Model Development for Bundle Pricing In Dual Channel Supply Chain

Nur Layli Rachmawati* and Erwin Widodo

Department of Industrial Engineering,

Sepuluh Nopember Institute of Technology (ITS),

Surabaya 60111, Indonesia

Email: laylirachmawati@gmail.com

Email: erwin@ie.its.ac.id

Abstrak

Bundling merupakan salah satu strategi pemasaran yang digunakan untuk meningkatkan penjualan dengan cara menjual dua produk atau lebih dalam satu paket pada tingkat harga tertentu. Disisi lain, beberapa kegiatan bisnis dilakukan dalam bentuk *online*, termasuk aktivitas jual beli. Beberapa diantaranya telah menyediakan fasilitas *online channel* tanpa menghilangkan *conventional store*. Fenomena tersebut sering disebut dengan *Dual Channel Supply Chain* (DCSC). Pada permasalahan ini akan dibahas mengenai *bundling strategy* di DCSC untuk produk komplementer. Jumlah produk yang dibundle ada dua. Pada penelitian ini akan dibandingkan dua skenario, *nobundling* dan *mixed bundling strategy* di DCSC dengan menggunakan *Nash game*. Variabel keputusan yang dicari adalah harga optimum untuk masing-masing produk di masing-masing *channel* untuk mendapatkan profit yang maksimal baik di masing-masing *channel* maupun *supply chain* secara keseluruhan. Pada penelitian ini dilakukan modifikasi fungsi *demand* yang selanjutnya akan dipakai sebagai penyusun fungsi tujuan maksimasi profit. Hasil dari percobaan numerik menunjukkan bahwa *mixed bundling strategy* memberikan nilai profit yang lebih besar dibandingkan dengan *unbundling strategy*.

Kata kunci: DCSC, Mixed Bundling, Nash Game, Produk Komplementer

Abstract

Bundling is a marketing strategy that used for increasing sales by selling two products or more at a package with specific price. On the other perspective, business activities have been done by online, include trading activity. Some of them provide direct channel (online channel) without eliminating the existing. When both channels work simultaneously, it called dual channel supply chain (DCSC). In here we will solve the problem about bundling strategy in DCSC for complemet products. The products to be bundled are two. We'll compare two scenarios, they are no bundling and mixed bundling in DCSC with Nash game. Our goal is to maximize profit and the decision variables are the optimum price for each product in each channel. We modify the demand function for this problem in which eventually will be used to construct the proposed profit maximization objective function.. The numerical experiment shows that mixed bundling strategy gives better total profit than unbundling strategy.

Keywords: *DCSC, Mixed Bundling, Nash Game, Complementary Product*

1. Introduction

Bundling became popular strategy since market competition rising. Bundling is one of marketing strategy by selling some products in a package at specific price (Stremersch & Tellis, 2002). This strategy gives good impact both customers and manufacturer. For the customers bundling strategy can minimize their consumption cost, depend on products bundle quantity, value of the products and degree of variance. And for manufacturer bundling can save logistics costs, administration cost and the most valuable benefit is rise their profitability. It can be showed by higher selling, market size penetration caused of heterogeneous customer (Yang & Ng., 2010).

Bundling strategy can be differentiated into some types, namely no-bundling, pure bundling, mixed bundling and customized bundling (Yang & Ng., 2010). No bundling means products are offered as individuals. Pure bundling means products are offers only in a bundle. Pure bundling also called full bundle. Mixed bundling applies both individuals and pure bundling simultaneously. While customized bundling gives freedom to customers to choose how many products will be bundled in n different products.

Some companies applied bundling strategy, such as BestBuy applied bundling for complementary products (i.e. bundle of DVD player and disk), bundle of hardware and software computer in Staples, bundle internet and hand set of hand phone by Comcast (Yan, Myers, Wang, & Ghose, 2014). Besides complementary product, there are substitution products in a bundle. Like in digital music industry, record company (such as Sony and Universal) sold album in a bundle (Girju, Prasad, & Ratchford, 2013).

