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Digital Convergence and Conglomerate Mergers*

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Abstract We develop a formal model to deal with bundling in complementary markets. We develop the antitrust analysis of a merger between potentially complementary product producing firms when the merged firm might engage in bundling such as the proposed GE/Honeywell merger. Our model can be applied to the analysis of economic consequences of digital convergence. We show that the new multi-functional product as an outcome of digital convergence of two different products does not necessarily enhance competition in markets.

Keywords Bundling, Technical Integration, Digital convergence, Complementary products

JEL Classification D4, L4, Q3

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1. Introduction

Tying or bundling arrangements play very important role in many high profile antitrust cases. Among those, the Microsoft case and the proposed GE/Honeywell merger are two most prominent cases. The Microsoft case was concerned with bundling of the OS system and other applications.[1] One of the issues in the Microsoft case was whether the so-called "leverage theory" was applicable and valid. There are many sophisticated models to choose from to analyze such cases.

On the other hand, the proposed GE/Honeywell merger case was unorthodox and very controversial. On July 3, 2001, the European Commission blocked the $42 billion merger between GE and Honeywell. GE had a dominant position in aircraft engines and Honeywell had a leading position in avionics. One of the main issues was concerned with the possibility of bundling of engines and avionics necessary to build an aircraft and the merged firm's potential for future anti-competitive behavior in engines and avionics markets. And the issue was quite novel in the sense that the possibility of bundling played the key role. The Commission's decision was much controversial. On May 2, 2001, the Antitrust Division of the United States Department of Justice decided not to challenge the proposed merger and two weeks later the Canadian Competition Bureau came to the same conclusion.

The Commission as described in the final Decision of 3 claimed that "the merged entity will be able to offer a package of products that has never been put together on the market prior to the merger and that cannot be challenged by any other competitor on its own. Thus the Commission's main concern was the market foreclosure implemented by the merged firm. Choi (2003, 2004) developed a formal model to analyze the proposed GE/Honeywell case and showed that the merger with bundling in complementary products has potential anticompetitive effects that would take the form of market foreclosure. Thus Choi gives an economic rationale for the Commission's concern.

But many economists believe that the Commission's reasoning is unsound and deeply flawed as a matter of economics. According to Patterson and Shapiro (2001), the aforementioned exit of rival is not a result of market foreclosure but a result of enhanced market competition that should be fostered by any antitrust regulation. Nalebuff (2002) even claims that "One

[1]In the U.S., the application was Internet Explorer and in the European case and Korean case, it was Media Player.

of the ironies of this case is that if one took the view that GE/Honeywell each had a monopoly position then bundling would unambiguously improve welfare. The only possible source of harm would be equilibrium impact on competitors. But to the extent that the firm does not face competitors, there is no harm done." So no foreclosure, no harm.

We provide a model in which there are two independent markets. Each market is monopolized by two different firms. We, then, introduce technological integration of two products and analyze the implication of possibility of bundling of two potential complementary products by the merged firm. We analyze three different scenarios. In first two scenarios, we investigate the economic implication when one of the firms succeed in innovation and enter the another market by the technically integrated product. In the third scenario, two firms merge and market technically bundled products.

We show that economic implications compared with those of technical bundling are similar in the sense that the low quality product disappears and the price of high quality product increases. But a very important distinctive feature of merger between two firms producing independent products is that the price of the bundle is a lot higher than that of both of two earlier scenarios. The conglomerate merger between two firms producing independent but possibly complementary products by technical improvement might be harming. More specifically speaking, the conglomerate merger between firms producing independent but potentially complementary products may harm what is known as actual potential competition by eliminating the possibility of the acquiring firm entering the market in a more procompetitive manner, that is, via an independent technological innovation. So we provides an economic rationale which can be used to prohibit a conglomerate merger that looks sound in a static point of view, but harmful in a dynamic point of view.

This paper also sheds light on the antitrust issue regarding digital convergence. It is quite often to see that new products with multi-function combining several digital products into one. The camera phone is one of the most distinguished examples. Before the technological innovations, cameras and mobile phones are two independent products. But now it is difficult to find a mobile phone without a built-in camera. Does this camera phone enhance competition in either of phone and camera markets? We will show that such an innovation does not necessarily enhance either competition or welfare.

2. Model

We consider two products, product A and product B, which can be consumed independent of each other, e.g., mobile phone and digital camera. Each product is produced by a different monopolist; firm A is the monopoly producer of product A and firm B is the monopoly producer of product B. The quality of product A is unique, denoted by q_A, while the quality of product B can be high, denoted by q_H and low, denoted by q_L $(q_H > q_L)$. Hence firm A produces products A of quality q_A but firm B can choose to produce product B of either high quality or low quality or both qualities. The cost of producing product A of quality q_A is c_A and the cost of producing product B ofq_H (q_L) quality is c_H (c_L) which satisfy $c_H > c_L$.

There is a continuum of consumers of total mass 1 who are characterized by their preferences for the two products. Let η represent the preference parameter for product A and θ represent the preference parameter for product B respectively. Thus, each consumer is characterized by a pair of parameters (η, θ) called *the consumer type*. We assume that there are two values of η, η_H and, η_L, while there are three values of θ, θ_H, θ_M, and θ_L. We assume that $\eta_H > \eta_L > 0$ and $\theta_H > \theta_M > \theta_L > 0$. The size of each consumer type is characterized by the distribution, μ_{ij}, where $i = H, L$ and $j = H, M, L$. For instance μ_{HL} is the mass of consumer of type (η_H, θ_L) so that $\sum_i \sum_i \mu_{ij} = 1$. The type of consumer is private information while the distribution of types is common knowledge. We assume that the consumer consumes at most one unit of each product.

We write the utility of the consumer with preferences of η_i and θ_j by u_{ij}. Let p_A be the price of product A and p_B where $B = H, L$ be the prices of product B of high quality and low quality, respectively. Then the utility of the consumer of type (η_i, θ_j) is given by

$$u_{ij}(x_A, y_B) = (q_A \cdot \eta_i - p_A) \cdot x_A + (q_B \cdot \theta_j - p_B) \cdot y_B \tag{1}$$

where $x_A = \{0, 1\}$ is the unit of product A purchased and $y_B = \{0, 1\}, B = \{H, L\}$ is the unit of product B purchased by the consumer.

When we consider technological integration among different products, firm A introduces a product which integrates the functions of product A and product B. A new product called product AL is introduced to the market by firm A whose quality is the sum of the quality of product A, q_A, and the quality of product B of q_L. In addition the consumer who purchases the newly introduced product enjoys additional utility which depends on the type of the consumer. In particular the consumer of type (η_i, θ_j) gets extra utility α_j, that is, extra utility depends on the consumer's type with respect to the product B. Since the new product integrates the functions of product A and B, the consumer purchases at most one unit of the product and moreover does not purchase any other product.[2]

Let p_{AL} and c_{AL} denote the price and costs of the integrated product, respectively. Then the utility of a consumer ij when purchasing product AL is written as:

$$\begin{aligned} u_{ij}(x_A, y_B, z_{AL}) =&[(q_A \cdot \eta_i - p_A) \cdot x_A + (q_B \cdot \theta_i - p_B) \cdot y_B](1 - z_{AL}) \\ &+ (q_A \cdot \eta_i + q_L \cdot \theta_j + \alpha_j - p_{AL})z_{AL} \end{aligned} \tag{2}$$

where $z_{AL} = \{0, 1\}$ is the unit of product AL purchased.

