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Competition among Firms in Digital Convergence era*

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ABSTRACT

Digital convergence which means the convergence of industry areas related to digital technologies is an important phenomenon in business, which will decide the fates of firms in the near future. The only firms which can create synergy effects from digital convergence are expected to be the winners in the fierce competition of digital convergence era. In our analysis, we examine the strategy of an integrated firm which has businesses in two different industry areas which are related to each other. By using a game theoretical model, we show how the integrated firm can win over two single separated firms which have business in only one industry area each by leveraging the two businesses the integrated firm has. In our welfare analysis, we also show that this convergence may be even beneficial to consumers, which seems counter-intuitive to social concerns about anti-competitive behaviors by integrated firms. Additionally, we study comparison between industry convergence and product convergence.

Keywords: Digital Convergence, Pricing Strategies, Network Externalities

1. Introduction

"Big Bang! Digital convergence is finally happening -- and that means new opportunities for upstarts and challenges for tech icons"

'Baker and Green in Business week, June 21, 2004'

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CEO of Apple Computer, Steve Jobs, who was ousted from his post, could come back to the company with the success of iPod portable music player and iTunes online music stores. He pointed out the value of iPod and iTunes combined and delivered to customers made big hits. Nowadays, the digital convergence between MP3 (MPEG Audio Layer-3) portable music player and MP3 online music stores such as iPod and iTunes has been claimed to cause the birth of a brand new era.

In fact, in the recent years, rapid developments in information technologies are driving them towards a "Digital Convergence" a unification of the functions, and a combination of the previously distinct digital technologies [12]. There are four categories of digital convergence; digital convergence of information, device, network, and industry. Among these kinds of digital convergence, our study concentrates on digital convergence of industry and focuses on the analysis of separated but digitally related products. In this paper, we analyze the competition in the presence of digital convergence of industry, a phenomenon of the convergence of industry areas which deal with related digital technologies.

In our analysis, we provide a game theoretic model and examine the strategy of an integrated firm which has businesses in two different industry areas which are related to each other. We show how the integrated firm can win over two single firms which have business in only one industry area each by leveraging the two businesses the firm has. The rest of the paper is structured as follows. In Section 2, we briefly review the studies related to our study. Section 3 presents basic modeling framework for a monopolistic model of an integrated firm and two separate firms in two digitally related industry areas. Section 4 describes the optimal strategy of digital convergence, and pricing strategies between the integrated firm and the separate firms are analyzed. Section 5 shows comparison between industry convergence and product convergence. Section 6 concludes with a summary of the managerial implications of our results and a brief discussion of future work.

2. Literature Review

Convergence is an often used but rarely defined concept. Ideas such as the creation of synergies, disappearance of industry boundaries, integration, or overlapping of markets, are all used to describe this phenomenon. Where is convergence occurring and

what effects does this phenomenon have for the industries involved? Convergence has been widely used in management practice in the IT, telecommunication and media industries the last decades. A working definition of convergence can be something like: "merging of hitherto separated markets, removing entry barriers across industry boundaries." The popular illustration of convergence was four circles representing the IT, telecommunication, media and consumer electronic industries moving into each other, creating on big "converging industry."

From the analysis of the multiple dimensions, it is possible to define two basic forms of convergence: convergence in substitutes and convergence in complements. According to Greenstein et al. [7], both products converge in substitutes when customers consider both products to be interchangeable with each other. This form of convergence occurs if different companies develop features of their products that make them similar to certain other products. It also appears, when companies develop standardized bundles of components to perform a certain range of functions, e.g. a company merges a monitor, keyboard, central processing unit, and a telephone to form a complete communication system.

Convergence in complements is the case when both products work better and more efficiently together than separately. It occurs when different companies develop standardized products or systems that interact to form a larger system. In this case, the components perform a combined function which none of them can do alone. The combination of these technologies creates a service that has not existed before. Thus, the output of this system can potentially be larger than the sum of the output of its parts.

