Impact of Unbundling on Digital Information Goods Market: A Case of Music Industry

Completed Research Paper

1. Introduction

For the first time since 2003, the sales of music albums increased by 3.6% during the first half of 2011 (Nielsen SoundScan 2011). This trend reversal was significant in the backdrop of steady decline of more than 30% sales of albums from the peak in early 2000s (RIAA 2011). The “rise of the digital technologies” marked the watershed of the traditional music market which was dominated by major record label companies (Hracs 2011). Music labels were vertically integrated and as they owned intellectual property rights over the content, they assumed monopolist power in producing, marketing and promoting recorded music (Cooper 2011), and preferred sales of albums over singles (individual song track) because of economic and strategic (IFPI 2004). Major record label companies have welcomed technological inventions like vinyl, magnetic tapes and CDs which significantly reduced production and distribution costs in the past (McLeod 2005), and it is surprising as why they were slow and often reluctant to adopt digital technology (Fisher 2000; Knopper 2009; Sisario 2011). This reluctance on part of the music industry is even more puzzling given the recommendation of academic literature that mixed bundling is optimal strategy when valuations are not perfectly positively correlated (Stigler 1963; Adams & Yellen 1976; Armstrong 1999; Bakos & Brynjolfsson 1999). Digital technologies only reduce distribution cost of mixed bundles and thus music industry should have welcomed the arrival of these technologies very early on in late 1990s. We unravel this puzzle in this paper by developing an analytical model to study the impact of technology mediated “unbundling” on the revenue of a monopolist firm that has traditionally adopted pure bundling strategy for experience goods whose ex-ante consumer valuation is uncertain. We also examine the claim of music industry represented by RIAA that decline in music sales are due to increased illegal sharing of music on the Internet and study the impact on music labels revenue when they do not adjust their product-pricing strategy to emergence of digital distribution channel.

As the world embraces the information super-highways and content is increasingly digitized, the music industry is forced to face the challenges brought by new technologies and evolution of consumer preferences. MP3 as one of many digital compression standards which reduced the size of music track to tenth of the original size and made it possible to download music files from the Internet. The emergence of the inexpensive fast broadband connections reduced the downloading time and personal portable music players, i.e. iPod, further drove the demand for digital music. Many internet music sharing or downloading sites emerged between 2000 and 2003. Among them, Napster and IRC drew a lot of attentions and debates from both music industry and academics. In 2003, it was estimated that 2.3 billion songs were downloaded across these file sharing networks every month (Leyshon 2009). Since then sale of digital music had grown at fast pace and has taken the place of physical CDs as dominant distribution channel in 2006. In total, 660 million units of digital tracks were sold compared to 155.5 million units of CD albums in the first six month of 2011(Nielsen SoundScan 2011).

The record label companies were aware of the challenges posed by the emergence of digital music. However, they were caught up with the legal wars with illegal music sharing network and other technical hurdles; they failed to establish legal alternatives to meet the consumer demand for high quality digital music. This left opportunities for new players to enter this new market of digital music. Apple launched the iTunes store which sold music tracks at a flat 99 cents to promote the sales of their more expensive proprietary hardware iPod. Till Feb 2010, iTunes has sold over 10 billion songs (Luttrell 2010) and has emerged as the largest music retailer in the music industry. In the recent past, record label companies had started taking digital music distribution channels seriously. BMG formed alliance with Napster and Sony started its own music downloading web portal “Connect”. This suggests that the record label companies are vertically integrating the digital music distribution in an attempt to regain the control lost to other online music download sites like iTunes in the past.
Digital technologies have given rise to a new trend towards unbundling in many information goods industries (Elberse 2010). While unbundling is widely believed to be beneficial to the consumers in music industry, its impact on producers is not clear as some argue that cherry-picking by consumers may lead to sales decline and others contend that higher song sales will more than compensate for lost album sales (Leeds 2006; Smith & Wingfield 2008). We inform this debate through an analytical model, wherein a music album is a bundle and song tracks are individual components. We incorporate the experience goods nature of music by positing that it is not possible to identify the “hit” song a-priori as consumers reveal their valuation only after consumption as “some product information is bundled with the product itself (Chellappa & Shivendu, 2005). Further this setting leads to an exogenous condition that components have to be sold at the same price and allows us to study the impact of the digital music channel on the market structure of the music industry by analyzing the record labels product and price strategy before and after the emergence of digital music distribution. Our analytical analysis addresses the following three research questions: (1) why did record labels choose selling albums only? (2) what is the impact on the revenue of music label company due to unbundling of albums? (3) what are the consequences if record label does not adjust its strategy in the face of the challenges posted by the emergence of digital music channels?

