Pricing in Channel Book Supply Chain Considering Possibility of Selling E-Book under Fixed and Decreasing Demands

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Abstract: The purpose of this research is to determine the optimal wholesale and final prices of printed and electronic books in a dual channel supply chain. Here, a comprehensive sensitivity analysis has been conducted on different supply chain parameters such as demand elasticity coefficients, customer tendency to printed books and book production costs. The effect of these variables on optimal prices, demands and final profit is analyzed. Results of centralized and fixed demand mode reveal that if the coefficient of customers' tendency to printed book is bigger than 0.5, then the final printed books' price will be higher than e-book prices. Pricing in decentralized model is done using the Stackelberg equilibrium. Results show that wholesale prices of p-book in decentralized and fixed demand system are equal to selling prices in centralized system, but the final selling price of p-book in decentralized system is higher than centralized one. In both systems, the e-book selling price is the same. In the fixed demand condition, either e-books are not published or they are simultaneously published with their printed versions; however, in the decreasing demand mode, e-books may be introduced to market at any time during books' life period.

Keywords: Electronic Book, Pricing, Printed Book, Publisher, Supply Chain

Introduction: In this paper, a three-level supply chain including publisher, bookstores, and final customers is considered. The publisher provides books to the market via printed and electronic versions. The production costs for one copy of e-book and p-book are denoted by c_p and c_e, respectively. The publisher provides p-books to bookstores at wholesale price, and customers can buy them at final selling price. E-books are provided to customers at price p_e.

The problem is defined in two time periods where in the first period, the publisher only delivers p-books at wholesale price w_1 and bookstores sell them at price p_{r_1}. In the second period of books' lifetime, the wholesale price is set to w_2 and e-books are simultaneously provided by the publisher to the market. The bookstores decide about the final selling price of p-books in the second period, p_{r_2}. The following figure outlines the considering supply chain and its different distribution channels:
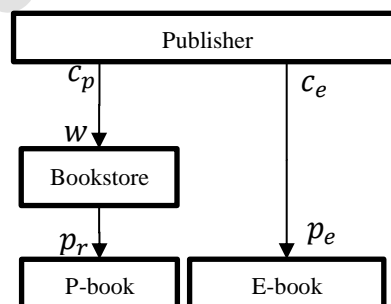

Fig. 1- Outline of the considering dual-channel supply chain

The demand function is defined in two modes of fixed and decreasing. Assuming that prices remain unchanged during lifetime of books, demands are unchanged in the fixed mode while the demands for p-books and e-books will diminish in the decreasing mode.

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Materials and Methods: Let D_{r_1} and D_{r_2} denote the demand of p-books in the first and second periods and D_e be the demand for e-books. Parameter D denotes the base demand of books when they are free. Parameter $0 < \alpha < 1$ shows the loyalty of customers to p-books meaning that $1 - \alpha$ percent of customers potentially prefer e-books to p-books. Parameters b_1 and b_2 respectively denote price elasticity of demand and cross-price sensitivity coefficients.

Results and Discussion: Table (1) shows the results of analysis on the supply chain with fixed demands in centralized and decentralized modes. In the centralized mode, the publisher and bookstores simultaneously decide regarding the prices and try to maximize total profit in the supply chain. In the decentralized mode, the publisher tries to maximize its own profit by adjusting prices p_e, w_1 and w_2 while bookstores want to maximize their profit via controlling prices p_{r_1} and p_{r_2}. Most of the results are achieved from Stackelberg games and solving systems of linear equations.

Table 1- Summary of Results for the Supply Chain with Fixed Demand

Centralized mode	$p_{r_1}^* = \dfrac{c_p}{2} + \dfrac{D}{2b_1}$	$p_{r_2}^* = \dfrac{c_p}{2} + \dfrac{\alpha.b_1 + (1-\alpha)b_2}{2(b_1^2 - b_2^2)}D$
	$p_e^* = \dfrac{c_e}{2} + \dfrac{(1-\alpha)b_1 + \alpha b_2}{2(b_1^2 - b_2^2)}D$	$D_{r_1}^* = \dfrac{-b_1.C_p + D}{2}$
	$D_{r_2}^* = \dfrac{b_2.C_e - b_1.C_p + \alpha.D}{2}$	$D_e^* = \dfrac{b_2.C_p - b_1.C_e + (1-\alpha)D}{2}$
	$b_2^2 > b_1(b_1 - b_2) \;\rightarrow\; p_{r_1}^* > p_{r_2}^*$	$\alpha > 0.5 \;\rightarrow\; p_{r_2}^* > p_e^*$
Decentralized mode	$p_{r_1}^* = \dfrac{w_1}{2} + \dfrac{D}{2b_1}$	$p_{r_2}^* = \dfrac{w_2}{2} + \dfrac{\alpha.D + b_2.p_e}{2b_1}$
	$w_1^* = \dfrac{c_p}{2} + \dfrac{D}{2b_1}$	$w_2^* = \dfrac{c_p}{2} + \dfrac{\alpha.b_1 + (1-\alpha)b_2}{2(b_1^2 - b_2^2)}D$
	$p_e^* = \dfrac{c_e}{2} + \dfrac{\alpha.b_2 + (1-\alpha)b_1}{2(b_1^2 - b_2^2)}D$	$D_{r_1}^* = \dfrac{-b_1.C_p + D}{4}$
	$D_{r_2}^* = \dfrac{b_2.C_e - b_1.C_p + \alpha.D}{4}$	$D_e^* = \dfrac{b_2.C_p - b_1.C_e + (1-\alpha)D}{2} + \dfrac{b_2^2.c_e + b_2.\alpha.D}{4b_1}$

Conclusion: In this paper, pricing policies in a dual-channel supply chain for printed and electronic books was considered. The demand function was defined as two types of fixed and decreasing and also, the supply chain was considered in centralized and decentralized modes.

The results show that if the coefficient of customers' tendency towards p-books is bigger than 0.5, then the optimal price for p-books is greater than price of e-books. Increasing the price elasticity of demand will reduce optimum selling prices and demands, and consequently reduces the final profit of publisher and bookstores. In the decentralized supply chain with fixed demand, pricing is done using Stackelberg equilibrium where publisher is the leader and bookstores are followers. Wholesale price of p-books in decentralized mode is equal to their final selling price in centralized mode; while the final price of p-books in decentralized mode is higher compared with centralized mode. The price of e-books is the same in both the modes. In the supply chain with decreasing demand, accelerating the demand reduction will postpone the introduction of e-books to the market in the centralized mode while it has a reverse effect in decentralized mode.

Many ideas are provided by researchers to encourage people to read e-books such as advertising electronic books in TV programs, developing websites and portals and supporting their admins (IRNA, 2015), laying down suitable laws (Fahimifar & Heidary, 2014) and providing high-speed internet and e-book reader tools to all the people (Tavakol & BaniJamal, 2014).

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