In both cases, the products are often unrelated and start to converge in complements or substitutes over time. An example for convergence in complements is the recent large-scale emergence of online-databases. These products unify two formerly distinct technologies: advanced online transaction computing technology and data compression methods for telecommunication [7].

The one of criteria which distinguishes between some generic types of digital convergence is the relationship between the respective markets. According to the relationship, digital convergence can be classified to complementary product convergence and substitutive product convergence [11]. Among them, our model is more similar to the case of complement and our study does not focus on the integration of technologies or products but on the convergence among industry areas (especially in

our study, we explain our results with an example of the convergence between consumer electronics industry and online music contents industry).

Convergence can reduce total surplus, since a monopolistic firm would provide a much higher level of product scope when faced with the same demand and cost of scope; however, the firm would also extract most or all of this higher level of surplus, leaving very little for the consumer [10]. However, we show here that complementary digital convergence among two industry areas is beneficial to consumers.

While convergence can be a source of increased competition if it creates new entry incentives and opportunities in each others' markets, increased concentration may reduce competition if there are significant economies of scope [6]. In theory, the concept of digital convergence has been known for decades. Scientists of various fields have predicted the coming of the digital revolution and have tried to assess its implications on industry and society [5].

However, it was not until a few years ago that digital convergence started to gain practical importance. At that time, large numbers of high-performance digital components were brought onto the market at relatively low costs, which facilitated the rate of adoption of these technologies in a variety of different products [6].

Network externalities have long been considered to be the primary factors that differentiate the "new economy" from the traditional economy [1]. And network externalities and economies of scale are decisive factors for firms' pricing strategy [2]. More importantly, with network effects, an increased market share does not translate into higher profits. Contradictory to conventional wisdom, our results indicate that in a static market, consumers rather than firms benefit from increasing network externalities with competitive effects outweighing the surplus-extraction abilities of firms [4]. Likewise, our model shows that those effects cause consumers to have more benefits than firms.

It shows several possible sources of these positive consumption externalities. The consumption externalities may be generated through a direct physical effect of the number of purchasers on the quality of the product (e.g. Telephone network). There may be indirect effects that give rise to consumption externalities such as trend, brand power, and popularity. In all of these cases, the utility that given consumer derives from the good depends on the number of other consumers who are in the same "network" as is he or she. The scope of the network that gives rise to the consumption externalities will vary across markets [8].

3. The Basic Model

3.1 The Integrated Firm

There is a firm (integrated firm) which produces two products which are related to each other in two different industry areas. The firm sells two kinds of products: a portable music player (e.g. iPod), and downloadable MP3 music files through online pay-sites (e.g. iTunes). From now, for illustration purpose, the two products are assumed to be an MP3 player and an MP3 online pay-site. The music file sold through the online site is a complementary good of the portable music player. The firm charges a price $P_{P|I}$ for portable music player and a price $P_{T|I}$ for the downloadable music file through online payment site. For the firm, when they sell their two products, portable music player and music file, they bear variable cost C_V^P (C_V^T) and fixed cost C_F^P (C_F^T) respectively. Because two products are related to each other closely, each product's demand affects on another product's demand respectively. When the mutual effects are arranged with respect to the price levels of two products, the demand of two products can be represented as equation (1) and (2). We assume that the demand functions are continuous and linear across each price. Thus the demand functions for music player and music file are given by

$$q_{P|I} = k - \alpha P_{P|I} - \gamma P_{T|I} \quad (1)$$

$$q_{T/I} = l - \beta P_{T/I} - \delta P_{P/I} \quad (2)$$

When the price of music player increases, the demand of music player, $q_{P|I}$, decreases by the responsiveness parameter for music player, α. Similarly, when the price of music file increases, the demand decreases by the responsive parameter for music files, γ. These parameters mean the elasticity of the change of demand with respect to that of price levels. Even though the original definition of the elasticity of demand in economics is the percentage of changes in demand with respect to the percentage of changes in price ($\varepsilon = -(\Delta demand / demand)/(\Delta price / price)$), for simplicity of analysis in our study, we defines that the elasticity of demand equals to negative demand variation over price variation ($\varepsilon = -(\Delta demand / \Delta price)$). α is the ratio of the change in demand with respect to that in price of music player. β is the ratio of the