In Indonesia bundling has been implemented in some companies, like fast food restaurant (i.e. McDonalds, KFC, Hoka Hoka Bento and etc). They offer some menus in a package. Other good example is cellular provider companies (Telkomsel, XL axiata and Indosat). They offer sim card and smart phone as a bundle, such as bundle of Simpati and iphone6, XL 4G LTE and LG G3 or LG G2.

The growth of technology has changed consumer behavior. In the past trading activity was occurred in retailer or store. But in this time those activity occur using internet. That phenomena is called Dual Channel Supply Chain (DCSC). The idea of DCSC is offering single product through both online (direct channel) and traditional store (offline store) simultaneously (Hua, Wang, & Cheng, 2010). The problem under DCSC is to solve conflict between its channels.

The previous research is conducted by Chakravarty, et al., (2013). They developed bundling strategy involved channels (retailer and manufacturer). They solved multi products (two products) in integrated channel to minimize double marginalization. The decision variables are unit price and bundle price with objective function is maximize profit both each channels and the whole supply chain. Moreover, Mayer, et al. (2013) determined an optimal bundling price for n products considering resource constraint in service provide to maximize their revenue. In addition, Girju, et al., (2014) analyzed the impact of interaction between each channels in bundling strategy decision, how to determine two products combination, and it’s done by which channel to maximize profit. Both Chakravarty, et al., (2013) and Girju, et al., (2014) solved their problem using game theory. They compared unbundling and pure bundling performance. While Mayer, et al. (2013) developed Mixed Integer Linear Programming using heuristics to solve their problem. They analyzed mixed bundling strategy.

In this research we compare bundling strategies, include unbundling and mixed bundling in DCSC to maximize profit. To reach that goal we optimize price in each channel for each product and bundle. To give best analysis we develop two scenario under game theory perspective. They are Nash game for unbundling strategy and Nash game for mixed bundling strategy. The challenge of this research is how to develop demand bundle model in DCSC.

The rest of this paper is organized as follows: in Section 2, problem description and assumptions is presented. Scenarios are developed in Section 3. Section 4 is dedicated to illustrate the results of three proposed models, include numerical experiments and its sensitivity analysis. Conclusion and some feasible future research is given in Section 5.

2. Problem description and assumptions

In this section, the problem statement and assumptions are briefly described. For the detail see Figure 1 as a basic system under discussion.

In this structure products are distributed by a wholesaler to retailer and online channel simultaneously. A wholesaler sales two complementary products to fulfil conventional store's demand. At the same time, online channel fulfil online customer demand.

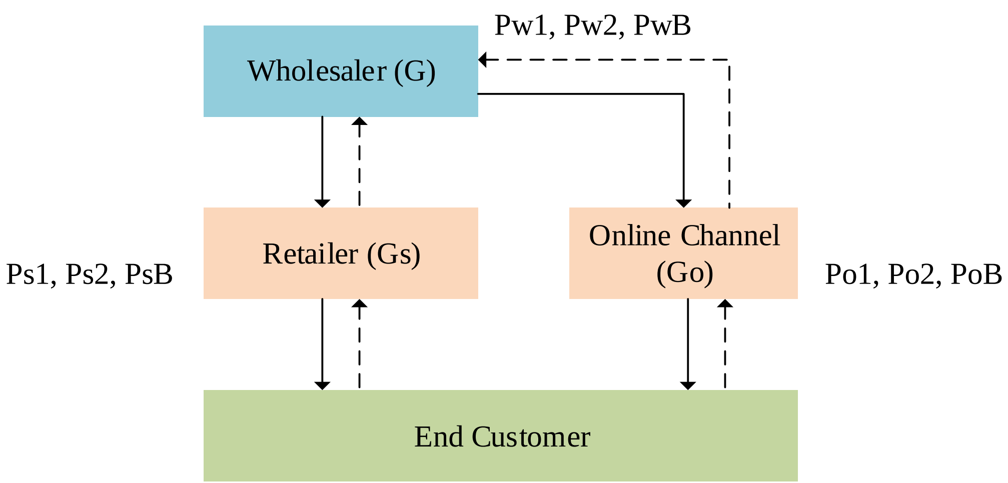

Figure 1. Conceptual Model of System under Discussion

There are several assumptions as follows:

1. Sales returns are not allowed. The products are qualified and there is no complaint from customer
2. Holding cost is not considered. It's assumed that the products are distributed as soon so they don't need to be hold.