In this paper, we study the optimality of mixed bundling, pure bundling strategy and component strategy with the constraint of single component price. Our contributions to the existing literature on bundling are twofold. We relax the assumptions on the symmetrical distribution of valuations of the components. Based on a simple analysis of two components which have different distribution of consumer valuation, our results on the condition of a optimal product strategy are driven by the relative valuation of the less valued component compared to the more valued component. This perfectly fits the property of music tracks in an album where some tracks are more popular than others. Second, we relax the monopolist assumption by introducing a new entrant firm who provides only components to compete with the incumbent firm which provides bundles. We study and compare different settings which mirror the market structures before and after the emergence of digital music distribution channel and compare the pricing and outcomes of the equilibrium for the components and the bundle. Our contribution to information goods literature in general and music industry in particular are threefold. First, we offer an economic explanation as to why the record label companies were reluctant to adopting to digital music distribution channels. Second, we show that the pure bundling strategy is dominant under some conditions on consumer valuations for components. Based on our analysis we call for re-examination of music industry claim that on-line piracy is the main culprit in declining sales, and propose that unbundling leads to decline in revenue even if there is no piracy.

In section 2 we provide literature review and then outline the basic model in section 3. In section 4, we study the component and pricing strategy of the record label companies. In section 5, we model the music industry after the appearance of digital music sites as a competitive market where the record label companies and digital music sites are competitors, and study the impact on music label company when they do not adjust bundle price in the presence of another firm selling components. In section 6, we discuss the theoretical and managerial implications of our results.

2. Literature Review

Bundling has been widely studied from economics, marketing and strategy perspectives since Stigler (1963) made his observation that bundling can increase sellers’ profits when consumers’ reservation prices for two goods are negatively correlated. Adam and Yellen (1976) are credited with providing a fundamental framework to study bundling from the perspective of economics and marketing. In their seminal work, they suggested a two-dimensional graphical interpretation to study the effect of bundling as a price discrimination tool. They classified three types of product strategy: component, pure bundling, and mixed bundling. Many studies that followed focused on the properties of components under an optimal bundle strategy from a product line perspective (Schmalensee 1982; Dansby & Conrad 1984; Schmalensee 1984).

Bundling may be beneficial for both the customer and the firm. (Basu & Vitharana 2009). The consumers benefit from reduced search cost (Harris & Blair 2006), and the firms gain from higher profit by reducing
the variance in consumer willingness to pay in a monopolist environment (Bakos & Brynjolfsson 1999, 2000; Fang & Norman 2006) and in a competitive market (Stole 2003; Nalebuff 2004; Crawford 2007; Bitran & Ferrer 2007).

Another stream of research focuses on whether a firm should adopt a pure component, pure bundling or mixed bundling strategy. Schmalensee (1984) deploys a Gaussian symmetric case and posits that mixed bundling can make use of advantages of a component strategy and a pure bundling strategy by selling the bundle to a group of buyers with reduced effective heterogeneity, while charging high markups to those on the fringes of the taste distribution who are mainly interested in only one of the two components. Thus, a mixed bundling strategy dominates. Venkatesh & Mahajan (1993) show that mixed bundling can be more profitable than pure component or pure bundling strategies by conducting an empirical study of a series of music/dance performance. Basu & Vitharana (2009) incorporate different levels of knowledge of component products among consumers and show that marginal costs of components, distribution of consumer knowledge of components and sizes of each consumer segment determine the optimality of the three strategies.

Bockstedt et al. (2006) provides a theoretical ground to study the impact of the digital music distribution channel on music industry. By outlining a series of propositions, they argued that the impact of digital distribution is profound in terms of the changing role of each player in the market and the shift of power from the record label companies to distributors, artists and consumers. Hracs et al. (2011) also provided an in-depth descriptive account of the transition in music industry brought about by the new forms of digital music distribution channels.

There is a growing literature that studies the impact of unbundling on firms’ profits and consumer surplus. Wilson, Weiss & John (1990) find that growth in market size due to unbundling is a crucial determinant of mixed bundling strategy. Venkatesh & Chatterjee (2006) show that offering online products in addition to offline products is beneficial to seller when the market strongly prefers offline product. Elberse (2010) shows through an empirical study that revenues decrease significantly as digital downloading becomes more prevalent.

3. Model

We consider a monopolist firm who owns two experience goods $X$ and $Y$. The monopolist firm has three product strategies: Sell $X$ and $Y$ separately (Pure component strategy), or bundle $X$ and $Y$ to create a bundle good $B$ and sell bundle only (Pure bundling strategy), or sell $X$ and $Y$ separately and also sell bundle $B$ (Mixed bundling strategy). All cost in acquiring ownership over these two experience goods is sunk, distribution cost is negligible, cost of bundling experience goods is zero, and marginal cost of serving additional consumer is zero. Monopolist firm’s objective is to maximize revenue. We assume that a consumer would purchase at most one unit of each experience good or the bundle.

We assume that consumers have heterogeneous valuation for the two components. Without loss of generality, consumer valuation for a component $i$ is denoted by $v_i$ and it is uniformly distributed over $[0, V_i]$, where $V_i$ represents the highest consumer valuation for the component $i$ among all consumers in the market. We also assume that components are of different consumer valuations. The consumer valuation for the component $X$ is uniformly distributed over $[0, V_X]$, while the consumer valuation for the component $Y$ is uniformly distributed over $[0, V_Y]$ and $V_X \neq V_Y$. Consumer surplus from purchasing the component $i$ is defined as her expected valuation for the product minus price, and is given by:

$$S(v_i, p_i) = v_i - p_i,$$

where $v_i \sim U[0, V_i]$ and $i \in \{X, Y\}$.