change in demand with respect to that in price of music file. γ is the ratio of the change in demand of music player with respect to that in price of music file, and δ is the ratio of the change in demand of music file with respect to price of music player ($\alpha = \Delta q_{P|I} / \Delta P_{P|I}$, $\gamma = \Delta q_{P|I} / \Delta P_{T|I}$, $\beta = \Delta q_{T|I} / \Delta P_{T|I}$, $\delta = \Delta q_{T|I} / \Delta P_{P|I}$). All responsiveness parameters have its own value between zero and one ($0 < \alpha, \beta, \gamma, \delta < 1$). It is assumed that the responsiveness parameter for music player α is greater than the responsiveness parameter for music file β, and the responsiveness parameter for music player δ is greater than the responsiveness parameter for music file γ because the slope of music player's demand curve is steeper than that of music file's demand curve ($\alpha > \beta, \delta > \gamma$). The reason why the demand of music player is more elastic is that the competition level of MP3 player market is greater than that of MP3 song market when there are many MP3 player manufacturers such as ReignCom, Cowon and Apple while Apple dominates MP3 song market. The high value of parameter means the steeper slope, that is, the demand is more sensitive to the variation of price. The responsiveness parameter for music player α and music file β are greater than the responsiveness parameter for music file γ and for music player δ because α, β affects the demand directly and γ, δ affects the demand indirectly ($\alpha, \beta > \gamma, \delta$). Thus these conditions arranged as $\alpha > \beta > \delta > \gamma$.

The benefit to buyers who purchase a music player and a music file from the integrated firm is affected by price charged for a music player and a music file. So, the demand reduces as price increases ($\partial q_{P|I} / \partial P_{P|I} < 0$, $\partial q_{P|I} / \partial P_{T|I} < 0$, $\partial q_{T|I} / \partial P_{T|I} < 0$, $\partial q_{T|I} / \partial P_{P|I} < 0$). As mentioned above, the direct effect of changes in $P_{P|I}$ ($P_{T|I}$) on $q_{P|I}$ ($q_{T|I}$) is greater than the indirect effect of changes in $P_{T|I}$ ($P_{P|I}$) on $q_{P|I}$ ($q_{T|I}$) ($\partial q_{P|I} / \partial P_{P|I} < \partial q_{P|I} / \partial P_{T|I}$, $\partial q_{T|I} / \partial P_{T|I} < \partial q_{T|I} / \partial P_{P|I}$). We assume that the second order conditions with respect to each price $P_{P|I}$ ($P_{T|I}$) are negative for concavity of music player's and music file's profit functions ($\partial^2 \pi_{P|I} / \partial P_{P|I}^2 < 0$, $\partial^2 \pi_{P|I} / \partial P_{T|I}^2 < 0$, $\partial^2 \pi_{T|I} / \partial P_{T|I}^2 < 0$, $\partial^2 \pi_{T|I} / \partial P_{P|I}^2 < 0$).

The optimal prices can be calculated from the first order conditions. We take the first order conditions of total profit function with respect to each price $P_{P|I}$ ($P_{T|I}$) because the integrated firm sells the digitally converged products. This is different from the separate firms' case where they sell products at price levels which maximize profit from each product of each firm. Unlike the case of the integrated firm, we take the first order conditions of each profit function with respect to each price $P_{P|S}$ ($P_{T|S}$)

because they can not sell their products as digitally converged products.

