11}^C > X_{22}^C > X^I > X_{12}^C = X_{21}^C$. A result obtained by Choi (2008) which we qualify with the pure bundling analysis.

In fact when pure bundling is used, for $\frac{\gamma}{\beta} > 0.665$, the strategic effect is completely twisted since $s_b^C > s_{22}^C > s^I$. The unilateral effect of a complementary merger is to increase prices upon the initial situation, which is followed by another increase in outsider prices ending up in a situation that harms consumers. Regarding profits, the merged firm obtains higher profits than outsiders:

$\pi_{A_1B_1}^C = \begin{cases} \frac{(\alpha-2c)^2(\beta-\gamma)(\beta+2\gamma)(17\beta^2+30\beta\gamma+\gamma^2)}{4(\beta+3\gamma)(3\beta^2+3\beta\gamma-2\gamma^2)^2} & \text{if } \frac{\gamma}{\beta} < 0.665 \\ \frac{(\alpha-2c)^2\beta(\beta-\gamma)(3\beta^2+2\gamma^2)}{4(\beta+\gamma)(3\beta^2-\gamma^2)^2} & \text{if } \frac{\gamma}{\beta} > 0.665 \end{cases}$
$\pi_{A_2}^C = \pi_{B_2}^C = \begin{cases} \frac{2(\alpha-2c)^2(\beta-\gamma)(\beta+\gamma)^3}{(\beta+3\gamma)(3\beta^2+3\beta\gamma-2\gamma^2)^2} & \text{if } \frac{\gamma}{\beta} < 0.665 \\ \frac{(\alpha-2c)^2\beta(\beta-\gamma)(2\beta+\gamma)^3}{4(\beta+\gamma)(3\beta^2-\gamma^2)^2} & \text{if } \frac{\gamma}{\beta} > 0.665 \end{cases}$

Interestingly, industry profits *decrease after the merger* for $0.129 < \frac{\gamma}{\beta} < 0.750$. The reason is that the increase in profits realized by the new entity is more than compensated by the reduction of outsiders' profits when the merged firm undertakes mixed bundling. The new entity's strategic superiority (three strategic variables) is used to drain profits from the outsiders composite good and the mix-and-match ones to the bundle. In fact the new entity gets more profits with the selling of the bundle than the pre-merger profits corresponding to the same composite good, i.e. $(s_b^C - 2c)X_{11}^C > (p^I + q^I - 2c)X^I$. This profits increase suffices to cover the reduction in profits coming from the mix-and-match composite goods. At the same time, mixed bundling pricing imposes a negative externality on outsiders, as they are compelled to reduce margins without getting a higher market share. In the case the merged firm undertakes pure bundling, i.e. for $0.665 < \frac{\gamma}{\beta} < 0.750$, the same argument applies. But for $\frac{\gamma}{\beta} > 0.750$, the situation is reversed as either the increase in the merged firm more than compensates the outsiders' profits reduction when $\frac{\gamma}{\beta} < 0.908$, or all firms see their profits increase.

Equilibrium merger (private solution)

Which merger will endogenously arise is the content of the next proposition.[16]

Proposition 1. *The equilibrium merger that will arise in this market depends on how differentiated the composite goods are. The Complementary merger will be the equilibrium one if* $0 < \gamma < 0.0958$, *the Horizontal merger otherwise.*

In Choi (2008) only complementary mergers are considered, however, when firms also have the option to create a horizontal merger, the complementary one only arises for a small range for parameter γ; in the rest of the interval a merger between substitutes is privately preferred. If γ is close to zero composite goods are very differentiated and competition is not intense, thus the merged firm prefers to fully control one composite good through a C merger. In this way the new entity benefits from the so-called *Cournot effect*, the price reduction for two complements when they are sold by the same firm rather than by separate monopolists. The merger leads to a reduction in both complement prices, since the new firm captures the demand increase in the composite good when it lowers the

[16] The term $(\alpha - 2c)^2$ is the scale parameter that can be sorted out when profits comparisons are made. Also note that comparisons are driven by the ratio $\frac{\gamma}{\beta}$, thus setting $\beta = 1$, for the sake of simplicity, does not alter the conclusions.

other component's price. As γ increases, composite goods are less differentiated and competition is more intense. Prices are already rather low, so a merger between complements makes prices decrease even more, and this makes the C merger less profitable. Then it is preferable to internalize the effects of competition within substitutes by monopolizing one component type. Therefore, the merged firm controls one component in every composite good in the market, increasing its market power. The above argument works out even for the case where the complementary merger implies pure bundling. Then, *horizontal mergers are those to be expected when only strategic reasons are in place. Horizontal mergers are more suitable tools rather than Complementary ones to increase business profits.* The Cournot effect is dominated by the competition effect.