We make the following assumption to restrict the analysis to the most interesting cases.

Assumption 1 $\alpha_M > \alpha_H = \alpha_L = 0$

Assumption 1 implies that the θ_M type consumers value the integrated product most.

To understand the situation we analyze, consider the example of a cellular phone with a built-in digital camera. The new product has the quality of phone, q_A , and the quality of the same as the low quality camera of firm B, i.e., q_L. In this sense the camera phone is an integrated product. The camera phone is not just a product integrating several functions into one product, but a new product creating new functions which results from the technological integration. For example, we can take pictures and send them to a friend right away, or even possible to post it directly to one's website. It also make it easy to do some transactions using the hotcode functions which are only possible by integrating the camera function and the phone together.

It is plausible that a consumer's valuation of these new services provided by the integrated product depends on the consumer's type. The built-in camera of a camera phone might not be such an attractive gadget to the consumer who has an eye for a high-end camera. The consumer who does not value the camera at all would not appreciate the new functions provided by the camera phone, either. For this reason we assume that the consumers of type θ_M gets the highest extra utility from the integrated product.

[2] We can allow consumers to purchase the integrated product together with separate product, in which case the analysis gets more complicated without adding interesting results.

3. Benchmark

In this section we fix the parameter conditions which generate the market structure adequate for ensuing analysis after the technological integration among the two products. The equilibrium is a map from parameter space to a set of available market structure. Thus a various market structure might occur as an equilibrium under different parametric values which describe a certain economic environment. For this reason, it is not interesting to investigate all the possible equilibrium market structures and the supporting parametric values. Instead we focus on a specific market structure which we are interested in and figure out parametric values supporting such a structure as an equilibrium. The market structure before the integrated product is introduced is fixed so that the product B of both high quality and low quality are produced. Only θ_H type consumers purchase product B of quality q_H, while product B of quality q_L is purchased by both of θ_M and θ_L type consumers. On the other hand, product A is purchased only by consumers of type η_H.

The following propositions give the conditions on the parameter values which support the aforementioned market structure at the equilibrium. Since the markets for the two products can be analyzed independently we present the analysis in two lemmas. For simplicity, we use the following notation: $\mu_{i\cdot} \equiv \sum_{j=H,M,L} \mu_{ij}$ for $i = H, L$ and $\mu_{\cdot j} \equiv \sum_{i=H,L} \mu_{ij}$ for $j = H, M, L$.

Proposition 1 *Suppose the following condition is satisfied:* $q_A\eta_L \leq c_A \leq q_A\eta_H$*. Then firm* A *sells product* A *at* $p_A = q_A\eta_H$ *and only consumers of type* η_H *purchase product* A*.*

Proof. It is clear from consumers' preferences that firm A can choose its prices from $p_A = q_A \cdot \eta_H$ and $p_A = q_A \cdot \eta_L$. If it chooses $p_A = q_A \cdot \eta_H$, then only η_H type consumers buy phones, and thus the profits are $\mu_{H\cdot}(\eta_H \cdot q_A - c_A)$. And if it chooses $p_A = q_A \cdot \eta_L$, then both types of consumers buy phones, and thus the profits are $\eta_L \cdot q_A - c_A$. Thus it is profitable for firm A to cover only a part of consumers. ■

The condition in Proposition 1 implies that the cost of product A is justified only by high type consumers.

The set of conditions needed for product B market is more complicated since we have to compare profits from diverse market configurations and conclude that a particular one yields the highest profit for firm B. First observe that thanks to the *monotonicity* property satisfied by this class of models, we can narrow down the possible configurations to 9 possibilities. The monotonicity condition states that if the consumer of a particular type purchases product B of a certain quality, the consumer of higher type also is willing to purchase it. However it does not rule out the possibility that the higher type consumer prefers to purchase product B of higher quality. The monotonicity property implies that there remain nine possible market configurations to be considered.

Proposition 2 *Suppose the following conditions (A1)-(A4) are satisfied.*

(A1) $\theta_L(q_H - q_L) \leq \theta_M(q_H - q_L) \leq c_H - c_L \leq \theta_H(q_H - q_L)$
(A2) $c_L \leq \theta_L q_L$
(A3) $\mu_{\cdot H} \leq \frac{\theta_L q_L - c_L}{\theta_H q_L - c_L}$
(A4) $\mu_{\cdot H} + \mu_{\cdot M} \leq \frac{\theta_L q_L - c_L}{\theta_M q_L - c_L}$

Then firm B sells product B of quality q_H *and* q_L *at* $p_H = q_H\theta_H - q_L(\theta_H - \theta_L)$ *and* $p_L = q_L\theta_L$*, respectively. Given the prices of the products, consumers of type* θ_H *purchase product B of quality* q_H *and consumers of type* θ_M *and* θ_L *purchase product B of quality* q_L*.*

Proof. It suffices to show that it is profitable to sell the high quality camera only to the θ_H type consumers and the low quality camera to the rest. Since there are only two possible qualities to choose from, we use $\pi_B(\{H\} : \{M, L\})$ to denote the profits from the aforementioned market structure. Let $\pi_B(\{\alpha\} : \{\beta\})$ be the profits when firm B sells the high quality to α type consumers and the low quality to β type consumers. Thus it suffices to show that given parametric values, $\pi_B(\{H\} : \{M, L\})$ is the maximal profits among all possible options. It is worth noticing that the camera which a lower type of consumers chooses to purchase is always an option worth buying for the higher type of consumers, and thus it is not a possible situation where only a lower type of consumers consumes a camera of some quality. Also notice that (A2) implies that it is profitable to sell the low quality camera at the price of $\theta_L q_L$ to θ_L type consumers.

We will denote the price of q_L and q_H by p_L and p_H, respectively. Now we need to figure out p_L and p_H which support the market structure of our interests. Clearly $p_L = \theta_L q_L$ should be chosen. And p_H must satisfy $\theta_H q_H - p_H \geq 0$ and $\theta_L q_H - p_H \leq 0$. And $\theta_H q_H - p_H \geq \theta_H q_L - p_L$ must also be satisfied. From these conditions, we can conclude that $p_H = \theta_H q_H - (\theta_H - \theta_L)q_L$.

Therefore given these prices, θ_H type consumers buy q_H cameras and θ_L type consumers buy q_L cameras. It is easy to see that $\theta_M q_H - p_H \leq \theta_M q_L - p_l$ holds and thus θ_M type consumers buy q_L cameras. Now it remains to show the following five claims analyzing nine possible market configurations. Notice that $\pi_B(\{\theta_H\} : \{\theta_M, \theta_L\}) = \mu_{\cdot H}(\theta_H q_H - (\theta_H - \theta_L)q_L - c_H) + (\mu_{\cdot M} + \mu_{\cdot L})(\theta_L q_L - c_L)$

Claim 1: $\pi_B(\{H\} : \{M, L\}) \geq \pi_B(\{H, M\} : \{L\})$.