Without loss of generality, we assume that (i) the highest consumer valuation for the component $Y$ to be 1, i.e., $V_Y = 1$, (ii) the highest valuation of component $Y$ is higher than the highest valuation of component $X$, i.e., $0 < V_X < 1$, (iii) consumer valuation for each experience good is independent, and (iv) bundle valuation is sum of valuations of each experience good (Adam & Yellen 1976; Schmalensee 1984).

The consumer surplus from purchasing the bundle of the two experience goods $X$ and $Y$ is:
\[ S(v_X, v_Y, p_B) = v_X + v_Y - p_B, \text{ where } v_Y \sim U[0,1] \text{ and } v_X \sim U[0, V_X]. \]

We extend the classical bundling literature (Schmalensee 1982; 1984) and focus only on revenue in our study as our context is one of experience goods. If the firm adopts pure component strategy by selling experience goods separately at the prices \( p_X \) and \( p_Y \), a consumer who gets non-negative surplus from purchasing individual experience good participates in the market. The revenue function of the firm under component strategy is:

\[ R_C(p_X, p_Y) = D_X(p_X)p_X + D_Y(p_Y)p_Y, \text{ where } D_X(p_X) = \frac{V_X - p_X}{V_X} \text{ and } D_Y(p_Y) = 1 - p_Y. \]

If the firm adopts a pure bundling strategy and sells the bundle \( B \) of \( X \) and \( Y \) at the price \( p_B \), a consumer who gets non-negative surplus from purchasing the bundle participates. The revenue function of the firm under pure bundling strategy is:

\[ R_B(p_B) = D_B(p_B)p_B, \text{ where } D_B(p_B) = \begin{cases} \frac{V_X - p_B^2}{2} & \text{if } p_B \leq V_X, \\ \frac{(2 - 2p_B + V_X)/2} & \text{if } p_B > V_X \end{cases} \]

Similarly, if the firm adopts a mixed bundling strategy by selling the bundle at the price \( p_{MB} \), and individual experience goods at the prices \( p_{MX} \) and \( p_{MY} \), a consumer purchases the individual experience good or the bundle whichever yields maximum non-negative surplus. The revenue function for a mixed bundling strategy is:

\[ R_M(p_{MX}, p_{MY}, p_{MB}) = D_Xp_{MX} + D_Yp_{MY} + D_Bp_{MB}. \]

The firm only knows the distribution of consumer valuations, and does not know as which individual experience good has higher consumer valuation. In order words, the firm knows that the consumer valuations are uniformly distributed over \([0,1]\) and \([0,V_X]\) for the two experience goods, but does not know which experience good is \( X \) and which one is \( Y \). Only after consumption of experience goods the consumer valuations are revealed and ex-post firm knows which experience good has higher valuation. Ex-ante firm does not know which experience good has higher valuation and therefore works under the setting where same price is set for both experience goods under pure component strategy and mixed bundling product strategy. This implies that prices for individual experience goods \( X \) and \( Y \) are the same, i.e. \( p_X = p_Y = p_C \), under pure component as well as under mixed bundling strategy.

Our model abstracts music industry wherein a music album is like a bundle consisting of multiple song tracks which could also be sold individually as singles. Consumers are heterogeneous in their valuation of individual music tracks and \( a-priori \) it is not known as which song track will be a hit and which will be a flop. A consumer knows that she is going to like some song tracks but not all music tracks in an album, but cannot figure out which tracks she likes before buying album/individual track and consuming it. Thus the firm knows that some tracks are like experience good \( Y \) that will have higher consumer valuations and some tracks are like experience good \( X \) with relatively low valuation. Experience good \( Y \) is like \( a-priori \ unknown \) hit song. Further, our abstraction fits well with the music industry practice of setting prices for individual songs in a very narrow band.

4. Firm’s Bundling Strategy

The monopolist experience good provider firm has three product strategies as stated in §3, a component strategy, a pure bundling strategy and a mixed bundling strategy. We will discuss the outcomes of each strategy in the following sub-sections.

4.1 Component Strategy

The firm sells the two components \( X \) and \( Y \) at a single component price \( p_C \), since the valuations of component \( X \) and \( Y \) are unknown \( ex \ ante \) in the context of experience goods. A consumer buys one component, \( X \) or \( Y \) when she has non-negative surplus from consuming the component. She does not
buy any component when no component yields non-negative surplus. The modified revenue function under a pure component strategy is:

\[ R_c(p_c) = (D_X(p_c) + D_Y(p_c))p_c, \]
where \( D_X(p_c) = \frac{V_X - p_c}{V_X} \) and \( D_Y(p_c) = 1 - p_c. \)

**Lemma 1:** When the components are sold at a single component price, the optimal pure component strategy for the monopolist firm is: when \( 0 < V_X \leq \frac{1}{3} \), the optimal component price is \( \frac{1}{2} \) and the optimal revenue is \( \frac{1}{4} \); when \( \frac{1}{3} < V_X < 1 \), the optimal component price is \( \frac{V_X}{1 + V_X} \) and the optimal profit is \( \frac{V_X}{1 + V_X} \).