Taking the first order conditions leads to the following optimal price for music player and music file. Then we can use these prices to determine the optimal profits of the integrated firm for each product respectively.

$$P_{P|I}^{*} = \frac{2k\beta - l(\delta+\gamma) + \{2\alpha\beta - \gamma(\delta+\gamma)\}c_V^P - \beta(\gamma-\delta)c_V^T}{4\alpha\beta - (\gamma+\delta)^2} \tag{3}$$

$$P_{T|I}^{*} = \frac{2l\alpha - k(\delta+\gamma) + \{2\alpha\beta - \delta(\gamma+\delta)\}c_V^T - \alpha(\delta-\gamma)c_V^P}{4\alpha\beta - (\gamma+\delta)^2} \tag{4}$$

Plugging the optimal prices $P_{P|I}^{*}$, $P_{T|I}^{*}$ defined into profit functions results in the optimal profit functions $\pi_{P|I}^{*}$, $\pi_{T|I}^{*}$.

$$\pi_{P|I}^{*} = (P_{P|I}^{*} - c_V^P)(k - \alpha P_{P|I}^{*} - \gamma P_{T|I}^{*}) - c_F^P \tag{5}$$

$$\pi_{T|I}^{*} = (P_{T|I}^{*} - c_V^T)(l - \beta P_{T|I}^{*} - \delta P_{P|I}^{*}) - c_F^T \tag{6}$$

The notation used in the paper is summarized in Table1.

Table 1. Notation

Notation	Description
k	Potential demand of iPod buyers
l	Potential demand of iTunes buyers
α, β	Responsiveness parameter of iPod
γ, δ	Responsiveness parameter of iTunes
$P_{P\|I}$, $P_{P\|S}$	Price of iPod (Integrated, Separate)
$P_{T\|I}$, $P_{T\|S}$	Price of iTunes (Integrated, Separate)
$q_{P\|I}$, $q_{P\|S}$	Quantity of iPod (Integrated, Separate)
$q_{T\|I}$, $q_{T\|S}$	Quantity of iTunes (Integrated, Separate)
$\pi_{P\|I}$, $\pi_{P\|S}$	Profit of iPod (Integrated, Separate)
$\pi_{T\|I}$, $\pi_{T\|S}$	Profit of iTunes (Integrated, Separate)
c_V^P, c_V^T	Variable cost of iPod and iTunes
c_F^P, c_F^T	Fixed cost of iPod and iTunes

3.2 The Separate Firm

Until now, we derive the optimal prices and profits for the integrated firm. From now, we derive the optimal prices and profits for two single firms which sell single product in only industry area each. In order to develop a fair comparison between the integrated firm and the separate firms, we assume that conditions are the same as the integrated firm's.

$$q_{P|S} = k - \alpha P_{P|S} - \gamma P_{T|S} \tag{7}$$

$$q_{T|S} = l - \beta P_{T|S} - \delta P_{P|S} \tag{8}$$

On the contrary to the integrated firm, we take the first order conditions of each profit function with respect to each price $P_{P|S}$, $P_{T|S}$.

$$P^*_{P|S} = \frac{2k\beta - l\gamma + 2\alpha\beta c^P_V - \beta\gamma c^T_V}{4\alpha\beta - \gamma\delta} \tag{9}$$

$$P^*_{T|S} = \frac{2l\alpha - k\delta + 2\alpha\beta c^T_V - \alpha\delta c^P_V}{4\alpha\beta - \gamma\delta} \tag{10}$$

Plugging the optimal prices $P^*_{P|S}$, $P^*_{T|S}$ defined into profit functions results in the optimal profit functions $\pi^*_{P|S}$, $\pi^*_{T|S}$.

$$\pi^*_{P|S} = (P^*_{P|S} - c^P_V)(k - \alpha P^*_{P|S} - \gamma P^*_{T|S}) - c^P_F \tag{11}$$

$$\pi^*_{T|S} = (P^*_{T|S} - c^T_V)(l - \beta P^*_{T|S} - \delta P^*_{P|S}) - c^T_F \tag{12}$$

Next, we examine and compare the pricing strategies of the integrated firm and the separate firms, and surplus levels from those cases.