Proof: It suffices to show that it is more profitable to sell to the θ_M type consumers the low quality camera at $\theta_L q_L$ than the high quality camera at $\theta_M q_H - (\theta_M - \theta_L)q_L$. Thus it suffices to check if $\theta_M q_H - (\theta_M - \theta_L)q_L - c_H \leq \theta_L q_L - c_L$. This holds if $\theta_M(q_H - q_L) \leq c_H - c_L$. Q.E.D.

Claim 2: $\pi_B(\{H\} : \{M, L\}) \geq \pi_B(\{H, M, L\} : \{\emptyset\})$.

Proof: It suffices to show that it is more profitable to sell to the θ_M and θ_L type consumers the low quality camera at the price of $\theta_L q_L$ than the high quality camera at the price of $\theta_L q_H$. It is easy to see that $\theta_L(q_H - q_L) \leq c_H - c_L$ implies that $\theta_L q_L - c_L \geq \theta_L q_H - c_H$. Q.E.D.

Claim 3: $\pi_B(\{H\} : \{M, L\}) \geq \pi_B(\{\emptyset\} : \{H, M, L\})$:

Proof: It suffices to show that it is more profitable to sell to the θ_H type consumers the high quality camera at the price of $p_H = \theta_H q_H - (\theta_H - \theta_L)q_L$ than the low quality good at the price of $\theta_L q_L$. By the similar argument, if $c_H - c_L \leq \theta_H(q_H - q_L)$ holds, then Claim 3 holds. Q.E.D.

Claim 4: $\pi_B(\{H\} : \{M, L\}) \geq \pi_B(\{H\} : \{\emptyset\}) \geq \pi_B(\{\emptyset\} : \{H\})$

Proof: The second inequality holds vacuously. So it suffices to show the first relation. And firm B sets $p_H = \theta_H q_H$ if it wants to produce and sell only the high quality camera to the θ_H type consumers. Thus we need to show that $\mu_{\cdot H}(\theta_H q_H - (\theta_H - \theta_L)q_L - c_H) + (\mu_{\cdot M} + \mu_{\cdot L})(\theta_L q_L - c_L) \geq \mu_{\cdot H}(\theta_H q_H - c_H)$. It is not difficult to see that this relation holds under $(A3)$. Q.E.D.

Claim 5: $\pi_B(\{H\} : \{M, L\}) \geq \pi_B(\{H\} : \{M\}) \geq \pi_B((\{\emptyset\} : \{H, M\}) \geq \pi_B((\{H, M\} : \{\emptyset\})$.

Proof: It is not difficult to see that the last two inequalities hold by (A1). Thus it suffices to show the first inequality. In order to sell the high quality camera to the θ_H type consumers and the low quality camera to the θ_M type consumers, firm B should set $p_H = \theta_H q_H - (\theta_H - \theta_M)q_L$ and $p_L = \theta_M q_L$ to maximize profits. Thus we need to show that $\mu_{\cdot H}(\theta_H q_H - (\theta_H - \theta_L)q_L - c_H) +$

$(\mu_{\cdot M}+\mu_{\cdot L})(\theta_L q_L - c_L) \geq \mu_{\cdot H}(\theta_H q_H - (\theta_H - \theta_M)q_L - c_H) + \mu_{\cdot M}(\theta_M q_L - c_L)$.
And this holds under $(A4)$. Q.E.D.

The market structures considered in the above five claims make the exhausting list of nine market configurations. This completes the proof of Proposition 2. ■

Proposition 2 implies that the camera market structure depends on parametric values characterizing economic environments. Thus a different market structure is also possible under a different parametric values. Similar analysis can be applied to the phone market and thus various market structures can occur depending on the market environment characterized by parametric values.

Consumers who decide to purchase the mobile phone at the price of p_A must have $q_A \cdot \eta_j - p_A \geq 0$. Thus if $q_A \cdot \eta_L \geq p_A$, then all consumers will buy phones. But if $q_A \cdot \eta_H \geq p_A > q_A \cdot \eta_L$, then only consumers with η_H preferences will buy phones. The firm B will choose its price in order to maximize profits, and thus the pricing policy necessarily depends on the parameters. In this paper, we are interested in the situation where the phone market is not fully covered.

The market configuration from Proposition 1 and 2 can be visualized in the following table.

θ_H	H	H, A
θ_M	L	L, A
θ_L	L	L, A
	η_L	η_H

Proposition 1 and 2 shows that there is a family of parameters that support the market structure of our interests, i.e., both quality of cameras are produced and the high quality camera is purchased only by the group of consumers with the highest willingness to pay and furthermore the mobile phone market is not fully covered. We believe this market structure best represents the reality. Almost every household has a camera which has limited functions but is very easy to handle. Only a handful of consumers buy a high-end camera with lots of difficult-to-handle functions. Thus the parametric values described in Proposition 1 and 2 are worth being given attention to.

Note that the market configuration obtained in Proposition 1 and Proposition 2 is valid under the given conditions even when the two firms are merged since the products are independent. The following proposition records this observation for future reference without formal proof.

Proposition 3 *Suppose that the 5 conditions in Proposition 1 and Proposition 2 are satisfied by the monopolist which is formed by a merger of firm A and firm B. The equilibrium market configuration obtained in Proposition 1 and Proposition 2 remains the equilibrium after the merger.*

4. Technological Integration

Having fixed the reference market configuration, we introduce technological integration of product A and product B of quality q_L and analyze the implication in terms of the new equilibrium market configuration and welfare performance. When technological integration among products is made feasible, there are 3 possibilities depending on who implements it: first, firm A implements it, second, firm B implements it, and third, the new firm formed by the merger of firm A and firm B implements it. We consider them sequentially.

4.1. Firm A implements technological integration

We will show that the following market structure is a Nash equilibrium under some conditions.

θ_H	H	H, A
θ_M	$\cdot$	AL
θ_L	$\cdot$	A
	η_L	η_H

Suppose that firm A strategically targets θ_M type consumers with the new product AL. If firm B decides to keep $p_L = \theta_L q_L$, then it is sufficient for firm A to choose $p_{AL} = \theta_M q_L + \eta_L q_A + \alpha_M - (\theta_M - \theta_L)q_L$ to steal all of θ_M type consumers. Then firm B loses all of θ_M type consumers. But if firm B slightly lowers p_L by $\epsilon > 0$, then it can recover its market share and it is profitable since $\mu_{\cdot H}(\theta_H q_H - (\theta_H - \theta_L)q_L - \epsilon - c_H) + (\mu_{\cdot M} + \mu_{\cdot L})(\theta_L q_L - \epsilon - c_L) > \mu_{\cdot H}(\theta_H q_H - c_H)$ for sufficiently small $\epsilon > 0$ by Claim 4 in Proposition 2. Thus firm B will reduce p_L as low as $\bar{p}_L$ satisfying $\pi_A(\bar{p}_L) \equiv \mu_{\cdot H}(\theta_H q_H - (\theta_H q_L - \bar{p}_L) - c_H) + (\mu_{\cdot M} + \mu_{\cdot L})(\bar{p}_L - c_L) = \mu_{\cdot H}(\theta_H q_H - c_H)$. Since $\pi_A(\bar{p}_L)$ is continuous in $\bar{p}_L$, there exists such $\bar{p}_L > c_L$. Define $\gamma \equiv \theta_M q_L - \bar{p}_L$. Then firm A must set $p_{AL} = \theta_M q_L + \eta_L q_A + \alpha_M - \gamma$ to steal θ_M type consumers.