When experience good \( X \) and \( Y \) are sold at the same price, then the firm’s decision on price depends on the heterogeneity in consumer valuation of the two components as shown in Figure 1. When the relative valuation of one component is very small compared to other component, i.e., \( 0 < V_X \leq \frac{1}{3} \), then firms sets the price taking into consideration only the high value component and shuts down the low value component. As the valuation of the other component in comparison to the high valued component increases beyond critical level \( (V_X \geq \frac{1}{3}) \), firms reduces the price of component \( p_c \) to tradeoff gain of some revenue from low value component and loss of revenue from high value component due to price reduction. Thus when \( \frac{1}{3} < V_X < 1 \), the firm has incentive to lower the component price so that the joint revenue from for both components is maximized.

![Figure 1: Optimal component price under pure bundling strategy](image)

**Proposition 1:** When the components are sold at a single price and the two components are of very different valuation, the monopolist provider shuts down the component with the lower valuation. As the low valued components valuation increases beyond a critical level, firm reduces the price of components.

When the component \( X \) and \( Y \) have very different valuation, i.e. \( 0 < V_X < \frac{1}{3} \), the firm’s optimal component price is the same price that it sets for the component of higher value if the two components were to be sold at different prices. This optimal component price is higher than the maximum valuation for the component \( X \) (\( p_c^* > V_X \)) which implies that the provider shuts down the component \( X \) and sells the component \( Y \) only. The economic intuition for this result is that by decreasing the price of
component, the firm is not able to recover the loss due to the decrease in the price of Y with the gain in the sales of the component X because valuation of component X is too small. The provider should maximize the revenue generated from the component Y only. We refer to this case as a partial pure component strategy.

### 4.2 Pure Bundling Strategy

The firm adopts a pure bundling strategy of bundling the two components and sells only the bundle. The exogenous constraint of selling both the components at the same price has no impact on the pricing strategy under pure bundling. The revenue function under this product strategy is:

$$ R_B(p_B) = D_B(p_B)p_B $$

where

$$ D_B(p_B) = p_B \left( V_X - \frac{p_X^2}{2} \right) / V_Y \text{ for } p_X \leq V_Y, \quad p_B \left( \frac{2 - 2p_X + V_Y}{2} \right) \text{ for } p_B > V_Y $$

The demand for the bundle is driven by consumers whose surplus of consuming the bundle is non-negative. That implies that the participating consumers should have total valuation for both components X and Y, \( v_X + v_Y \), not less than the bundle price \( p_B \), i.e., a consumer buys bundle if \( v_X + v_Y \geq p_B \).

**LEMMA 2:** The optimal pure bundling strategy is (i) when \( \frac{2}{3} < V_X < 1 \), the firm sets the optimal bundle price as \( \sqrt{\frac{2V_X}{3}} \) and gets optimal revenue as \( \frac{2}{3} \sqrt{\frac{2V_X}{3}} \); and (ii) when \( 0 < V_X \leq \frac{2}{3} \), the firm sets the optimal bundle price at \( \frac{2 + V_X}{4} \) and gets optimal revenue as \( \frac{1}{16}(2 + V_X)^2 \).

When \( 0 < V_X \leq \frac{2}{3} \), the line representing the optimal bundle price is always above the 45 degree line as in Figure 2. It implies that when the consumer valuation of the component of lower value X is relatively low compared to the consumer valuation of the component Y, the firm sets the bundle price greater than the maximum valuation of the component X, i.e. \( p_B^* > V_X \). Some consumers who have extremely high valuation for the component X but relatively very low valuation for the component Y may get negative surplus by consuming the bundle and therefore, do not purchase the bundle. It implies that the firm sells the bundle only to those consumers who have relatively high valuation for the component Y too. It is intuitive to see that the firm sets a higher bundle price as consumers value the component Y more than the component X. When \( \frac{2}{3} < V_X < 1 \), the firm sets the component price lower than the maximum valuation of the component X, i.e. \( p_{MB}^* \leq V_X \).
PROPOSITION 2: When the experience good component $X$ and $Y$ are sold at the same price, then firm's revenue is always higher under pure bundling strategy compared to pure component strategy. The optimal bundle price under pure bundling strategy is always lower than twice the optimal component price under pure component strategy, i.e. $p_B^* < 2p_C^*$, when the components are sold at the same price. It implies that under pure bundling strategy, the firm is better off by selling the bundle at a discounted price.

In Figure 3, we can see that the provider gets higher revenue by adopting the bundling strategy than the component strategy, i.e. $R_B^* > R_C^*$. Note that revenue under pure component strategy remains flat if highest valuation of low valued component is less than the critical value of $\frac{1}{3}$ as the firm shuts down the low value component. This result is similar to standard bundling literature findings and is not impacted by exogenous constraint of selling two experience goods components of different valuations at the same price.