Socially optimal merger

Finally, to answer our initial research question, it is important to analyze whether the proposed mergers arising from the previous subsection would be cleared by antitrust authorities. Antitrust authorities make decisions based on how the proposed merger affects either Consumer Surplus (CS) or Social Welfare (SW) standards. To obtain the Social Welfare measure we take the utility function and subtract the costs paid by firms. Then, to obtain Consumer Surplus, we have to subtract the profits of all firms in the market to the Social Welfare. The precise expressions can be found in the Appendix. To compare SW and CS in both mergers, the same normalization as above is used. Which merger is socially preferred is in the next proposition.

Proposition 2. *The highest level of Social Welfare, which is a function of the degree differentiation, is attained as follows:*

i) through a Complementary merger if $0 < \gamma < 0.4090$,

ii) or not clearing any type of merger if $0.4090 < \gamma < 1$.

Similarly, the highest level of Consumer Surplus is attained as follows:

i) through a Complementary merger if $0 < \gamma < 0.6259$,

ii) or by not clearing any type of merger if $0.6259 < \gamma < 1$.

After an H merger the new firm is the only producer of A-type components. Consumers are worse off because they have to pay a higher price for this type of component.

This result generalizes to the case with more than two components of each type, where the merged firm would partially monopolize the A-type component, since the same-type outsiders will react by increasing prices. Although B-type producers react by decreasing prices, the total effect is that composite good prices are higher and outputs lower in comparison to the initial situation. Even industry profits might fall when products are sufficiently differentiated. Thus the conclusion is clear: *when only strategic effects considered, the H merger is never socially preferred.* On the contrary, with a C merger consumers can be better off depending on how similar composite goods are perceived. Only C mergers that undertake mixed bundling at equilibrium may attain the highest consumer and total surplus. The new firm sets a bundle price lower than the composite good price prior to the merger. In addition, the strategic reaction by outsiders leads to outsider composite good prices decrease with respect to the initial situation. Finally, mix-and-match composite goods have increased their price. Thus, it turns out that CS is higher after the C merger if products are differentiated enough, despite consumption is diverted from the mix-and-match to the bundle and outsider composite goods. Additionally, industry profits might decrease which explains why the clearing threshold is more restrictive under the SW standard. The results about the C merger are partially in line with those in Choi (2008), since at some threshold in the differentiation parameter, it is socially better not to engage in any merger. However, we have proven that C mergers will not be typically proposed when firms have the option to engage in H mergers.

Policy Implications

In view of Propositions 1 and 2, there is a clear-cut policy implication regardless of the standard considered: *when only strategic effects are reckoned, proposed C mergers have to be always cleared while proposed H mergers must be always forbidden by antitrust authorities.*

Therefore, a market failure arises for $0.0958 < \gamma < 1$ since the proposed merger (a H merger) would never be approved. In fact, two types of market failure can be considered, one that implies a proposed merger type different to the socially optimal one (i.e. for $0.0958 < \gamma < 0.4090$ under the SW standard), and a second one that implies that no merger is the social maximizing outcome. Finally, for $\gamma < 0.0958$, when composite goods are very differentiated, no market failure arises as any proposed C merger will be cleared.[17]

To complete the analysis let us think of a situation, which is usually the case, where antitrust authorities have less information than firms involved in a merger. Then, if firms submit a C merger proposal that is not expected at equilibrium, that is for $\gamma > 0.0958$, antitrust authorities should infer that this C merger will come out in cost efficiencies and, therefore, should be approved. This is a sign that the strategic incentives to merge have being countervailed by efficiency gains (such as production cost savings through economies of scale and scope, improvements in quality or service, reductions in transactional costs or increased incentives for R&D processes, and so on) anticipated by the firms which are making the C merger more profitable than a H one in that case. Since efficiency gains are good for consumers, antitrust authorities will be more willing to accept the proposed merger. In other words, *when firms propose a type of merger different from the equilibrium one, authorities face cases where the efficiency effects obtained are substantial to make that merger type preferable.*

In the next Section, we analyze situations where firms involved in H mergers are able to realize some sort of cost savings and we check the conditions for proposed H mergers to be cleared.

3 Horizontal mergers with efficiencies

Now the model is extended to include efficiency effects in case a merger between substitute components occurs. Because the merging companies' business operations may be very similar, there may be opportunities to join certain operations, such as manufacturing or advertising, and reduce costs. Obviously, cost savings could also be obtained in C mergers, but we focus on the more interesting case since otherwise the conclusion would

[17] In this section we are considering myopic antitrust authorities. If forward looking antitrust authorities were considered instead, they will not challenge mergers that are initially welfare reducing but that induce a reaction of the outsiders ending up in a welfare increasing market structure. In Pardo-García (2012), such kind of antitrust authorities is considered and the following conclusions are worth to mention. First, the firms reaction after any merger, either horizontal or complementary, is that one of the outsiders joins the initial merger instead of forming a counter-merger (the two outsiders merging too). Second, welfare increases in any case. Therefore myopic authorities will challenge mergers that forward looking authorities would not.

be that C merger would be more frequently proposed and therefore cleared by antitrust authorities.