We will show the following Lemmata.

Lemma 1 *Suppose that (A1) holds and that $p_A = \eta_H q_A$ and $p_{AL} = \theta_M q_L + \eta_L q_A + \bar{\alpha}_M$ are chosen by firm A, where $\bar{\alpha}_M = \alpha_M - \gamma$. Then firm B charges the high quality product high enough that only the θ_H type consumers purchase one and does not produce the low quality product if the following conditions are satisfied.*

(B1) $\gamma \geq Max\{(\theta_M - \theta_L)q_H, \theta_M q_L - c_L\}$
(B2) $\mu_{\cdot H}(\theta_H - \theta_M)q_L \geq \mu_{\cdot L}(\theta_L q_L - c_L)$
(B3) $q_L(\theta_H - \theta_L) - q_A(\eta_H - \eta_L) \leq 0 \leq q_L(\theta_H - \theta_L) + q_A(\eta_H - \eta_L) \leq \bar{\alpha}_M$

Proof. Suppose that firm B decides to sell the high quality product only to the θ_H type consumers and not to produce the low quality product at all. Given that $p_{AL} = \theta_M q_L + \eta_L q_A + \bar{\alpha}_M$ is chosen by firm A, firm A will choose $p_H = \theta_H q_H$ under($B3$). Under ($B3$), θ_{HH} type consumers will not buy AL product and neither do θ_{LH} type consumers since $\theta_H q_L + \eta_H q_A - (\theta_M q_L + \eta_L q_A + \bar{\alpha}_M) \leq 0$. Thus $\pi_B(\{H\} : \emptyset) = \mu_{\cdot H}(\theta_H q_H - c_H)$. It suffices to show that given parametric values, $\pi_B(\{H\} : \emptyset)$ is the maximal profits among all possible options of market structures. Notice that given $p_{AL} = \theta_M q_L + \eta_L q_A + \bar{\alpha}_M$, firm B need not consider producing the low quality product since the only viable price of $p_L = \bar{p}_L$ and it is more profitable to sell the high quality product at $p_H = \theta_H q_L$. Thus there remain only the following cases to consider.

First, it is not difficult to see that it is impossible to sell the high quality product only to θ_H and θ_M type consumers. In order to persuade θ_M type consumers to buy the high quality product, p_H must be lower than $\theta_M q_H$. But θ_M type consumers do not buy the high quality product even at $\theta_L q_H$ since $\theta_M q_L + \eta_L q_A + \alpha_M - (\theta_M q_L + \eta_L q_A + \bar{\alpha}_M) \geq \theta_M q_H - \theta_L q_H$ by ($B1$). If p_H is lower than $\theta_L q_H$, then it is impossible to exclude θ_L type consumers.

Second, it is not difficult to see that it is not profitable to set $p_H = \theta_L q_H$ and to make θ_H and θ_L type consumers buy the high quality product. Suppose that $p_H = \theta_L q_H$. Then θ_L type consumers buy the high quality product, and profits of firm B are $(\mu_{\cdot H} + \mu_{\cdot L})(\theta_L q_H - c_H) \leq \mu_{\cdot H}(\theta_H q_H - (\theta_H - \theta_L)q_L - c_H) + \mu_{\cdot L})(\theta_L q_L - c_L)$ since $\theta_H q_H - (\theta_H - \theta_L) > \theta_L q_H$ and $\theta_L q_L - c_L \geq \theta_L q_H - c_H$ by ($A1$). Thus it suffices to show that $\mu_{\cdot H}(\theta_H q_H -$

$c_H) \geq \mu_{\cdot H}(\theta_H q_H - (\theta_H - \theta_L)q_L - c_H) + \mu_{\cdot L}(\theta_L q_L - c_L)$. This relation holds if $\frac{\mu_{\cdot H}}{\mu_{\cdot L}} \geq \frac{\theta_L q_L - c_L}{(\theta_H - \theta_L)q_L}$, which is valid under (B2).

Third the following argument shows that it is not profitable to make all three types of consumers buy the high quality product. Firm A needs to lower the high quality product than $\theta_L q_H$ to make it attractive to θ_M type consumers. Since γ is the surplus that θ_M type consumers when they buy AL, p_H cannot be greater than $\theta_M q_H - \gamma$. And $\theta_M q_H - \gamma \leq \theta_M(q_H - q_L) + c_L \leq c_H$ by $(A1)$.

This completes the proof of Lemma 1. ■

Lemma 1 shows that if firm A sets $p_A = \eta_H q_A$ and $p_{AL} = \theta_M q_L + \eta_H q_A + \bar{\alpha}_M$, it is the optimal choice of firm B to give up the low quality product market and to try to exercise the market power it has in the high quality product market charging the maximal price. In other words, if firm A makes a different pricing and marketing options, then firm B's optimal choice will differ. When firm A consider which pricing and marketing options to take, it will consider all the available market configurations to choose from and commit prices which will bring the best possible results. We will show that it is optimal for firm A to commit $p_A = \eta_H q_A$ and $p_{AL} = \theta_M q_L + \eta_H q_A + \bar{\alpha}_M$ among all possible options. Recall that it is not profitable to sell the phone to the η_L type consumers no matter what the firm B does.

Under Assumption 1, the bundled product does not give a merit to the θ_H and θ_L type consumers unless it is cheaper than when purchased separately.

We make the following assumption.

Assumption 2 $c_{AL} = c_A + c_L$.

The following assumption allows us to avoid unnecessary complications.

Assumption 3 $\theta_H q_L + \eta_L q_A - c_{AL} \leq 0$.

Assumption 3 together with the assumption of $\eta_L q_A - c_A \leq 0$ in Lemma 1 tells that the profits of selling the low quality product at the price of $\theta_H q_L$ is not sufficient enough to recover the loss of selling the product at the price of $\eta_L q_A$.

Lemma 2 *Suppose that Assumption 3 and* $(B3)$ *holds. Then there exists*[3] $\hat{\alpha}$ *such that it is better for firm A to sell only to* θ_M *type consumers if* $\alpha_M \geq \hat{\alpha}$.

[3] We will give an approximate value of $\hat{\alpha}$ in Appendix.

Proof. Notice that it is not profitable to make either one of μ_{LL} and μ_{LH} population buy AL product at any price level. The maximum willingness to pay by μ_{LH} is $\theta_L q_L + \eta_L q_A$, but this value does not cover the costs by Assumption 3. Similarly it is not profitable to provide AL to μ_{LL}. Thus potential customers are all of η_H type consumers and μ_{LM} populations.

Now suppose that firm A decides to make μ_{HL} population buy AL. The maximum willingness to pay by μ_{HL} type is $\theta_L q_L + \eta_H q_A$, and thus firm A needs to charge lower than $\theta_L q_L + \eta_H q_A$. The exact price of AL to attract μ_{HL} depends on firm B's responses. But it is clear that firm A fails to sell AL to μ_{HL} at $\theta_L q_L + \eta_H q_A$ since firm B can lower p_L. Thus p_{AL} should be strictly lower than $\theta_L q_L + \eta_H q_A$. Let π_1 denote the maximum profits of firm A when it charges such a price of AL and $p_A = \eta_H q_A$. Suppose that firm A decides to make μ_{HH} population buy AL. The maximum willingness to pay by μ_{HL} type is $\theta_H q_L + \eta_H q_A$, and thus firm A needs to charge lower than $\theta_H q_L + \eta_H q_A$. Let π_2 denote the maximum profits of firm A when it charges such a price of AL and $p_A = \eta_H q_A$. Notice that none of π_1 and π_2 depend on α_M.