4.3 Mixed Bundling Strategy

The monopolist experience good firm can adopt a mixed bundling strategy of selling both the components $X$ and $Y$, and the bundle $B$. In the context of experience goods, the firm sets the same price for components $X$ and $Y$. The market demand is illustrated in Figure 4, wherein the demand for the bundle is by the Area $B$, the demand for the component $X$ and $Y$ is Area $X$ and Area $Y$ respectively. Note that as the component price decreases, demand for components increases and demand for bundle decreases. Similarly, as the price of bundle decreases, demand for component decreases and demand for bundle increases.
Figure 4: Market demand of a mixed bundling strategy with a single component price

Under mixed bundling strategy, the firm’s revenue maximization problem is:

\[
\max_{p_{MC}, p_{MB}} R_M, \text{ where } R_M = (D_{MX} + D_{MY}) p_{MC} + D_{MB} p_{MB}, \text{ and }
\]

\[
D_{MX} = \frac{(V_X - p_{MC})(p_{MB} - p_{MC})}{V_X},
\]

\[
D_{MY} = \frac{(1 - p_{MC})(p_{MB} - p_{MC})}{V_X},
\]

\[
D_{MB} = \frac{(V_X - p_{MC})(1 - p_{MC}) + (V_X + 1 - 2p_{MC})(2p_{MC} - p_{MB}) + (2p_{MC} - p_{MB})^2/2}{V_X}.
\]

**Lemma 3:** The optimal mixed bundling strategy when components have same price is: (i) when \(0.57 < V_X < 1\), the firm sets the optimal prices for the components at \(\frac{1 + V_X}{3}\) and for the bundle at \(\frac{1}{3}(2V_X + 2 - \sqrt{2\sqrt{4(1 + V_X(V_X - 1))}})\), and optimal revenue is \(\frac{1}{27V_X}(2\sqrt{2\sqrt{1 + (V_X - 1)V_X}} + V_X(9 - 2\sqrt{2\sqrt{1 + (V_X - 1)V_X}} + V_X(9 - 3V_X + 2\sqrt{2\sqrt{1 + (V_X - 1)V_X}}) - 3))\); (ii) when \(0 < V_X \leq 0.57\), the firm sets the optimal bundle price and the optimal component price at \(\frac{2 + V_X}{4}\), and optimal revenue is \(\frac{1}{16}(2 + V_X)^2\).

Note that when highest valuation of low value component is less than a critical value \(0 < V_X \leq 0.57\), the firm set the same price for the component and the bundle. This surprising result is driven by the fact that by lowering the component price firm gains some revenue from those who now buy the component, but loses more revenue from cannibalization of bundle sales by component sales. Note that when component price and bundle price is the same no consumer buys component. When the valuation of low value component is relatively closer to the valuation of the higher value component, then firm sets higher price for the bundle and some consumers buy only the component.

Now we can compare the optimal revenues of a pure bundling strategy and a mixed bundling strategy in Figure 5. Note that pure bundling revenue dominates pure component strategy revenue as in Proposition 2. We can see that the line of the optimal revenue of mixed bundling strategy dominates the line of the
optimal revenue of pure bundling strategy if the components are of relatively similar values, i.e.
\[0.57 < V_X < 1\]. And when the two components X and Y are of different values, i.e. \[0 < V_X \leq 0.57\], the
lines representing the optimal revenues of a pure bundling strategy and a mixed bundling strategy
converge, wherein bundle and component prices are same.

![Figure 5: Comparison of revenues of a pure bundling strategy and a mixed bundling strategy](image)

**PROPOSITION 5:** When the firm sells the components at the same, the firm implements a pure
bundling strategy when the components have very heterogeneous valuations.

When the two components are of very different valuations, i.e. \[0 < V_X \leq 0.57\], the firm’s optimal strategy
is to sell the bundle and individual components at the same price. This implies that no consumer buys
individual component and components are shut down. Firm sells only the bundle as consumers strictly
prefer the bundle over the components at the same price. This is as good as pure bundling strategy. The
economic intuition for this surprising result is as follows. Since the component X is of very low value
compared to the component Y, the firm does not have incentive to serve consumers who have relatively
high value for the component X but low value for the component Y. It gives some insight as to why the
record label companies tend to push the sales of the albums when there is large variation in the valuation
of music tracks in the albums.

5. **Unbundling and emergence of competing distribution channel**

Our results from §4 show that a monopolist firm would adopt a pure bundling strategy when the
components are very different in valuation and the components are sold at a single component price in
the context of experience goods. Music is a type of experience good and consumers have heterogeneous
valuation for music. Thus, we can link our analytical recommendation to the music industry where a
record label company is monopolist experienced goods provider. Each music album is a bundle and each
music track is a component. A translation of the results from §4 in the context of music industry is that
since music is experience good and the valuation of each song track is *a priori* unknown, it is optimal
strategy for the record labels to sell only albums when individual music tracks are of very different
valuations.

The basic model that we had discussed in §3 and §4 allows us to examine the optimality of a pure
bundling strategy of selling albums only by the record labels in the music industry before the emergence
of the digital music distribution channel. We see a growing sale of digital music by the digital music
distributors, i.e. Apple and Amazon, since 2003. Sale of digital music surpassed the sale of physical music
for the first time in 2012 (Segall 2012). In this section, we enhance our basic model to deal with a duopoly
competitive market which includes one existing firm who is the record label company (monopolist in §4 )
and the other firm who is a new entrant who sells individual digital tracks (like iTunes) to capture the
market dynamics in the music industry after the emergence of the digital music distribution channel.
Extending the result from §4, it is optimal for the existing firm to sell the bundle only in the monopolist environment. First, we consider the case where the incumbent firm ignores the threat from the new entrant firm and does not adjust its pure bundling strategy pricing. The new entrant firm observes the outcome of the market, and decides to unbundle and sell the components in the market. The entrant firm faces the same difficulty of correctly determining the valuation of each component ex-ante in the context of experience goods, and therefore, the entrant firm sells each component at a single component price. Both firms are revenue maximizing.