Recent developments in merger enforcement place an important role, when considering the unilateral effects of a merger, to the UPPI as an alternative way to assess merger effects on prices. The upward pricing pressure approach is easy to implement, it does not rely on explicit market definition but instead relies on measures of product substitution and can be especially relevant in a differentiated products context. The price incentives a merged firm faces after a horizontal merger of differentiated products are of two kinds. The first one is driven by the internalization of competition between the two products sold by the new entity and the second accounts for the potential cost efficiencies derived from the merger. The first effect is positive in the sense that it implies post-merger price increases, while the second is negative since it works in the opposite direction. A post-merger increase in prices would be expected only if the former effect dominates the second. In this section we will provide the UPPI that corresponds to the Horizontal merger in a composite good industry and compare it with the one that would arise if the industry would not be a composite good one.

The UPPI for a composite good market

To obtain the UPPI that corresponds to the composite good market analyzed above, take the post-merger profit function and allow for efficiencies in the form of synergies affecting marginal costs as follows: $\pi_{A_1A_2} = (p_1 - c)(X_{11} + X_{12}) + (p_2 - c)(X_{21} + X_{22}) + Ec(X_{11}+X_{12}+X_{21}+X_{22})$, where E stands for the merger induced marginal costs savings, where $E < 1$. Then, we can easily compute the post-merger equilibrium profits arising from profit maximization accounting for the effect of synergies and denote them by p^{Hs} and q^{Hs}, thus the price of composite goods is $s^{Hs} = p^{Hs} + q^{Hs}$. Following Shapiro (2010b) the UPPI is defined as the post-merger percentage increase for the composite good price,[18] that is $\frac{s^{Hs}-s^I}{s^I}$. As indicated above, the UPPI is the sum of two terms, the first is a function of the diversion ratio[19] from components A_1 and A_2, denoted by D_{12}, and the pre-merger

[18] Despite firms select component prices the relevant price is the composite price and not the component price since consumers do not derive any utility from consumption of single components. We will establish their relationship below.

[19] The diversion ratio is not such a new concept. Shapiro (2010a) defends that economists have measured diversion from one product to another using cross-elasticity of demand between two products, and agencies

margin of a single component, denoted by M; while the second term is the pass-through rate which is a function of the marginal cost saving measured as a fraction of its price.

The diversion ratio D_{12} is defined as the share of sales lost by one merging component, say component A_1, that is recaptured by the other, component A_2, when the price of the former increases, that is $D_{12} = \frac{\frac{\partial(X_{21}+X_{22})}{\partial p_1}}{\frac{\partial(X_{11}+X_{12})}{\partial p_1}} = -\frac{2\gamma}{\beta+\gamma}$, where the demand of component A_2 is precisely $X_{21} + X_{22}$ and that of component A_1 is $X_{11} + X_{12}$.[20] Regarding the pre-merger margin of a single component, M is defined as $\frac{p^I-c}{p^I}$ which is the same as the one resulting for the composite good, $\frac{s^I-2c}{s^I}$, just noting that $s^I = 2p^I$ by the symmetry considered. We can express it as a function of the diversion ratio and other parameters as follows: $M = \frac{s^I-2c}{s^I} = \frac{p^I-c}{p^I} = \frac{(1+D_{12})(\alpha-2c)}{(1+D_{12})\alpha+c}$. Finally the UPPI that arises is given by

$$\frac{s^{Hs}-s^I}{s^I} = \frac{1}{2}(\frac{p^{Hs}-p^I}{p^I} + \frac{q^{Hs}-q^I}{q^I}) = -M\frac{D_{12}}{2(3+D_{12})(1+D_{12})} - \frac{(1-M)E}{2(3+D_{12})}. \tag{2}$$

Which equals the average UPPI of the corresponding components. As expected there are two opposing terms which allows us to find the minimum reduction in the marginal costs as a fraction of the price that ensures a nonincrease of post-merger prices, that is $\varepsilon^0 = (1-M)E^0 = \frac{-MD_{12}}{1+D_{12}} > 0$. This threshold is increasing in the pre-merger margin and in the diversion ratio. Then and since the diversion ratio is decreasing in the degree of differentiation, a lower synergy would be required to clear a horizontal merger when composite goods are very differentiated.