Now suppose that firm A charges $p_A = \eta_H q_A$ and $p_{AL} = \theta_M q_L + \eta_L q_A + \alpha_M - \gamma$. It is not difficult to see that none of μ_{HH} and μ_{HL} type population buy AL by $(B3)$. Given these prices only θ_M type consumers buy AL products, and μ_{HH} and μ_{HL} type population buy the product A. The profits of firm A is $\pi_B(\alpha_M) = (\mu_{HL} + \mu_{HH})(\eta_H q_A - c_A) + \mu_{\cdot M}(\theta_M q_L + \eta_L q_A + \alpha_M - \gamma - c_A - c_L)$. Recall that γ is independent of α_M. Clearly $\pi_B(\alpha_M)$ is continuous and increasing in α_M. Thus there exists $\hat{\alpha}$ such that $\pi_B(\alpha_M) \geq Max\{\pi_1, \pi_2\}$ for all $\alpha_M \geq \hat{\alpha}$. This completes the proof of Lemma 2. ∎

Lemma 3 *Suppose that Assumption 2 and 3 holds. Suppose that* $(B3)$ *holds and* $\alpha_M \geq \hat{\alpha}$. *Then it is optimal for firm A to choose and to commit* $p_A = \eta_H q_A$ *and* $p_{AL} = \theta_M q_L + \eta_L q_A + \bar{\alpha}_M$ *if the following (C) holds.*

(C) $\alpha_M \geq \mu_{MH}(\eta_H - \eta_L)q_A - \mu_{LM}(\eta_L q_A + \theta_L q_L - c_A - c_L) - \mu_{\cdot M}((\theta_M - \theta_L)q_L - \gamma)$.

Proof. Assumption 3 implies that it will never be profitable to sell AL to either μ_{LL} or μ_{LH} types. Lemma 2 shows that firm A will charge p_{AL} so as to make none other than θ_M types buy AL products. If firm A chooses $p_{AL} = \theta_M q_L + \eta_L q_A + \bar{\alpha}_M$, then $\pi_B = (\mu_{HL} + \mu_{HH})(\eta_H q_A - c_A) + \mu_{\cdot M}(\theta_M q_L + \eta_L q_A + \alpha_M - \gamma - c_A - c_L)$. Now suppose that firm A considers selling AL only μ_{HM} types. If firm B decides to keep $p_L = \theta_L q_L$, then it is sufficient for firm A to choose $p_{AL} = \theta_M q_L + \eta_H q_A + \alpha_M - (\theta_M - \theta_L)q_L$ to steal μ_{HM} type consumers. Then the profits of firm A in this case will be $\pi_B^{HM} \equiv (\mu_{HL} + \mu_{HH})(\eta_H q_A - c_A) + \mu_{HM}(\theta_M q_L + \eta_H q_A + \alpha_M - (\theta_M - \theta_L)q_L - c_A - c_L)$. But as we have discussed before, firm B reacts to such a pricing strategy by firm A and will lower p_L and thus profits will be lower than π_B^{HM}. Thus it suffices to show that $\pi_B - \pi_B^{HM} = \mu_{\cdot M}(\theta_M q_L + \eta_L q_A + \alpha_M - \gamma - c_A - c_L) - \mu_{HM}(\theta_M q_L + \eta_H q_A + \alpha_M - (\theta_M - \theta_L)q_L - c_A - c_L) \geq 0$, which holds under (C). This completes the proof. ■

The following Theorem 1 is immediate from Lemma 1 , Lemma 2 and Lemma 3.

Theorem 1 *Suppose that Assumption 1, 2 and Assumption 3 hold. Suppose that (A1)-(A4), (B1)-(B3), and (C) hold. Then it is optimal in the sense of subgame perfect Nash equilibrium for firm A to set* $p_A = \eta_H q_A$ *and* $p_{AL} = \theta_M q_L + \eta_H q_A + \bar{\alpha}_M$*. And given such pricing strategies by firm A, it is optimal for firm B to set* $p_H = \theta_H q_H$ *and not to produce the low quality product.*

It is easy to see that firm A is better off. Also firm B is worse off since (A3) implies that it is more profitable to sell both the high quality and low quality product if possible. Notice that θ_L type consumers are neither better off nor worse off. Notice that θ_H type consumers make the same consumption choices but are paying a lot more and thus are worse off. The θ_M type consumers enjoyed $(\theta_M - \theta_L)q_L$ gains from consuming the low quality product. But due to the technical innovation it is impossible to buy the low quality product and this make μ_{LM} consumers worse off. The μ_{HM} consumers are buying the new product but are paying less than their maximum willingness to pay. So the technical innovation makes most of consumers except μ_{LM} type worse off.

Theorem 1 shows that there exists a non-empty set of family of parameters which supports a specific post-digital convergence market configuration when firm A moves first and decides to enter the product B market. But Lemma 2 tells that a different post-convergence market configuration is possible when α_M is not too large. Thus it is possible that different market structures emerge as equilibrium market configuration under different parametric values. Then it is very natural to ask if it is possible for all market participants to be better due to the technical integration. The next theorem tells that the answer is negative.

Theorem 2 *Suppose that (A1) -(A5) are satisfied. Then it is impossible that all of firm A, firm B and consumers are better off at any post-digital convergence equilibrium market configuration.*

Proof. By Proposition 1 and Proposition 2, the equilibrium market configuration before the digital convergence is as follows;

θ_H	H	H, A
θ_M	L	L, A
θ_L	L	L, A
	η_L	η_H

It suffices to show that the firm B cannot be better off, that is, the profits of firm B cannot be larger after the digital convergence. It is clear that after the digital convergence the firm A will take away some of firm A's previous market share with the new product AL. In other words, firm B will lose a part of its market share. Suppose that firm A takes a part or all of θ_H type consumers. Thus firm B needs to increase either p_H or p_L to increase its profits compared with the profits without AL. However it cannot increase p_H nor p_L unless it gives up marketing low quality products to θ_L type consumers. But Claim 4 and Claim 5 in Proposition 2 show that firm B cannot be better off in this case.

Suppose that firm A takes a part or all of θ_L type consumers. As in the above case, firm B needs to increase either p_H or p_L to make up the lost profits due to the loss of market share. Again it cannot increase p_H nor p_L unless it gives up marketing low quality products to θ_L type consumers. But Claim 4 and Claim 5 in Proposition 2 show that firm B cannot be better off in this case.