3. Transportation cost from wholesaler to retailer has been considered when determine COGS

In the model development, the following notations are used:

- Index:
  - i : products i= 1,2,3
  - j : channels j= s and o
- Decision variables:
  - P_{Si} : price in offline channel for product i
  - P_{Oi} : price in online channel for product i
- Demand functions:
  - D_{Si} : in-store demand for product i
  - D_{Oi} : demand in online channel for product i
- Parameters
  - ρ_i : costumer acceptance ratio of online products i compared offline
  - a_i : market base for product i
  - α_i : its price sensitivity
  - β_i : cross channel price sensitivity
  - θ : degree of non-complementarity between each products
  - γ_i : the complement price elasticity
  - λ_i : bundling price discount elasticity
- Dependent variables:
  - π_j^s : gain total in j channel and s strategy

Based on study in literature the bundle basic model refers to Yan & Bandyopadhyay (2011) and Gupta & Loulou (in Yan & Bandyopadhyay, 2011). Demand function for two complementary products have following form:

$$D_1 = a - bp_1 - b\theta p_2 \quad (1)$$

$$D_2 = a - bp_2 - b\theta p_1 \quad (2)$$

Demand for each complementary product (product 1 and 2) depends on market base, its own price and the price of the its complement. They assumed demand is linear with regard to self and cross price sensitivity. θ is assumed between $0 \leq \theta \leq 1$ and product's self-price sensitivity must be greater than cross channel price sensitivity (Gupta & Loulou in Yan & Bandyopadhyay, 2011). Based on those model, Yan & Bandyopadhyay (2011) modified the previous model by considering a bundling policy. The assumptions are bundle price lower than sum of individual price and the wholesaler generates higher demand from a larger bundling discount, and model is as follow:

$$D_B = a - bP_B + \lambda(P_1 + P_2 - P_B) \tag{3}$$

Demand for product bundle depens on market base, its own price and efficacy of bundling policy. The greater value of λ, the more bundling policy contribute to demand. It's assumed that $b \geq \lambda > 0$.

The other basic model refers to Huang, et al. (2011) for demand in DCSC structure. The model is developed for single product in DCSC. Other assumption is the relationship between price and demand is known and deterministic, the detail model is as follows:

$$D_S = (1-\rho)a - \alpha_1 P_S + \beta_1 P_O \tag{4}$$

$$D_O = \rho a - \alpha_2 P_O + \beta_2 P_S \tag{5}$$

Based on three basic model previous we modify the model by considering two products, degree of non-complementarity, and channels. Then demand function for unbundling strategy as follows:

$$D_{S1} = (1-\rho_1)a_1 - \alpha_1 P_{S1} + \beta_1 P_{O1} - \gamma_1 \theta P_{S2} \tag{6}$$

$$D_{O1} = \rho_1 a_1 - \alpha_2 P_{O1} + \beta_2 P_{S1} - \gamma_2 \theta P_{O2} \tag{7}$$

$$D_{S2} = (1-\rho_2)a_2 - \alpha_3 P_{S2} + \beta_3 P_{O2} - \gamma_3 \theta P_{S1} \tag{8}$$

$$D_{O2} = \rho_2 a_2 - \alpha_4 P_{O2} + \beta_4 P_{S2} - \gamma_4 \theta P_{O1} \tag{9}$$