Focusing on each component price effects, we have that

$$\begin{array}{l} \frac{p^{Hs}-p^I}{p^I} = (2+D_{12})[-M\frac{D_{12}}{(3+D_{12})(1+D_{12})} - \frac{(1-M)E}{(3+D_{12})}] \\ \frac{q^{Hs}-q^I}{q^I} = (1+D_{12})[M\frac{D_{12}}{(3+D_{12})(1+D_{12})} + \frac{(1-M)E}{(3+D_{12})}] \end{array}. \tag{3}$$

It is interesting to see that the UPPI for the composite good price is explained by opposing effects on the different component prices. The horizontal merger has an upward effect on p's while there is a downward effect on q's absent synergies. Also regarding the pass-through rates the horizontal merger has a negative effect on p's while the effect is positive on q's. Since the effect derived from p's is a direct effect it dominates the induced

have used elasticities to measure "reasonable interchangeability". In fact, it is stated that by 1995, the DOJ was using the term "diversion ratio" to capture this same concept in a more intuitive way.

[20] It can be easily shown that in a composite good industry the diversion ratio for the general case with n components of the same type is $-\frac{n\gamma}{\beta+\gamma(n^2-n-1)}$.

effect on q's so the final UPPI follows the same pattern than the effect on p's.

The UPPI for a regular good industry

Now we are interested in finding whether the upward pricing pressure of a horizontal merger is higher when the market is characterized by composite goods or by regular goods. In order to make the comparison properly we have to consider the same utility function as before and also to eliminate the possibility that consumers choose about components. Thus the representative consumer maximizes utility noting that only products X_{11} and X_{22} will be available. The simplest way to do it is to assume away compatibility between components of the same type and also consider that there are only two firms, each producing one component of each type. That is, firm 1 produces components A_1 and B_1 while firm 2 produces components A_2 and B_2, therefore only two products are sold provided incompatibility, that is X_{11} and X_{22}, as required. We solve the model for the pre-merger situation and when both firms 1 and 2 merge, where of course only *horizontal* mergers make sense. Denote by $\bar{s}^I$ and by $\bar{s}^{Hs}$ the equilibrium prices pre-merger and post-merger when efficiencies are resulting after the merger. Also denote by $\bar{D}_{12}$ and $\bar{M}$ the corresponding diversion ratios and initial price margins, where it turns out that $\bar{D}_{12} = \frac{-\gamma}{\beta}$ and $\bar{M} = \frac{\bar{s}^I - 2c}{\bar{s}^I} = \frac{(1+\bar{D}_{12})(\alpha-2c)}{(1+\bar{D}_{12})\alpha+2c}$. Therefore the UPPI corresponding to the regular good industry is [21]

$$\frac{\bar{s}^{Hs} - \bar{s}^I}{\bar{s}^I} = -\bar{M}\frac{\bar{D}_{12}}{2(1+\bar{D}_{12})} - \frac{(1-\bar{M})E}{2}. \tag{4}$$

Where the minimum reduction in the marginal costs as a fraction of the price that ensures a non-increase of post-merger prices, that is $\bar{\varepsilon}^0 = (\frac{2c\bar{E}^0}{\bar{s}^I}) = (1-\bar{M})\bar{E}^0 = \frac{-\bar{M}\bar{D}_{12}}{1+\bar{D}_{12}} > 0$.

Comparison between UPPI's

First of all it is important to comment that the diversion ratio for composite goods is greater (in absolute terms) than that of the regular good industry, $D_{12} > \bar{D}_{12}$. The reason is that an increase in one component price affects two composite goods. Thus the opportunity cost of that price increase in terms of sales in favor of the other component of

[21] We define the diversion ratio with its sign and not in absolute value as in Farrell and Shapiro (2010). From their equation number 7, using symmetry and the definition of M, the expression in the text is obtained.

the same type is higher as compared with the regular product market. Secondly, the price margin ratio for the composite good market is greater than that of the regular market, $M > \bar{M}$. Therefore, four independent firms in a composite good market have more market power than a duopoly in a regular market. Note that higher diversion ratios and higher price margin ratios are conditions that tend to increase the upward pricing pressure after the merger. Thus as products become more substitutes the pressure on prices increases and this is true for both type of goods.

Thirdly, the following proposition is reached:

Proposition 3: *A greater marginal cost saving is required for a horizontal merger in a composite good industry not to increase prices as compared with a horizontal merger in a regular good industry. In other words,* $E^0 > \bar{E}^0$.

The above result is useful for antitrust authorities since it advises them to be more demanding when dealing with horizontal mergers in composite goods industries. Note that this difference is rooted to the higher diversion ratio and margin that arises in composite good industries.