Suppose that firm A takes a part of all of θ_M type consumers. If firm A takes only a part of θ_M type consumers away from firm B, then firm B will not change any of its prices. Clearly it cannot increase p_L without losing θ_L type consumers. And it cannot increase p_H without losing θ_H type consumers unless it gives up marketing the low quality products, and Claim 5 in Lemma 2 shows that it is not a profitable change at all. Neither can it lower p_H due to Claim 2 and Claim 4 in Proposition 2. Suppose that firm A takes all of θ_M type consumers away from firm B. Then this equilibrium strategy by firm A reveals additional information regarding consumers' types to firm B. Thus firm B can identify θ_M type consumers. But this additional piece of information does not help firm B to recover its lost profits due to the digital convergence. Clearly firm B cannot increase p_L without losing θ_L type consumers. If it does, then p_H should be charged higher, and Claim 4 in Proposition 2 shows that this is not a profitable change at all. Since firm B cannot increase p_H without giving up selling the low quality products, the only remaining option to firm B is to lower p_H. However Claim 1, 2, and Claim 5 in Proposition 2 show that this change cannot increase profits compared with those without digital convergence. This completes the proof. ■

Theorem 2 is not surprising in the sense that more competition typically results in lower profits of competitors. In this case, firm A steals the market from firm B and thus lower the profits of firm B. In other words, market stealing effects dominate information revealing effects. Notice that in the pre-digital convergence equilibrium in Theorem 2, firm B fully covers the product B market. Thus firm A, if it enters the product B market, steals the market from firm B. But suppose that firm B does not cover the entire market in pre-digital convergence equilibrium. Then it might be possible for firm A to enter the market without harming firm B. The next Theorem 3 shows that it will not be the case. The following theorem is a stronger version of Theorem 2.

Theorem 3 *Given a pre-digital convergence equilibrium market configuration, it is impossible that all of the market participants, i.e., firm A, firm B, and consumers, are better off at post-digital convergence equilibrium market configuration.*

Proof. In pre-digital convergence period, firm B maximizes its profits by choosing marketing strategy of high and low quality products. Since there are three different types of consumers, it will choose optimal separation of consumers using two products. Let $\{\{\alpha\},\{\beta\}\}$ be a such possible separation where firm B sells the high quality to α type consumers and the low quality to β type consumers. Notice that one of $\{\alpha\}$ and $\{\beta\}$ can be an empty set. In other words, firm B solves the following maximization problem; $Max_{p_H,p_L}\pi_B\{\{\alpha\},\{\beta\}\}$ subject to $\{\{\alpha\},\{\beta\}\} \in \Phi$, where Φ denotes all reasonable collection of sets satisfying $\{\alpha\}\cup\{\beta\}\subseteq\{H,M,L\}$. It is clear that not all possible collection of sets satisfying $\{\alpha\}\cup\{\beta\}\subseteq\{H,M,L\}$ need not be considered. First, it is impossible to sell the low quality product to the higher type and the high quality product to the lower type. Thus such a choice as $\{\{L\},\{H,M\}\}$ is not available. Second, if a type afford to buy a product, then the higher type also afford to buy the same product. Thus such a choice as $\{\{H\},\{L\}\}$ is not available since it is possible for θ_M type consumers to buy the low quality product. Let $\{\{\alpha^*\},\{\beta^*\}\}$ be the optimal choice of firm B at pre-digital convergence equilibrium. Recall that one of $\{\alpha^*\}$ and $\{\beta^*\}$ can be an empty set.

Suppose that firm A develops a new product AL and enter the product B market. First, consider the case where firm A takes a part or all of θ_H type consumers using AL. If it takes only a part of θ_H type consumers, then it does not add any more information to firm B regarding the types of consumers. Therefore the constraint set must not be different from Φ and thus the optimal choice of firm B in this case could not be better than $\{\{\alpha^*\},\{\beta^*\}\}$. If firm A takes all of θ_H type consumers, then this equilibrium strategy reveals the θ_H type to firm B. Then $\{\{M,L\},\emptyset\},\{\emptyset,\{M,L\}\}$ and $\{\{M\},\{L\}\}$ are only available options to firm B. It is clear that $\pi_B(\{\{M,L\},\emptyset\}) \leq \pi_B(\{\{H,M,L\},\emptyset\})$, $\pi_B(\{\emptyset,\{M,L\}\}) \leq \pi_B(\{\emptyset,\{H,M,L\}\})$, and $\pi_B(\{\{M\},\{L\}\}) \leq \pi_B(\{\{H,M\},\{L\}\})$. And thus the optimal choice of firm B in this case could not be better than $\{\{\alpha^*\},\{\beta^*\}\}$.

Suppose that firm A takes a part or all of θ_L type consumers. If it takes only a part of θ_L type consumers, then it does not add any more options to Φ and thus the optimal choice of firm B in this case could not be better than $\{\{\alpha^*\},\{\beta^*\}\}$. Now suppose that firm A takes all of θ_L type consumers. Then this equilibrium strategy reveals the θ_L type to firm B. And $\{\{H,M\},\emptyset\}$, $\{\{H\},\{M\}\}$, $\{\emptyset,\{H,M\}\}$, and $\{\emptyset,\{H\}\}$ are available options to firm B. Clearly, this options are included in Φ. Thus And thus the optimal choice of firm B in this case could not be better than $\{\{\alpha^*\},\{\beta^*\}\}$.

Suppose that firm A takes a part or all of θ_M type consumers. If it takes only a part of θ_M type consumers, then it does not add any more information to firm B regarding the types of consumers. Therefore the constraint set must not be different from Φ and thus the optimal choice of firm B in this case could not be better than $\{\{\alpha^*\},\{\beta^*\}\}$. Now suppose that firm A takes all of θ_M type consumers. Then this equilibrium strategy reveals the θ_M type to firm B. And $\{\{H,L\},\emptyset\}$, $\{\{H\},\{L\}\}$, $\{\emptyset,\{H,L\}\}$, and $\{\emptyset,\{H\}\}$ are available options to firm B. Notice that $\{\emptyset,\{H\}\}\in\Phi$, but the other three options are not included in Φ. However it is clear that $\pi_B(\{\{H,L\},\emptyset\}) \leq \pi_B(\{\{H,M,L\},\emptyset\})$, $\pi_B(\{\{H\},\{L\}\}) \leq \pi_B(\{\{H\},\{M,L\}\})$, and $\pi_B(\{\emptyset,\{H,L\}\}) \leq \pi_B(\{\emptyset,\{H,M,L\}\})$. And thus the optimal choice of firm B in this case could not be better than $\{\{\alpha^*\}, \{\beta^*\}\}$.

This completes the proof of Theorem 3. ■

4.2. Firm B implements technological integration

So far, we only investigates what happens when the firm A is the innovator. In this section, we consider the case when firm B enters the product A market by technically integrating the product B and product A. We will denote the bundled new product by AL as in the earlier case and assume that the characteristics of AL is exactly the same as the case when firm A innovates. Thus the only difference is who is the innovator.

We will first show that it is optimal for firm B to set the price of AL so as to make only the θ_M type consumers to buy the new product. Unlike the case when firm A innovates, the responses by fir A in this case is relatively simple. The only option firm A has is to choose a single price of p_A. Thus when firm B first chooses a pricing strategy, the response from firm A is easy to guess. The following Lemma 4 shows that when α_M is large enough, then firm B's optimal choice is independent of the response by firm A.