Demand function for each channel using unbundling strategy depend on customer acceptance ratio for online product compared to offline product, market base, unit price its product, cross channel price, degree of non-complementary, and complement price. Then we modify demand function for mixed bundling strategy too. The different with the previous one is we considering bundling price in each individual demand. the formula is as follows:

$$D_{S1} = (1-\rho_1)a_1 - \alpha_1 P_{S1} + \beta_1 P_{O1} - \gamma_1 \theta P_{S2} + \lambda_1 P_{SB} \tag{10}$$

$$D_{O1} = \rho_1 a_1 - \alpha_2 P_{O1} + \beta_2 P_{S1} - \gamma_2 \theta P_{O2} + \lambda_1 P_{OB} \tag{11}$$

$$D_{S2} = (1-\rho_2)a_2 - \alpha_3 P_{S2} + \beta_3 P_{O2} - \gamma_3 \theta P_{S1} + \lambda_1 P_{SB} \tag{12}$$

$$D_{O2} = \rho_2 a_2 - \alpha_4 P_{O2} + \beta_4 P_{S2} - \gamma_4 \theta P_{O1} + \lambda_1 P_{OB} \tag{13}$$

$$D_{SB} = (1-\rho_3)a_3 - \alpha_5 P_{SB} + \beta_9 P_{OB} + \lambda_2(P_{S1} + P_{S2} - P_{SB}) \tag{14}$$

$$D_{OB} = \rho_3 a_3 - \alpha_6 P_{OB} + \beta_{10} P_{SB} + \lambda_2(P_{O1} + P_{O2} - P_{OB}) \tag{15}$$

3. Scenarios

In this section, three scenarios are developed as a representation of actual condition for bundle pricing under DCSC system.

3.1. Scenario 1: Nash Game Unbundling Strategy

When the product is offered as individual, it called unbundling strategy. The game categorized as Nash game when the store and online channel have the same decision power. To maximize their profit, they determine their strategy independently and simultaneously. The solution of this game called Nash equilibrium. To determine Nash equilibrium, retailer and online channel's decision variables are solved separately and these as follows:

$$max\, \pi_S^{NU}\,(P_{S1}, P_{S2}) = \pi_{S1}^{NU} + \pi_{S2}^{NU} \quad (16)$$

$$= (P_{S1} - P_{W1})D_{S1} + (P_{S2} - P_{W2})D_{S2}$$

s.t.

$P_{oi} \geq P_{wi}$

$P_{si} \geq P_{wi}$

$P_{si} \geq \dfrac{P_{Oi}}{\rho_i}$

$D_{si} \geq 0$

$P_{si} \geq P_{Oi}$

$\sum P_{si} \geq P_{SB}$

$$max\, \pi_O^{NU}\,(P_{O1}, P_{O2}) = \pi_{O1}^{NU} + \pi_{O2}^{NU} \quad (17)$$

$$= (P_{O1} - P_{W1})D_{O1} + (P_{O2} - P_{W2})D_{O2}$$

s.t.

$P_{oi} \geq P_{wi}$

$P_{si} \geq P_{wi}$

$D_{Oi} \geq 0$

$\sum P_{Oi} \geq P_{OB}$

$$\pi_{DCSC}^{NU} = \pi_S^{NU} + \pi_O^{NU} \quad (18)$$

3.2. Scenario 2: Nash Game Mixed Bundling Strategy

This scenario is based on the idea of rising market size. Customers is faced an interest option where channels offer bundle with lower price. To determine optimal decisions, retailer and online channel's decision variables are solved separately and these as follows:

$$\max \pi_S^{NM,}(P_{S1}, P_{S2}, P_{SB}) = \pi_{S1}^{NM} + \pi_{S2}^{NM} + \pi_{SB}^{NM} \tag{19}$$
$$= (P_{S1} - P_{W1})D_{S1} + (P_{S2} - P_{W2})D_{S2} + (P_{SB} - P_{W1} - P_{W2})D_{SB}$$

s.t.