Finally, to compare the two UPPIs just note that horizontal mergers in composite good industries are less effective in passing efficiencies derived from the merger to consumers, since pass-through rates are larger for regular good industries, that is $\frac{(1-M)E}{2(3+D_{12})} < \frac{(1-\bar{M})E}{2}$. Also and in case of no realized efficiencies after the merger, that is for $E = 0$, an interesting result is that the comparison among UPPIs is not univocal and depends on the degree of product differentiation and on the size of the $\frac{\alpha}{c}$ ratio. In particular, the UPPI in composite-good industries is greater if and only if $\frac{\alpha}{c} > \frac{\beta+\gamma}{\beta-\gamma}$. A sufficient condition is that the UPPI in composite-good industries is greater for all $\frac{\alpha}{c}$ if $\frac{\gamma}{\beta} < \frac{1}{3}$.

4 Conclusions

This paper studies merging behavior in a composite good industry allowing firms to choose the type of partner, either a complementary or a substitute component producer. Previous analysis has focused on just one type of merger and papers on composite goods have considered only the possibility of complementary mergers. We find that complementary mergers arise at equilibrium only when composite goods are very differentiated, while horizontal mergers are preferred otherwise. A simple policy implication is derived: a complementary merger will be always allowed by antitrust authorities under any standard, either the consumer surplus or the social welfare one, while a horizontal merger will never be when only strategic effects are taken into account. Therefore, we identify a market failure since horizontal mergers when proposed are never allowed. This never happens in case a complementary merger is proposed. Another interesting advise for antitrust authorities is that if they receive notifications of complementary mergers when products are close substitutes, they should conclude that some efficiencies are associated to complementary mergers since they would not otherwise be proposed.

Notice that horizontal mergers are commonly proposed and usually accepted in case there is no substantial lessening of competition or the merger is a necessary condition to achieve efficiency gains. Since the particular model presented focuses on a highly concentrated industry, we resort to considering efficiency effects linked to horizontal mergers to check the conditions antitrust authorities should impose to clear them. To tackle this issue we consider the new approach to assess horizontal mergers incorporated in the *Horizontal Merger Guidelines* issued in 2010. This new approach based on the upward price pressure index to evaluate unilateral effects of a merger takes into account, on the one hand, the diversion ratio and the pre-merger margin and, on the other, the pass-through rate. We find that both the diversion ratio and the pre-merger margin are greater in a composite good industry, compared to a regular good industry. Thus, despite being counter intuitive, firms' market power is greater in a four-firm composite good industry than in a standard duopoly of a regular good. The pass-through rate, however, is lower in a composite good industry. An important result is that the marginal cost saving required for a horizontal merger in order not to increase prices is greater in a composite good industry than in a regular good one. Antitrust authorities should request, therefore, higher savings levels in the case of horizontal mergers in composite good markets.

It will be interesting to study in future research efficiency effects when components can give some utility to consumers by themselves, not only if they are combined and used inside a composite good. Moreover, a policy maker can be incorporated to the model, to study the implications of a policy aimed to make firms reduce post-merger prices or to subsidize firms involved in desirable mergers for the society.

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A Proofs

Consider throughout $\beta > \gamma$ and $\frac{\alpha}{c} > 2$.

a) **Regarding the Horizontal merger** (H)

- *The merger is profitable if* $\pi^H_{A_1A_2} > 2\pi^I = \pi^I_{A_1} + \pi^I_{A_2}$. This is true if $\frac{8(\alpha-2c)^2\gamma(\beta+\gamma)(3\beta^2+\gamma^2)}{(\beta+3\gamma)(9\beta^2-\gamma^2)^2} > 0$, that always holds.
- *Outsiders are worse off after the merger,* $\pi^I > \pi^H_{B_1} = \pi^H_{B_2}$. This is true if $\frac{24(\alpha-2c)^2\beta(\beta-\gamma)\gamma(\beta+\gamma)}{(\beta+3\gamma)(9\beta^2-\gamma^2)^2} > 0$ which always holds.
- *Industry profits are smaller after the merger if* $\frac{\gamma}{\beta} < 2\sqrt{3} - 3$.

Just note that $\frac{8(\alpha-2c)^2\gamma(\beta+\gamma)(3\beta^2+\gamma^2)}{(\beta+3\gamma)(9\beta^2-\gamma^2)^2} < \frac{48(\alpha-2c)^2\beta(\beta-\gamma)\gamma(\beta+\gamma)}{(\beta+3\gamma)(9\beta^2-\gamma^2)^2}$, if $\frac{\gamma}{\beta} < 2\sqrt{3} - 3$.