Lemma 4 *Suppose that Assumption 1, 2 and Assumption 3 hold. Suppose that (A1)-(A4), (B1)-(B3), and (C) hold. There exists $\bar{\alpha} > 0$ such that it is optimal for firm B to set p_{AL} to make only the θ_M type consumers to buy the AL product if $\alpha_M \geq \bar{\alpha}$.*

Proof. Suppose that $\alpha_M = 0$. In other words, the new product does not provide any extra utilities to the buyer. Thus the product AL is nothing but a packaged product of the product A and the low quality product B. In this case, the maximum profits of firm B by producing three products of the high quality of product B, the low quality of product B, and the new product AL cannot be greater than the sum of profits A in lemma 1 and B in lemma 2. In other words, the profits cannot be greater than those possible when firm B is the only monopolist of both of product A and and B. In fact, the maximum possible profits are a lot lower than this upper bound since firm A will strategically react to firm B by lowering its price of the product A. Let this upper bound of maximum profits be denoted by $\bar{\pi}$.

Now suppose that $\alpha_M \neq 0$ and firm B does not make the price of AL as a function[4] of α_M. Let $\hat{\pi}$ be the upper bound of maximum profits of this

[4]This is the case when firm B decides to sell AL either to θ_L type or to θ_H type.

case. Let $\tilde{\pi} = Max\{\bar{\pi}, \hat{\pi}\}$.

Now suppose that firm B set p_{AL} dependent on α_M. Since only the θ_M type consumers enjoy this extra utilities, firm B should target only the θ_M type consumers to set the price of AL as a function of α_M. Let $\pi(\alpha_M)$ denote the profits. Since π_B is increasing with regard to α_M in this case, there exists $\bar{\alpha}$ such that $\pi(\alpha_M) \geq \tilde{\pi}$ if $\alpha_M \geq \bar{\alpha}$. This completes the proof. ■

Lemma 4 shows that if α_M is large, then firm B will strategically select the price of AL and try to utilize the high willingness to pay of the θ_M type consumers. Thus $\alpha_M < \bar{\alpha}$ is not an interesting case since the strategic bundling does not make any difference than one without digital convergence. Thus from now on, we will assume $\alpha_M > \bar{\alpha}$.

Lemma 5 *Suppose that it is possible not to sell either the high quality product or the low quality product to the θ_M type consumers. Then it is optimal for firm B to set $p_H = \theta_H q_H$ and does not produce the low quality product if (A1) and (B2) holds.*

Proof. By assumption, firm B can set p_H and p_L without considering the θ_M type consumers. Then the only concern is whether to produce both products or not. Notice that it is not optimal to produce only the low quality product and sell it to both type of consumers since it is more profitable to sell the low quality product to the θ_L type consumers and the high quality product to θ_H type consumers by (A1). Similarly it is not optimal to produce only the high quality product and sell it to both type of consumers since it is more profitable to sell the low quality product to the θ_L type consumers and the high quality product to θ_H type consumers by (A1). Therefore it suffices to show that $\mu_{\cdot H}(\theta_H q_H - c_H) \geq \mu_{\cdot H}(\theta_H q_H - (\theta_H - \theta_L)q_L - c_H) + \mu_{\cdot L}(\theta_L q_L - c_L)$. This relation holds if $\frac{\mu_{\cdot H}}{\mu_{\cdot L}} \geq \frac{\theta_L q_L - c_L}{(\theta_H - \theta_L)q_L}$, which is valid under (B2). This completes the proof. ■

Now suppose that firm B strategically targets θ_M type consumer with the new product AL which competes with the product A. Since it is not profitable to sell the product A to the η_L type consumers, firm A will try to defend the η_H type consumers. If it set $p_A = \eta_H q_A$ as in the benchmark case and firm B sets p_{AL} low enough to attract μ_{HM} consumers, firm A will lose μ_{HM} consumers to firm B. Thus it is not optimal to set $p_A = \eta_H q_A$ since such a high price take all of the consumer surplus away from consumers and thus make firm A very vulnerable to firm B's entry. By lowering p_A below $\eta_H q_A$, firm A may keep its market share, and it will do so if it is profitable. It is not difficult to see that firm A will decrease p_A as low as $\bar{p}_A(< \eta_H q_A)$ satisfying $\mu_{H\cdot}(\bar{p}_A - c_A) = (\mu_{HL} + \mu_{HH})(\eta_H q_A - c_A)$. Define $\beta \equiv \eta_H q_A - \bar{p}_A (> 0)$, and we will show that the following market configuration emerges as an equilibrium. Notice

θ_H	H	H, A
θ_M	$\cdot$	AL
θ_L	$\cdot$	A
	η_L	η_H

Theorem 4 *Suppose that Assumption 1, 2, 3 hold and that (A1)-(A4), (B1)-(B2), and (C) hold. Then it is optimal for firm B to set and to commit* $p_H = \theta_H q_H$ *and* $p_{AL} = Min\{\theta_M q_L + \eta_H q_A + \alpha_M - \beta, \theta_M q_L + \eta_L q_A + \alpha_M\}$ *if* $(B3')$ *holds*[5]. *Given such pricing strategies by firm B, it is optimal for firm A to set* $p_A = \eta_H q_A$.

$(B3')$ $(\theta_H - \theta_M)q_L + (\eta_H - \eta_L)q_A \leq \alpha_M - \beta$

Proof. Under given conditions, it is optimal for firm B to sell AL only to θ_M type consumers and the high quality product to θ_H type consumers and not to produce the low quality product at all. Since $\theta_L q_L + \eta_H q_A - p_{AL} \leq \theta_L q_L + \eta_H q_A - (\theta_M q_L + \eta_L q_A + \alpha_M - \beta) \leq 0$ by $(B3')$, all of θ_L type consumers do not buy AL. Similarly $(B3')$ guarantees that none of θ_H type consumers buy AL. It is not difficult to see that μ_{HM} type consumers are better off when they buy AL unless $p_A < \bar{p}_A$. Thus firm A cannot do better than setting $p_A = \eta_H q_A$. Finally (C) implies that it is optimal to sell AL to all of θ_M type consumers. This completes the proof. ■

Notice that the equilibrium market configuration is independent of the innovator. Also notice that p_H and p_A are same as those in two different cases of innovation. If $\theta_M q_L + \eta_H q_A + \alpha_M - \beta \geq \theta_M q_L + \eta_L q_A + \alpha_M$, then the price of AL in case firm B innovates is lower than that in case firm A innovates. Otherwise it is indeterminate.

[5]Notice that $(B3')$ is only slightly different from (B3)

4.3. Monopolist after the merger implements technological integration

So far, we only investigate the economic implications of technical integration of two independent products. We have shown that the welfare implications are very similar no matter who innovates. The low quality product B will disappear and the price of high quality product B will increase. And thus both of θ_H and θ_L type consumer are worse off when markets are getting more competitive. In this section, we investigate what happens when two firms are merged into a single firm. And we will assume that the single firm will innovate and produce AL products. The following Theroem 5 shows that matters will be even worse.

Theorem 5 *Suppose that Assumption 1, 2, 3 hold and that (A1)-(A4), (B1)-(B3), and (C) hold. Then the monopolized firm will charge* $p_A = \eta_H q_A$, $p_H = \theta_H q_H$, $p_{AL} = \theta_M q_L + \eta_L q_A + \alpha_M$ *and exclude the low quality product B from the market if* $\alpha_M \geq Min\{\hat{\alpha}, \bar{\alpha}\}$.

Proof. It is not difficult to see that if $\alpha_M \geq Min\{\hat{\alpha}, \bar{\alpha}\}$, it is optimal to sell AL only to θ_M type consumes by Lemma 2 and Lemma 4.