4. Results and Analysis

4.1 Pricing Strategy

Proposition 1: The optimal unit price of music player for the integrated firm is less

than that for the separate firm while the optimal unit price of music file for the integrated firm is greater than that for the separate firm.

From the results we have got above, we can see that the optimal price of music player for the integrated firm is less than that for the separate firm ($\therefore P^*_{P|I} < P^*_{P|S}$). Meanwhile, the optimal price of music file for the integrated firm is greater than that for the separate firm ($\therefore P^*_{T|I} > P^*_{T|S}$).

In our study which develops the model in static and single period game, the integrated firm adjusts the price of music player lower than that of the separate firm. Then, the firm expects the increasing demand of music players resulting from the lower price. Even though the firm may lose profits from music player part, the increased demand of music players affects the demand of music file positively because the demand of music file increases when the price of music players decreases as in equations (7) and (8). With this increased demand, the integrated firm can increase the price of music file. If so, what would be the levels of the integrated firm's total profits, profit from the sales of music players and music files when compared to those of separated firms? The levels depend on the level of demand and the level of the profit from each product. The proposition related to these comparisons is as follows.

Proposition 2: Even though the profit from music player for the integrated firm is less than that for the separate firm, total profit of the integrated firm is greater than the sum of profits of two separate firms.

From the results we have got, we can see that the integrated firm's profit partly from music player is less than that of the separated firm selling music player ($\therefore \pi^*_{P|I} < \pi^*_{P|S}$). Meanwhile, the integrated firm's profit partly from music file is greater than that of the optimal profit of the separate firm $\pi^*_{T|S}$ ($\therefore \pi^*_{T|I} > \pi^*_{T|S}$). By comparing the sum of profits of two separate firms $(\pi^*_{P|S} + \pi^*_{T|S})$ and the total profit of the integrated firm $(\pi^*_{P|I} + \pi^*_{T|I})$, we find that the total profit of the integrated firm is greater than the sum of profits of two separate firms $((\pi^*_{P|I} + \pi^*_{T|I}) - (\pi^*_{P|S} + \pi^*_{T|S}) > 0)$. These results show that the integrated firm compensates the loss profit of one good by increased profit of another good and gain even more than total profit of the separate firm.

Next, we examine how the digital convergence of the integrated firm's optimal pricing strategies and optimal profits has effect on surpluses.

4.2 Surplus Level

We now compare the surpluses generated by the integrated firm and the two separate firms.

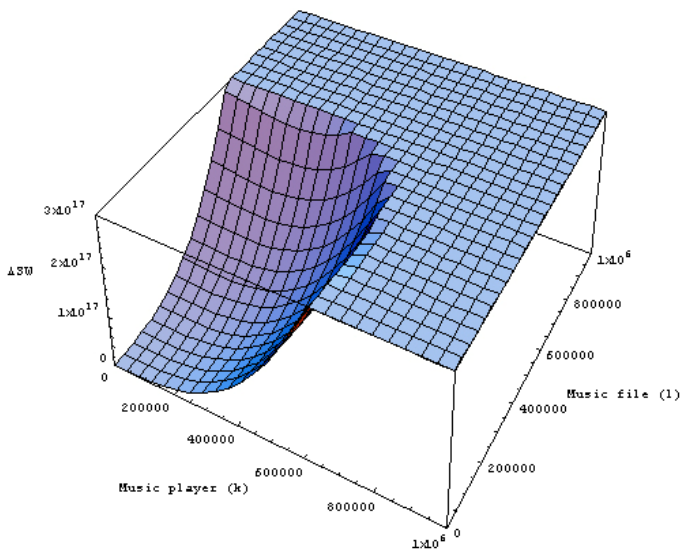
Proposition 3: The total surplus generated by the integrated firm is greater than the sum of surpluses generated by the two separate firms.