$P_{oi} \geq P_{wi}$

$P_{si} \geq P_{wi}$

$P_{si} \geq \frac{P_{Oi}}{\rho_i}$

$D_{si} \geq 0$

$P_{si} \geq P_{Oi}$

$\sum P_{si} \geq P_{SB}$

$$\max \pi_O^{NM}(P_{O1}, P_{O2}, P_{OB}) = \pi_{O1}^{NM} + \pi_{O2}^{NM} + \pi_{OB}^{NM} \tag{20}$$
$$= (P_{O1} - P_{W1})D_{O1} + (P_{O2} - P_{W2})D_{O2} + (P_{OB} - P_{W1} - P_{W2})D_{OB}$$

s.t.

$P_{oi} \geq P_{wi}$

$P_{si} \geq P_{wi}$

$D_{Oi} \geq 0$

$\sum P_{Oi} \geq P_{OB}$

$$\pi_{DCSC}^{NM} = \pi_S^{NM} + \pi_O^{NM} \tag{21}$$

4. Discussion of the results

In this section we show the numerical experiments results to illustrate, evaluate, and compare each scenario. First let us set some parameters bellows:

Table 1. Parameters and its value in numerical analysis

Parameters	Base value	Parameters	Base value
a_1	920	α4	0.0025
a_2	858	α5	0.001
a_3	1100	α6	0.0015
P_{W1}	125000	β1	0.0008

Parameters	Base value	Parameters	Base value
P_{W2}	50000	β2	0.000005
ϴ	0.1	β3	0.0007
ρ	0.6	β4	0.000009
P_{S1}	250000	β5	0.0005
P_{O1}	225000	β6	0.000001
P_{S2}	100000	γ1	0.0003
P_{O2}	80000	γ2	0.000004
P_{SB}	280000	γ3	0.0005
P_{OB}	250000	γ4	0.000008
α1	0.0009	λ1	0.00001
α2	0.001	λ2	0.0005
α3	0.0015		

To provide the optimal decision variables $P_{S1}, P_{S2}, P_{SB}, P_{O1}, P_{O2}, P_{OB}$, the objective function (16), (17), (19), (20) are solved by . The corresponding profits for each player in each scenario as shown in Table 2.

Table 2. Result of each Scenario

Scenario	1: NU	2: NM
Scheme	Nash	Nash
Ps1	375,000	429,350
Po1	339070	250,000
Ps2	149,320	189,530
Po2	128,070	100,000
PsB	-	416,670
PoB	-	280,000
Ds	523	507
Do	409	849
Gs	67,046,000	122,620,000
Go	61,082,000	100,770,000
G	128,128,000	223,390,000

Considering the Table 2. above, we can conclude that to maximize their profit mixed bundling strategy gives the better performance than unbundling. It’s known by greater amount of total profit in each channel and whole supply chain.

4.1. Sensitivity analysis

The first parameter to be analyzed is, customer acceptance ratio for online product compared offline product, ρ. When initial value of ρ shift up to $\rho_{ub} = 0.69$ and shift down to $\rho_{lb} = 0.57$, the effect on the total profit is shown in Figure 2. The grey line is represent of Nash unbundling and the other line is represent Nash Mixed Bundling. It's shown that mixed bundling strategy always gives the better total profit than unbundling strategy. But the greater ρ stimulate the decreasing total profit in both scenario. The reason is greater ρ stimulate greater product online demand and we know that price in online channel is lower than store, that's why the greater ρ stimulate the decreasing total profit.