- *The merged firm prefers selling both components instead of eliminating one of them.*

In case the merged firm decides not to produce A_2, the demands for the two possible composite goods X_{11} and X_{12} have to be reformulated leading to expressions: $X_{11} = \frac{\alpha(\beta-\gamma)-\beta s_{11}+\gamma s_{12}}{\beta^2-\gamma^2}$ and $X_{12} = \frac{\alpha(\beta-\gamma)-\beta s_{12}+\gamma s_{11}}{\beta^2-\gamma^2}$. Finding the new equilibrium at $p_1^{He} = c + \frac{\beta(\alpha-2c)}{3\beta-\gamma} < p_1^H$, $q_1^{He} = q_2^{He} = \frac{\alpha(\beta-\gamma)+c(\beta+\gamma)}{3\beta-\gamma} > q_1^H$ and the following profits: $\pi^{He}_{A_1A_2} = \frac{2\beta^2(\alpha-2c)^2}{(\beta+\gamma)(3\beta-\gamma)^2}$. Remind that $\pi^H_{A_1A_2} = \frac{4(\alpha-2c)^2(\beta+\gamma)^2}{(3\beta+\gamma)^2(\beta+3\gamma)}$. Finding that $\pi^H_{A_1A_2} > \pi^{He}_{A_1A_2}$ always.

b) **Regarding the** C **merger**

- *The new firm will only sell the bundle when composite goods are not very differentiated (i.e. for* $\frac{\gamma}{\beta} > 0.6653$), *otherwise mixed bundling arises at equilibrium.*

a) First solve for the case of mixed bundling.

Under mixed bundling, the new firm selects three prices p_1, q_1 and the bundle price s_b, where at equilibrium, $s_b < p_1 + q_1 = s_{11}$. The demand system must be reformulated substituting s_{11} for s_b, as now composite good A_1B_1 is only demanded as a bundle. Equilibrium prices and outputs, where superscript C^* denotes complementary merger under mixed bundling, are:

	Prices	Outputs
Merged firm	$s_b^{C^*} = \frac{\alpha(\beta-\gamma)(3\beta+5\gamma)+2c(\beta+\gamma)(3\beta+\gamma)}{2(3\beta^2+3\beta\gamma-2\gamma^2)}$ $p_1^{C^*} = q_1^{C^*} = \frac{(\alpha+c)\beta(\beta+\gamma)-2(\alpha-c)\gamma^2}{(3\beta^2+3\beta\gamma-2\gamma^2)}$	$X_{11}^{C^*} = \frac{(\alpha-2c)(3\beta+\gamma)(\beta+2\gamma)}{2(\beta+3\gamma)(3\beta^2+3\beta\gamma-2\gamma^2)}$
Outsiders	$p_2^{C^*} = q_2^{C^*} = \frac{\alpha(\beta-\gamma)(\beta+\gamma)+c\beta(\beta+3\gamma)}{(3\beta^2+3\beta\gamma-2\gamma^2)}$	$X_{22}^{C^*} = \frac{(\alpha-2c)(2\beta^2+5\beta\gamma+5\gamma^2)}{2(\beta+3\gamma)(3\beta^2+3\beta\gamma-2\gamma^2)}$
Mix-and-match		$X_{12}^{C^*} = X_{21}^{C^*} = \frac{(\alpha-2c)(2\beta^2+3\beta\gamma-\gamma^2)}{2(\beta+3\gamma)(3\beta^2+3\beta\gamma-2\gamma^2)}$

Profits read $\pi^{C^*}_{A_1B_1} = \frac{(\alpha-2c)^2(\beta-\gamma)(\beta+2\gamma)(17\beta^2+30\beta\gamma+\gamma^2)}{4(\beta+3\gamma)(3\beta^2+3\beta\gamma-2\gamma^2)^2}$ and $\pi^{C^*}_{A_2} = \pi^{C^*}_{B_2} = \frac{2(\alpha-2c)^2(\beta-\gamma)(\beta+\gamma)^3}{(\beta+3\gamma)(3\beta^2+3\beta\gamma-2\gamma^2)^2}$.

b) Consider now the case where the new firm will only sell the bundle.

Only two composite goods can be purchased by consumers, the bundle sold by the merged firm and X_{22}. The merged entity selects s_b and each of the component producers select component prices p_2 and q_2, respectively. Solving for the equilibrium prices we obtain for the merged firm the following equilibrium variables: $s_b^{C+} = \frac{\alpha(\beta-\gamma)(3\beta+2\gamma)+2\beta(3\beta+\gamma)c}{2(3\beta^2-\gamma^2)}$, $X_{11}^{C+} = \frac{(\alpha-2c)(3\beta+2\gamma)\beta}{2(\beta+\gamma)(3\beta^2-\gamma^2)}$ and $\pi_{A_1B_1}^{C+} = \frac{(\alpha-2c)^2\beta(\beta-\gamma)(3\beta^2+2\gamma^2)}{4(\beta+\gamma)(3\beta^2-\gamma^2)^2}$

Similarly for outsiders, $p_2^{C+} = q_2^{C+} = \frac{\alpha(\beta-\gamma)(2\beta+\gamma)+2\beta(\beta+\gamma)c}{2(3\beta^2-\gamma^2)}$, $X_{22}^{C+} = \frac{(\alpha-2c)(2\beta+\gamma)\beta}{2(\beta+\gamma)(3\beta^2-\gamma^2)}$ and $\pi_{A_2}^{C+} = \pi_{B_2}^{C+} = \frac{(\alpha-2c)^2(\beta-\gamma)(\beta+\gamma)^3}{4(\beta+\gamma)(3\beta^2-\gamma^2)^2}$.