Firstly, we compare consumer surplus of the integrated firm and the separate firms. For consumer surplus from buying music player, when we compare consumer surplus from the separate firm selling music player ($CS^*_{P|S}$) and from the integrated firm ($CS^*_{P|I}$), we find that the surplus from the integrated firm is greater ($CS^*_{P|I} - CS^*_{P|S} > 0$). This comparison is intuitive and the result which consumer surplus from buying goods of lower price is beneficial is out of doubt. However, for consumer surplus from buying music file, when we compare consumer surplus from the separate firm selling music files ($CS^*_{T|S}$) and from the integrated firm ($CS^*_{T|I}$), we find that the surplus from the integrated firm is smaller ($CS^*_{T|I} - CS^*_{T|S} < 0$). This implies that consumers who buy only one good with higher price such as music files from the integrated firm may have fewer surpluses compared to consumers who buy the good from the separate firm. We address this result to point out that misfit costs may occur on consumers who do not want both goods provided by the integrated firm in digitally convergent environment.

Social welfare can be expressed as the sum of the surpluses obtained by the profits of the integrated firm and those of the separate firm, and consumer surplus from the integrated firm and those from the separate firm ($SW^*_I = (\pi^*_{P|I} + \pi^*_{T|I}) + (CS^*_{P|I} + CS^*_{T|I})$, $SW^*_S = (\pi^*_{P|S} + \pi^*_{T|S}) + (CS^*_{P|S} + CS^*_{T|S})$).

The comparison of social welfares generated by the integrated firm and separate firms shows that the integrated firm's social welfare is greater than the separate firm's one ($SW^*_I > SW^*_S$). In fact, the difference of total consumer surplus with the integrated firm and with two separated firms is greater than the difference of total prof-

its of the integrated firm and two separated firms. In other words, consumers get more benefits rather than the integrated firm. Moreover, this effect is influenced by network externalities. To explain the effect of network externalities, we show a figure. Figure 1 shows that the difference of total social welfare between the integrated firm and the separate firms. When the levels of potential demands are low, the difference is not noticeable, but as potential demand music player k and music file l increase, the difference in terms of total social welfare increases.



Axis x :	*Potential demand of music player* (k)
Axis y :	*Potential demand of music file* (l)
Axis z :	*Difference of total social welfare*

Figure 1. Difference of Total Social Welfare

Figure 1 shows much more differences between them in the high level of potential demands. For simplicity, we restrict the degree of difference (z axis).

4.3 Industry Convergence vs. Product Convergence: Inefficiency of Product Convergence

In the prior subsections, we analyze pricing strategy of the integrated and separated firms, and compare consumer surpluses in those cases. Moreover, we find that

demand levels of iPod and iTunes affect the demand levels of other sides respectively in industry convergence. If we define the value R is the ratio of iTunes sold and iPod sold, R becomes more than one by the effect of industry convergence ($q_P = Rq_T$, $R > 1$) when more than one songs in iTunes are sold per iPod.

However, in product convergence, the ratio becomes fixed to one because two products are physically combined in one to one ratio. For examples, iPod and iTunes can be converged infinitely by industry convergence, as much as iPod has enough memory. In case of product convergence, however, a cellular phone and a digital camera are converged in one unit at a time. Both a cellular phone and a digital camera here mean each component of the mobile phone which has functions of telecommunications and image processing. When the mutual effects are arranged with respect to the price levels of two products, the demand levels of two products by product convergence can be represented as equation (13) and (14). We assume that the demand functions are continuous and linear across each price. For convenience, we reset potential demands k and l, and responsiveness parameter α, β, γ, δ for products of product convergence. Subscript C and D mean a digital camera and a cellular phone respectively. Thus the demand functions for a cellular phone and a digital camera are given by

$$q_C = k - \alpha P_C - \gamma P_D \tag{13}$$

$$q_D = l - \beta P_D - \delta P_C \tag{14}$$

Unlike the case of industry convergence, we have one more constraint for product convergence. The constraint makes the ratio R one and this means the equivalence of demand levels for two products.

$$q_C = Rq_D \tag{15}$$
$$q_C = q_D, \; if \; R = 1$$

Compared to the optimization problem of industry convergence situation in the prior subsections, the optimization problem of product convergence with one more constraint, equation (15), is expected to produce less profit, surpluses and so on. More discussion about this concern is followed in next section.