The existing firm continues selling the bundle at the price that it had set under a monopolist pure bundle strategy. The bundle price schedule is:

\[ p^*_B = \begin{cases} \sqrt{2V_X}, & \text{if } \frac{2}{3} < V_X < 1 \\ \frac{1}{4} (V_X + 2), & \text{if } 0 < V_X \leq \frac{2}{3} \end{cases} \]

The new entrant firm observes the bundle price and sets the optimal component price to maximize revenue. The revenue maximizing problem for the entrant firm who sells components at a single price, \( p^*_C \), is:

\[
\max_{p^*_C} R^N_C(p^*_C, p^*_B) \text{, where } R^N_C = \frac{(V_X + 1 - 2p^*_C)(p^*_B - p^*_C)p^*_C}{V_X}.
\]

**Lemma 4:** When the existing firm sells the bundle only and does not adjust its pricing strategy in response to the emergence of the new entrant firm who sells the component at a single component price, the optimal strategy for the entrant firm is: (i) when \( \frac{2}{3} < V_X < 1 \), the optimal component price is \( \frac{1}{18} (3 + 2\sqrt{6V_X} + 3V_X - \sqrt{9 - 6\sqrt{6V_X} + 42V_X - 6\sqrt{6V_X^{3/2} + 9V_X^2}}) \); (ii) when \( \frac{18}{47} < V_X \leq \frac{2}{3} \), the optimal component price is \( \frac{1}{12} (4 + 3V_X + \sqrt{4 + 3V_X(2 + V_X)}) \); (iii) when \( 0 < V_X \leq \frac{18}{47} \), the optimal component price is \( \frac{1}{4} (2 - 3V_X) \).

The revenue and the market coverage of the existing firm and the entrant firm are given in the Appendix.

![Figure 6: Comparison of revenues of a monopolist pure bundling strategy, revenues of the existing and the insurgent firms and the total industry revenue](image-url)
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PROPOSITION 7: When the components are of very different valuations and the components are sold at a single component price, the revenue and the market coverage of the existing firm who sells the bundle only drops significantly in the competitive market compared to the monopolist market. And the total industry revenue is lower in the competitive market than in the monopolist market.

When the valuation of the component $X$ is very different from the component $Y$, i.e., $\frac{2}{7} < V_X \leq \frac{18}{47}$, the component provider will set the price of the components in such a way that the consumers who would have bought the bundle buy the component $Y$ since the component price is low compared to the bundle price. It forces the revenue of the existing firm who sells the bundle to zero. When $0 < V_X \leq \frac{2}{7}$, the component price is higher than the maximum valuation of the component $X$, which implies that the new entrant firm also chooses to shut down the component $X$ when the components are of very different values, just like the monopolist firm under a pure component and a mixed bundling strategy.

In general, the total market revenue of the two firms is lower than the revenue of the monopolist firm under pure bundling strategy (Figure 6). One reason for this reduction in joint revenue is competitive pressure on component prices wherein the entrant firm engages in one way price competition. The other reason for lower joint revenue is that some consumers who would purchase the bundle in the market where only the bundle is available, buy only the component that they value the most in a market where the components are available. Since a bundle is more expensive than a component, the overall industry revenue drops.

We also find that the total market coverage is higher in a competitive market where the components and the bundle are available than a monopoly market where only the bundles are available (Figure 7). Some consumers who do not participate in a monopoly market due to availability of bundle only, buy component(s) in a competitive market because the entrant firm offers a competitive component price which is lower compared to the bundle price. Other consumers who have very high valuation for one component than the other and find the bundle not appealing buy the component which they value more.

To summarize, the existing monopoly firm who does not adjust its bundle price in response to new entrant, loses significant market demand and revenue due to the emergence of the entrant firm who sells components. The consumers benefit from the lower prices and more consumers participate in the market which may lead to a higher social welfare on the expense of the existing monopoly firm. It is also consistent with the market dynamic in the music industry where record labels who were the monopoly have been losing revenue of albums, the digital distribution channels who came to the market had become the dominant power in the market, and consumers have gained since the emergence of the digital music distribution channel.

6. Conclusion

In this paper, we have discussed the optimality of three product strategies, a pure component strategy, a pure bundling strategy and a mixed bundling strategy with the constraint of selling components in a single price in the context of experience goods. We show that it is optimal for the firm to adopt a pure
bundling strategy when the components are of different values and are sold at a single component price. It contrasts with the classical literature (Schmalensee 1984) which recommends that a mixed bundling strategy dominates a pure bundling strategy. Moreover, we link this result to the music industry and offer an explanation to why record label companies prefer albums over singles even after the emergence of digital technologies lowering the distribution cost of singles.