By comparing $\pi_{A_1B_1}^{C+}$ and $\pi_{A_1B_1}^{C*}$ we find that $\pi_{A_1B_1}^{C*} > \pi_{A_1B_1}^{C+}$ iff $\frac{\gamma}{\beta} < 0.665$.

- *Industry profits decrease after the merger iff* $0.129 < \gamma < 0.750$.

+*First* note that *the merger is profitable:*

-for $\frac{\gamma}{\beta} < 0.665$, we check $\pi_{A_1B_1}^{C*} > \pi_{A_1}^{I} + \pi_{B_1}^{I}$, that is equivalent to $\frac{(\alpha-2c)^2(\beta-\gamma)(9\beta^5+42\beta^4\gamma-58\beta^3\gamma^2-44\beta^2\gamma^3+177\beta\gamma^4-62\gamma^5)}{4(\beta+3\gamma)(9\beta^3+6\beta^2\gamma-9\beta\gamma^2+2\gamma^3)^2} > 0$ and always holds.

-for $\frac{\gamma}{\beta} > 0.665$, we check $\pi_{A_1B_1}^{C+} > \pi_{A_1}^{I} + \pi_{B_1}^{I}$ iff $\frac{\gamma}{\beta} > 0.604$.

Therefore the merger is always profitable.

+*Second*, *outsiders are worse off after the merger iff* $\frac{\gamma}{\beta} < 0.908$,

-we check $\pi_{A_2}^{I} = \pi_{B_2}^{I} > \pi_{A_2}^{C*} = \pi_{B_2}^{C*}$ for $\frac{\gamma}{\beta} < 0.665$, this is equivalent to $\frac{2(\alpha-2c)^2(\beta-\gamma)^2\gamma(\beta+\gamma)(6\beta^2+5\beta\gamma-3\gamma^2)}{(\beta+3\gamma)(9\beta^3+6\beta^2\gamma-9\beta\gamma^2+2\gamma^3)^2} > 0$, and it always holds.

- we check $\pi_{A_2}^{I} = \pi_{B_2}^{I} > \pi_{A_2}^{C+} = \pi_{B_2}^{C+}$ for $\frac{\gamma}{\beta} > 0.665$, which holds iff $\frac{\gamma}{\beta} < 0.908$

+Finally

- we check $\pi_{A_1B_1}^{C*} + 2\pi_{A_2}^{C*} < 4\pi^I$for $\frac{\gamma}{\beta} < 0.665$. The inequality holds iff $\frac{\gamma}{\beta} \in [0.129, 0.809]$
- we check $\pi_{A_1B_1}^{C+} + 2\pi_{A_2}^{C+} < 4\pi^Ifor\frac{\gamma}{\beta} > 0.665$, the inequality holds iff $\frac{\gamma}{\beta} < 0.750$.

Which proves the above claim.

c) **Proof of Proposition 1.**

We compare $\pi_{A_1A_2}^{H} > \pi_{A_1B_1}^{C*}$. Note that $(\alpha - 2c)^2$ does not affect the sign of the inequality and normalize $\beta = 1$, therefore $\gamma \in (0, 1)$. Thus from $\pi_{A_1A_2}^{H} - \pi_{A_1B_1}^{C} > 0$, the next expression $\frac{-9+78\gamma+166\gamma^2+4\gamma^3-5\gamma^4+22\gamma^5}{4(3+\gamma)^2(-3-3\gamma+2\gamma^2)^2}$, is reached which is negative for $0 < \gamma < 0.0958$ and positive otherwise.

Similarly, we find that $\pi_{A_1A_2}^{H} - \pi_{A_1B_1}^{C+} > 0$ for all $\gamma \in (0, 1)$. Thus Proposition1 holds.

d) **Proof of Proposition 2.**

First, we provide the CS and SW corresponding to each possible merger and the initial situation:

$CS^I = \frac{2(\alpha-2c)^2(\beta+\gamma)^2}{(3\beta-\gamma)^2(\beta+3\gamma)}$, $CS^H = \frac{2(\alpha-2c)^2(\beta+\gamma)^2}{(3\beta+\gamma)^2(\beta+3\gamma)}$,
$CS^{C^*} = \frac{(\alpha-2c)^2(21\beta^4+83\beta^3\gamma+105\beta^2\gamma^2+49\beta\gamma^3-2\gamma^4)}{8(\beta+3\gamma)(3\beta^2+3\beta\gamma-2\gamma^2)^2}$ when $\frac{\gamma}{\beta} < 0.665$,

and $CS^{C^+} = \frac{(\alpha-2c)^2\beta^2(13\beta^2+15\beta\gamma+4\gamma^2)}{8(\beta+\gamma)(3\beta^2-\gamma^2)^2}$ for $\frac{\gamma}{\beta} > 0.665$.