5. Business Implications: Industry Convergence vs. Product Convergence

If the number of the product which is digitally converged to another product is one, this can be interpreted as product convergence of two goods by one to one matching such as camera phone. In this case, compared to industry convergence where the number can be internally decided to produce optimal outcomes, product convergence may bring about negative effects. Interestingly, we easily find these cases in industry areas of mobile phone and PDA. During the last two years, super phones which have multiple functions such as digital camera, DMB (Digital Multimedia Broadcasting), MP3P, and Vehicle Navigation were very popular in mobile phone markets in the world. As time goes by, however, mobile phones come to have the more functions, their shape becomes larger and more expensive. In addition, some customers become aware of troubles from its expensive price and inconvenience. Finally, firms such as Motorola started to provide phones with simple functions and cheaper prices as their main products and became successful in mobile phone market. The advent of Motorola's simple phone RAZR was a shock in mobile phone market. RAZR solved consumers suffer from complicate functions and much higher price and hit the jackpot. Another case similar to that of RAZR would be that of Blackberry for mobile e-mail service in U.S. Those two products solved inefficiency of product convergence and they could be a great success in their industry.

Added to that, the product convergence of substitutes having similar functions such as e-mail, Internet access, and schedule management may cannibalize each market's demand. In technical perspective, the mobile phone of the specific function is usually inferior to the function of the product devoted to that function in quality. (e.g. The digital camera function in mobile phone is more expensive and worse than that of digital camera).

As Bakos and Brynjolfsson [4] show, the strategy to bundle functions becomes more inefficient as more and more functions are converged and variable costs to include those functions increases.

So, compared to industry convergence, firms must be more cautious when they consider convergence of products because product convergence cannot be as efficient as industry convergence in terms of combination of different business functions.

6. Discussions and Conclusions

We have examined how a firm should design and develop their products in severely competitive markets in digital convergence era. We show how the prices of digitally converged products of the integrated firms are different from those of the separated firms. Additionally, our theoretical analyses show the effect of the digital convergence on the integrated firm's optimal pricing strategies, optimal profits and customer surplus. Even though we have focused on the analysis of online music songs and MP3 player markets in our draft, we believe that our results can be applied in any industry areas where markets of products are interrelated in terms of market demands.

Our results show that customers who purchase digitally converged products from the integrated firm which provide products in multiple product markets have more total surplus than customers who purchase the products from the separate firms. However, we also show that the surplus by buying one product from the integrated firm may be less than that by buying one product from the separated firm. Even though, in total surpluses, the customers who buy digitally converged products from the integrated firm have more surpluses, the surplus of the customers who buy only one of the products whose price by the integrated firm is higher than the price by the separated firm may be less. Likewise, the integrated firm itself may gain positive profit from only some part of products even though the total profits from the whole markets would be greater than the sum of profits of separate firms.

We find that consumers rather than firms benefit from digitally converged products with increasing network externalities. This finding also corresponds with that of Viswanathan [13]. In the comparison of the difference of firms' profits and the difference of consumer surpluses, the difference of consumer surpluses is greater than the difference of profits. That is, the network externalities with digital convergence have more positive effects on consumer surplus than firms' profits.

Because, for simplicity of analysis, our model assumes a monopolistic market to focus on the comparison of pricing strategies of the integrated firm and the separated firms, the generalizability of our results may be limited to be applied to firms in competition. Our further study may consider competition among firms and further empirical validation of our analytical results.

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