We enhanced our model to capture the effect of the emergence of an entrant firm who sells components at a competitive price to consumers while the existing monopoly firm does not adjust the bundle price. The market outcomes are 1) the existing monopoly firm loses market demand and revenue at a significant scale, 2) the entrant firm gains market demand that was served by the monopoly firm and new demand due to a lower component price and availability of the components, and 3) consumers benefit on the expense of the existing monopoly firm. It mirrors the market dynamic of the music industry after the emergence of the digital music distribution channel while the record labels did not adjust their bundle strategy. Our analytical findings find support in a recent empirical work relating to unbundling in music industry (Elberse 2010)

Based on the results, we would attribute the record labels’ loss of revenue in the last decade to some extent to the emergence of the digital music distribution channel which offers consumers individual music tracks at a competitive price. Record labels have been blaming piracy as the cause for the decline of revenue in the music industry, and this research calls for revisiting their claims through empirical estimations. Future studies may separate the part of the revenue loss due to the unbundling effect from that which may be due to illegal music sharing on the Internet. Since our results show that consumers benefit from the availability of music tracks at a competitive price, it may be worthwhile to investigate the impact of unbundling on social welfare in future research.

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Appendix

Mathematical Proof/Summary:

Proof of Lemma 1:

Solve \( \frac{V_X}{V_X + 1} = 1 / 4 \), and we get \( V_X < 1 / 3 \), which is the boundary for \( V_X \) for an optimal pure component strategy:

\[
\begin{align*}
    p_C^* &= 1 / 2, R_C^* = 1 / 4, & \text{if } 0 < V_X \leq \frac{1}{3} \\
    p_C^* &= \frac{V_X}{V_X + 1}, R_C^* = \frac{V_X}{V_X + 1}, & \text{if } \frac{1}{3} < V_X < 1
\end{align*}
\]

Proof of Lemma 2:

Solve \( \frac{2V_X}{3} = \frac{(V_X + 2)^2}{16} \), and we get \( V_X < 2 / 3 \), which is the boundary for \( V_X \) for an optimal pure bundling strategy:

\[
\begin{align*}
    p_B^* &= \frac{\sqrt{2V_X}}{3}, & \text{if } 0 < V_X < \frac{2}{3} \\
    R_B^* &= \frac{2}{3} \sqrt{\frac{2V_X}{3}}, & \text{if } \frac{2}{3} < V_X < 1 \\
    p_B^* &= \frac{1}{4} (V_X + 2), & \text{if } 0 < V_X \leq \frac{2}{3}
\end{align*}
\]

Proof of Lemma 3:

Solve \( \frac{1}{27V_X} \left( V_X (9 - 2\sqrt{2V_X - 1}V_X - 3 + \sqrt{8V_X^2(1 - V_X^2)} + V_X (9 - 3V_X + 2\sqrt{2V_X^2(1 - V_X^2)})) \right) = \frac{1}{16} (2 + V_X)^2 \), and we get \( V_X \approx 0.57 \), which is the boundary for \( V_X \) for optimal strategy:
\begin{align*}
p_{MC}^* &= \frac{1 + V_X}{3}, \quad p_{MB}^* = \frac{1}{3}(2V_X + 2 - \sqrt{2}V_X(V_X - 1)), \quad \text{if } 0.57 < V_X < 1 \\
p_{MC}^* &= \frac{2 + V_X}{4}, \quad p_{MB}^* = \frac{3}{4}V_X, \quad \text{if } 0 < V_X \leq 0.57 \\
R_M^* &= \begin{cases} 
\frac{1}{27V_X} \left( V_X \left( 9 - 2\sqrt{2}V_X(V_X - 1) \right) + V_X \left( 9 - 3V_X + 2\sqrt{2}V_X(V_X - 1) \right) \right), & \text{if } 0.57 < V_X < 1 \\
\frac{1}{16}(2 + V_X)^2, & \text{if } 0 < V_X \leq 0.57 
\end{cases}
\end{align*}

**Proof of Lemma 4:**

\[ p_C^{N^*} = \begin{cases} 
\frac{1}{18}(3 + 2\sqrt{6V_X} + 3V_X - \sqrt{9 - 6\sqrt{6V_X} + 42V_X - 6\sqrt{6V_X^{3/2}} + 9V_X^2}), & \text{if } \frac{2}{3} > V_X > 1 \\
\frac{1}{12}(4 + 3V_X + \sqrt{4 + 3V_X(2 + V_X)}), & \text{if } \frac{18}{47} \leq V_X \leq \frac{2}{3} \\
\frac{1}{4}(2 - 3V_X), & \text{if } 0 < V_X \leq \frac{18}{47}
\end{cases} \]