Recall that the price of AL in Theorem 1 and Theorem 4 is lower than $p_{AL} = \theta_M q_L + \eta_L q_A + \alpha_M$. The reason why it was lower than the maximum willingness to pay by μ_{LM} type consumers was that the firm was constrained by competition. Since two firms are merged, it can remove such constraints by itself and thus will charge $p_A = \eta_H q_A$ and not produce the low quality product B at all. Lemma 1 and Lemma 5 guarantee that such decision are profitable. Since there are no more competitive restraints, the monopolized firm will charge $p_{AL} = \theta_M q_L + \eta_L q_A + \alpha_M$. This completes the proof. ■

Theorem 5 shows that economic implications compared with those of technical bundling are similar in the sense that the low quality product disappears and the price of high quality product increases. But a very important distinctive feature of merger between two firm producing independent but potentially complementary products is that p_{AL} is a lot higher than that of both of two earlier cases. The conglomerate merger between two firms producing independent but potentially complement products by technical improvement might be harming. The source of this harmful aspect is from "actual potential competition" concern.

When two firms producing independent products propose a merger, then authority in charge of evaluating economics consequence of mergers typically investigate whether the proposed merger raises potential competition concern[6]. Potential competition can be either of two types; actual potential competition and perceived potential competition. The merger could result in market deterioration by eliminating a present competitive threat that constraints the behavior of firms. This concern is known as "perceived potential competition" and the economic theory of limit pricing justifies such concerns. Perceive potential competition questions eliminating a competitive restraint. On the other hand, "actual potential competition" concern questions the way the acquiring enters the market. That is, if the acquiring firm could have entered market in a more pro-competitive alternative manner, then the proposed merger is harmful. In this sense, Theorem 5 provides an example when actual potential competition can be harmed. So Theorem 5 provides an economic rationale which can be used to prohibit a conglomerate merger that looks sound in a static point of view, but harmful in a dynamic point of view.

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[6]In U.S. the Department of Justice evaluate such concern in case of non-horizontal merger.

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Appendix

In this appendix, we will show how to find an approximate $\hat{\alpha}$ in Lemma 2. In fact, we will find an upper bound of $\hat{\alpha}$. Suppose that $(B3)$ holds and firm A to choose $p_A = \eta_H q_A$and $p_{AL} = \theta_M q_L + \eta_L q_A + \breve{\alpha}$. And assume that given such prices, profits of the firm A are $\pi_B = (\mu_{HL} + \mu_{HH})(\eta_H q_A - c_A) + \mu_{\cdot M}(\theta_M q_L + \eta_L q_A + \breve{\alpha} - c_A - c_L)$. It is easy to see that if $\breve{\alpha}$ is large, then AL is not attractive to θ_L and θ_H type consumers. In order to calculate the upper bound of $\hat{\alpha}$, we will assume that firm B does not strategically react to firm A's choices, but to set $p_H = \theta_H q_H$ and $p_L = \theta_L q_L$. We will further assume that consumers buy firm A's products when consumers are indifferent.

Since it is not profitable to sell any of product A and AL to either μ_{LL} or μ_{HH}, it suffices to consider the following two cases.

Case 1: $p_{AL} = \theta_L q_L + \eta_H q_A$

Since $\theta_H q_L + \eta_L q_A - (\theta_L q_L + \eta_H q_A) \leq 0$ by (B3), μ_{HL} population does not purchase (AL) product and neither does μ_{LL} population. And the rest of population purchase (AL) products given $p_H = \theta_H q_H$ and $p_L = \theta_L q_L$. Notice that firm B does not behave rationally. Thus the following is the market share of firm A.

θ_H	$\cdot$	AL
θ_M	AL	AL
θ_L	$\cdot$	AL
	η_L	η_H

The profits of firm A under Case 1 pricing strategy is $(\mu_{H\cdot} + \mu_{LM})(\theta_L q_L + \eta_H q_A - c_L - c_A)$. Recall that this profit is the greatest upper bound of profits in case when firm A can take the market share described above. Notice that $(\mu_{HL}+\mu_{HH})(\eta_H q_A - c_A) + \mu_{\cdot M}(\theta_M q_L + \eta_L q_A + \breve{\alpha} - c_A - c_L) \geq (\mu_{H\cdot} + \mu_{LM})(\theta_L q_L + \eta_H q_A - c_L - c_A)$ if $\breve{\alpha} \geq \frac{1}{\mu_{\cdot M}}(\mu_{HM} c_L + \mu_{LM}\theta_L q_L) - (\theta_M q_L - (\eta_H - \eta_L) q_A))$.

Case 2: $p_{AL} = \theta_H q_L + \eta_H q_A$

It is clear that μ_{LL}, μ_{HL} and μ_{LH} agents do not buy (AL) products in this case. And μ_{HH} agents buy (AL) products. Since $\theta_M q_L + \eta_L q_A + \alpha_M - (\theta_H q_L + \eta_H q_A) = (\theta_M - \theta_H) q_L + (\eta_L - \eta_H) q_A + \alpha_M \geq 0$ by (B3), μ_{LM} population buy

(AL) product and so do μ_{HM} population given $p_H = \theta_H q_H$ and $p_L = \theta_L q_L$. Thus the following is the market share of firm A.

θ_H	$\cdot$	AL
θ_M	AL	AL
θ_L	$\cdot$	A
	η_L	η_H

Thus the greatest upper bound of profits in case when the market share is described as above is $\mu_{\cdot M}(\theta_H q_L + \eta_H q_A - c_A - c_L) + \mu_{HL}(\eta_H q_A - c_A) + \mu_{HH}(\theta_H q_L + \eta_H q_A - c_A - c_L)$. Since $(\mu_{HH} + \mu_{HL})(\eta_H q_A - c_A) + \mu_{\cdot M}(\eta_M q_L + \eta_L q_A + \breve{\alpha} - c_A - c_L) - \mu_{\cdot M}(\theta_H q_L + \eta_H q_A - c_A - c_L) - \mu_{HL}(\eta_H q_A - c_A) - \mu_{HH}(\theta_H q_L + \eta_H q_A - c_A - c_L) = \mu_{\cdot M}((\theta_M - \theta_H)q_L + (\eta_L - \eta_H)q_A + \breve{\alpha}) - \mu_{HH}(\theta_H q_L - c_L)$, it is more profitable to set $p_{AL} = \theta_M q_L + \eta_L q_A + \breve{\alpha}$ if $\breve{\alpha} \geq (\theta_H - \theta_M)q_L + (\eta_H - \eta_L)q_A + (\mu_{HH}/\mu_{HM})(\theta_H q_L - c_L)$.

Thus if $\breve{\alpha} \geq Max\{\frac{1}{\mu_{\cdot M}}(\mu_{HM} c_L + \mu_{LM}\theta_L q_L) - (\theta_M q_L - (\eta_H - \eta_L)q_A)), (\theta_H - \theta_M)q_L + (\eta_H - \eta_L)q_A + (\mu_{HH}/\mu_{HM})(\theta_H q_L - c_L)\}$, then firm A will not consider to sell AL to either θ_L or θ_H type consumers. Notice that $\breve{\alpha}$ must be greater than $\hat{\alpha}$ and therefore is finite.