$SW^I = \frac{2(\alpha-2c)^2(5\beta-3\gamma)(\beta+\gamma)}{(3\beta-\gamma)^2(\beta+3\gamma)}$, $SW^H = \frac{2(\alpha-2c)^2(5\beta+\gamma)(\beta+\gamma)}{(3\beta+\gamma)^2(\beta+3\gamma)}$,
$SW^{C^*} = \frac{(\alpha-2c)^2(87\beta^4+241\beta^3\gamma+99\beta^2\gamma^2-133\beta\gamma^3-38\gamma^4)}{8(\beta+3\gamma)(3\beta^2+3\beta\gamma-2\gamma^2)^2}$ when $\frac{\gamma}{\beta} < 0.665$,
and $SW^{C^+} = \frac{(\alpha-2c)^2\beta(47\beta^3+21\beta^2\gamma-24\beta\gamma^2-12\gamma^3)}{8(\beta+\gamma)(3\beta^2-\gamma^2)^2}$ for $\frac{\gamma}{\beta} > 0.665$.

Social Welfare.

To prove that $SW^{C^*} > SW^H$ is equivalent to check whether the sign of the expression, $\frac{(63\beta^5+198\beta^4\gamma+198\beta^3\gamma^2+4\beta^2\gamma^3-173\beta\gamma^4-34\gamma^5)}{8(3\beta+\gamma)^2(3\beta^2+3\beta\gamma-2\gamma^2)^2}$, is positive and this is always true. Next $SW^{C^*} > SW^I$ if $\frac{(\gamma-1)(-63+18\gamma+390\gamma^2+20\gamma^3-455\gamma^4+154\gamma^5)}{8(3-\gamma)^2(1+3\gamma)(-3-3\gamma+2\gamma^2)^2} > 0$, which is positive for $0 < \gamma < 0.4090$ and negative otherwise. Next, $SW^I > SW^H$ if $\frac{8(\alpha-2c)^2\gamma(\beta+\gamma)(6\beta^2-3\beta\gamma-\gamma^2)}{(\beta+3\gamma)(9\beta^2-\gamma^2)^2} > 0$ and this is always true. Finally, $SW^{C^*} > SW^{C^+}$ iff

$$360\beta^8 + 1008\beta^7\gamma + 420\beta^6\gamma^2 - 750\beta^5\gamma^3 - 533\beta^4\gamma^4 - 127\beta^3\gamma^5 - 33\beta^2\gamma^6 + 65\beta\gamma^7 + 38\gamma^8 > 0$$

which is the case for all $\gamma \in (0, 1)$.

Therefore, the highest SW is:

$$\begin{aligned} SW^{C^*} > SW^I \quad & if \quad 0 < \gamma < 0.4090 \\ SW^I > SW^{C^*} \quad & if \quad 0.4090 < \gamma < 1 \end{aligned}$$

Consumer Surplus.

First to prove $CS^{C^*} > CS^H$ is equivalent to $\frac{(45\beta^5+162\beta^4\gamma+306\beta^3\gamma^2+236\beta^2\gamma^3+41\beta\gamma^4-22\gamma^5)}{8(3\beta+\gamma)^2(3\beta^2+3\beta\gamma-2\gamma^2)^2} > 0$ which is always true. Next, $CS^{C^*} > CS^I$ if $\frac{(\gamma-1)(-45-90\gamma+114\gamma^2+220\gamma^3+59\gamma^4-66\gamma^5)}{8(3-\gamma)^2(1+3\gamma)(-3-3\gamma+2\gamma^2)^2} > 0$, which holds for $0 < \gamma < 0.6259$. Next, $CS^I > CS^H$ if $\frac{24(\alpha-2c)^2\beta\gamma(\beta+\gamma)^2}{(\beta+3\gamma)(9\beta^2-\gamma^2)^2} > 0$ and this is always true. Finally, $CS^{C^*} > CS^{C^+}$ iff

$$72\beta^8 + 288\beta^7\gamma + 480\beta^6\gamma^2 + 570\beta^5\gamma^3 + 413\beta^4\gamma^4 - 17\beta^3\gamma^5 - 163\beta^2\gamma^6 - 45\beta\gamma^7 + 2\gamma^8 > 0$$

which is the case for all $\gamma \in (0, 1)$.

Therefore, the highest CS is

$$\begin{aligned} CS^{C^*} > CS^I \quad & if \quad 0 < \gamma < 0.6259 \\ CS^I > CS^{C^*} \quad & if \quad 0.6259 < \gamma < 1 \end{aligned}$$

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