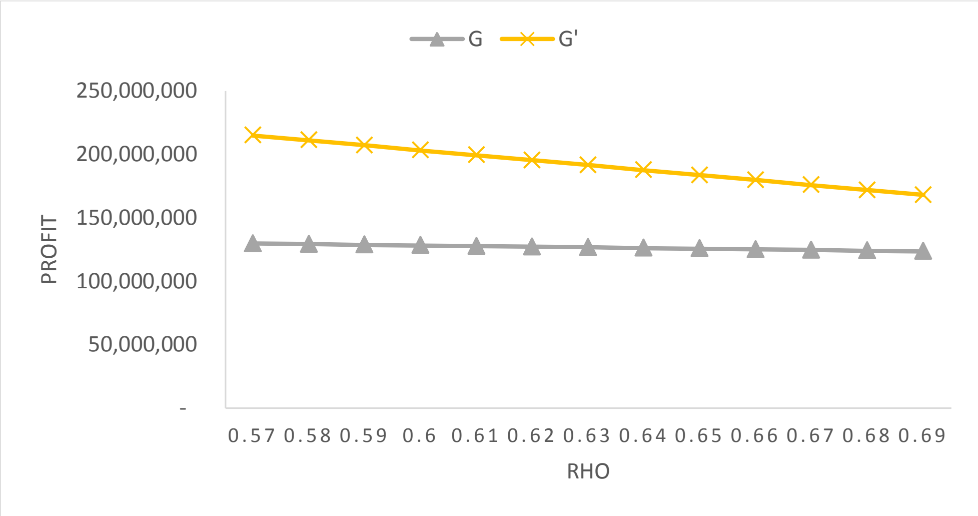

Figure 2. Sensitivity of total profit to customer acceptance ratio for online product compared offline product, ρ

The second parameter to be analyzed is degree of non-complementary, θ. The higher θ means that the product tends to be not complement. When initial value of θ shift down to $\theta_{lb} = 0.9$, the effect on total profit is shown in Figure 3. It's shown that the greater θ stimulate the decreasing of total profit. It's caused by greater θ stimulate the decreasing of complement product demand. Simultaneously the total profit will decrease too. Generally mixed bundling strategy always give the better total profit than unbundling strategy.

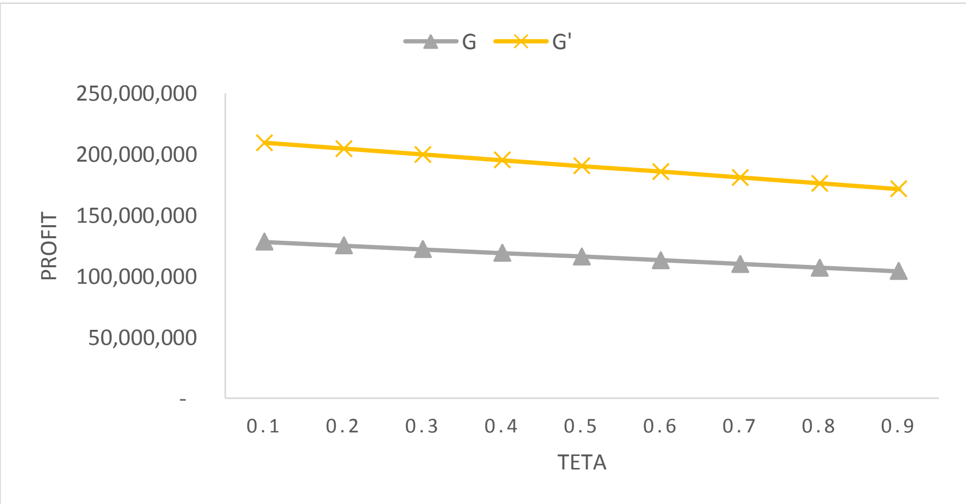

Figure 3. Sensitivity of Total Profit to Degree of Non-Complementary Product

5. Conclusion

In this research, we considered price bundling model under DCSC structure and discussed the bundling strategy for complementary products. Unbundling strategy and mixed bundling strategy are compared under Nash game perspective.

In current study we have proposed demand function, its objective function and constraint set for unbundling and mixed bundling strategy in DCSC for complementary product. The product quantities are two. When developing our model we considered the channels and degree of non-complementarity. This is our theoretical contribution. Based on numerical experiment, it's clear that mixed bundling gives better total profit both in each channel and whole supply chain.

We left further consideration as future works. More comprehensive scenario such as bundling strategy under Bertrand (all at once) simulation is worth to research. Moreover, detail leveling on complementary relationship is also possible to be considered. In addition, more parameters should put under scrutiny in sensitivity analysis in giving more managerial implication to this work.

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