If $\frac{2}{3} > V_X > 1$

\[ R_B^{N^*} = \frac{1}{162\sqrt{6V_X}} \left( -3 + 4\sqrt{6V_X} - 21V_X + \sqrt{9 - 6\sqrt{6V_X} + 42V_X - 6\sqrt{6V_X^{3/2}} + 9V_X^2} \right) \]

\[ R_C^{N^*} = \frac{1}{2916V_X} \left( 3 + 2\sqrt{6V_X} + 3V_X - \sqrt{9 - 6\sqrt{6V_X} + 42V_X - 6\sqrt{6V_X^{3/2}} + 9V_X^2} \right) \]

\[ D_C^{N^*} = \frac{1}{162V_X} \left( -3 + 4\sqrt{6V_X} - 3V_X + \sqrt{9 - 6\sqrt{6V_X} + 42V_X - 6\sqrt{6V_X^{3/2}} + 9V_X^2} \right) \]

\[ D_B^{N^*} = \frac{1}{324V_X} \left( -3 + 4\sqrt{6V_X} - 21V_X + \sqrt{9 - 6\sqrt{6V_X} + 42V_X - 6\sqrt{6V_X^{3/2}} + 9V_X^2} \right) \]

If $\frac{18}{47} < V_X \leq \frac{2}{3}$

\[ R_B^{N^*} = \frac{(2 + V_X)(-10 + \sqrt{4 + 3V_X(2 + V_X)})(2 - 12V_X + \sqrt{4 + 3V_X(2 + V_X)})}{576V_X} \]

\[ R_C^{N^*} = \frac{1}{864V_X} \left( 2 + \sqrt{4 + 3V_X(2 + V_X)}(4 + 3V_X - \sqrt{4 + 3V_X(2 + V_X)}) \right) \]

\[ D_B^{N^*} = \frac{(-10 + \sqrt{4 + 3V_X(2 + V_X)})(2 - 12V_X + \sqrt{4 + 3V_X(2 + V_X)})}{144V_X} \]

**Proof of Lemma 4:**

\[ p_C^{N^*} = \begin{cases} 
\frac{1}{18}(3 + 2\sqrt{6V_X} + 3V_X - \sqrt{9 - 6\sqrt{6V_X} + 42V_X - 6\sqrt{6V_X^{3/2}} + 9V_X^2}), & \text{if } \frac{2}{3} > V_X > 1 \\
\frac{1}{12}(4 + 3V_X + \sqrt{4 + 3V_X(2 + V_X)}), & \text{if } \frac{18}{47} \leq V_X \leq \frac{2}{3} \\
\frac{1}{4}(2 - 3V_X), & \text{if } 0 < V_X \leq \frac{18}{47}
\end{cases} \]

If $\frac{2}{3} > V_X > 1$

\[ R_B^{N^*} = \frac{1}{162\sqrt{6V_X}} \left( -3 + 4\sqrt{6V_X} - 21V_X + \sqrt{9 - 6\sqrt{6V_X} + 42V_X - 6\sqrt{6V_X^{3/2}} + 9V_X^2} \right) \]

\[ R_C^{N^*} = \frac{1}{2916V_X} \left( 3 + 2\sqrt{6V_X} + 3V_X - \sqrt{9 - 6\sqrt{6V_X} + 42V_X - 6\sqrt{6V_X^{3/2}} + 9V_X^2} \right) \]

\[ D_C^{N^*} = \frac{1}{162V_X} \left( -3 + 4\sqrt{6V_X} - 3V_X + \sqrt{9 - 6\sqrt{6V_X} + 42V_X - 6\sqrt{6V_X^{3/2}} + 9V_X^2} \right) \]

\[ D_B^{N^*} = \frac{1}{324V_X} \left( -3 + 4\sqrt{6V_X} - 21V_X + \sqrt{9 - 6\sqrt{6V_X} + 42V_X - 6\sqrt{6V_X^{3/2}} + 9V_X^2} \right) \]

If $\frac{18}{47} < V_X \leq \frac{2}{3}$

\[ R_B^{N^*} = \frac{(2 + V_X)(-10 + \sqrt{4 + 3V_X(2 + V_X)})(2 - 12V_X + \sqrt{4 + 3V_X(2 + V_X)})}{576V_X} \]

\[ R_C^{N^*} = \frac{1}{864V_X} \left( 2 + \sqrt{4 + 3V_X(2 + V_X)}(4 + 3V_X - \sqrt{4 + 3V_X(2 + V_X)}) \right) \]

\[ D_B^{N^*} = \frac{(-10 + \sqrt{4 + 3V_X(2 + V_X)})(2 - 12V_X + \sqrt{4 + 3V_X(2 + V_X)})}{144V_X} \]
\[ D_C^{N^*} = \frac{(2 + \sqrt{4 + 3V_X(2 + V_X)})(2 + 3V_X + \sqrt{4 + 3V_X(2 + V_X)})}{72V_X} \]

If \( \frac{2}{7} < V_X \leq \frac{18}{47} \)

\[ R_B^{N^*} = 0 \]
\[ R_C^{N^*} = \frac{5}{8}(2 - 3V_X)V_X \]
\[ D_C^{N^*} = \frac{5V_X}{2} \]
\[ D_B^{N^*} = 0 \]

If \( 0 < V_X \leq \frac{2}{7} \)

\[ R_B^{N^*} = 0 \]
\[ R_C^{N^*} = \frac{1}{16}(4 - 9V_X^2) \]
\[ D_C^{N^*} = \frac{1}{4}(2 + 3V_X) \]
\[ D_B^{N^*} = 0 \]