Operational Research (2024) 24:58
https://doi.org/10.1007/s12351-024-00850-9

ORIGINAL PAPER

National brands versus store brands: retailer fight against national brands to improve store brands via a dynamic discount pricing strategy

Dawood Yahyavi[1] · Ata Allah Taleizadeh[1] · Park Thaichon[2]

Received: 29 January 2023 / Revised: 18 June 2024 / Accepted: 2 July 2024 /
Published online: 18 September 2024

Abstract
Today, there is a lot of competition between competitors in the market of different products. The level of complexity of relationships and behavior of active players in the market has also increased. So that a manufacturer and retailer work together to increase the profit of the supply chain through the sale of products. On the other hand, the retailer and the manufacturer as competitors are competing with each other to sell more of their products. This issue has increased the complexity of the relationship between retailers and manufacturers. This study aims to explore how retailers can strengthen the self-introduced store brand (SB) and resist the pressures of manufacturers by using dynamic discount pricing (DDP) strategy. Numerical examples are proposed to clearly explain the validity and applicability of the model. Based on the managerial insights developed by analyzing the model's results, we evaluated the influences of DDP strategy on the retail prices and demands of national brands (NB) and SB and the profit of the retailer and the manufacturer. We found that discounts on the manufacturer's product by the retailer increase the demand for both NB and SBs. An increase in demand leads to an increase in the profits of manufacturers and retailers. However, the increase in the manufacturer's profit does not compensate for the decrease in his market share. In other words, the introduction of an SB always causes damage to the manufacturer, but the amount of damage depends on various factors. These findings offer manufacturers and retailers useful insights and help them adopt effective marketing strategies.

Keywords Dynamic discount pricing · DDP · Store brand · National brand · Differential game · Game theory · Private label · Supply chain · Advertising · Strategy

---

Extended author information available on the last page of the article

1 Introduction

Big retailers in the retail industry, such as Costco, Amazon, Walmart, and Prince and Spring have introduced their SBs in the market in recent decades (Nasser, 2021). Kirkland Signature as a Costco's SB has sales about 30% of Costco's total sales in 2019, growing more than 10% in 2018 compared to 2017 (Green 2019). As a giant e-commerce in 2020, Amazon has sold 22,617 different products under 111 SBs. AmazonBasics is Amazon's biggest SB which consists of about 4000 products (Davis 2020). However, Prince and Spring brand as a Boxed.Com's SB now covers 15% of the online sales of Boxed.Com and has an impressive growth of 400% in October 2017 a year from October 2016 (Green 2018). Also, as a giant supermarket, Wal-Mart sells at the same time Procter & Gamble products as the NB and its Great Value brand product as the SB (Neff, 2009; Zhe Zhang et al. 2021). As another example, over 300 SBs have been introduced by Sephora and Watsons in the market of personal care products (Jin et al. 2017; Safdar et al., 2017). These are just a few examples that indicate the importance of SBs in today's market.

Retail stores have an essential role in the distribution and exposure of goods (Sarkar et al. 2022; Shah et al. 2018). Retailers also have golden opportunities to interact with customers in their stores (Thaichon et al. 2020). In retail chains, the retailers, especially those dominant ones, did not traditionally own product brands (Mao et al. 2021; Martinelli and De Canio 2021). In recent years, due to competition with the National Brands (NB) manufacturers, they have started to push ahead with their brands, which are called store brands (SBs) or private labels (Hara and Matsubayashi 2017; Liu et al. 2022). Besides, we observe a global shift in consumers' loyalty from the NBs to retailers' SBs because customers are less reliant on NBs and more dependent on the store itself (Mckinsey 2020).

The SBs increase the sales and profit of retailers and even manufacturers by managing profit margins and price competition (Bulter and Yang, 2018) as well as attracting new customers and developing product categories (Chintagune and Bonfrer, 2002; Pauwels and Srinivasan 2004). The SBs can be beneficial for the manufacturer (Raju, 2015), on the other hand, they grow the retailer's market share and competition among SC members. In terms of experience, SBs' success in the market depends on several factors, such as customer price sensitivity (Seyedhosseini et al. 2019), their loyalty to the NBs, as well as retailer positioning strategies (Nasser et al. 2013; Scott-Morton and Zettelmeyer 2004).

In addition to the benefits that the introduction of an SB can have in the supply chain, on the other hand, they can also be considered as a source of potential threats for manufacturers. Therefore, manufacturers use different strategies against the entry of SBs. For instance, some manufacturers have tried to monopolize the market (Chaleshtari et al. 2022), preventing retailers from offering other products to customers (Ailawadi 2001). The other strategies can include managing value and innovation (Moencks et al. 2022; Quelch and Harding 1996), using accommodate, displace, and buffer strategies (Nasser et al. 2013), or using different strategies in the distribution channel (Jin et al. 2017). In another work, Karray et al. (2019) examined the impact of changing the timing of strategic decisions such as pricing and advertising on the SB entry. Other studies have analyzed the manufacturer's encroachment on the introduction of SB by retailers (Ganash and Arulanantha, 2021; Zhe Zhang et al. 2021).

In contrast to the inhibitory strategies of the manufacturers, this research intends to provide a resistance strategy for the retailer. The retailer needs to use appropriate strategies to support his SB product against the NB manufacturer. One of these resistance strategies is the use of a dynamic discount strategy. Price discount is an effective and valuable marketing tool (Jian et al. 2019) that has not been implemented in SB entry literature yet. Price discount gives freedom to the retailers who determine the retail price of products and sells them to customers (Gholamian and Ebrahimzadeh-Afruzi 2021; Nagare et al. 2020). Implementing a wise price discount strategy can stimulate demand and increase profit (Mathewson and Winter 1998).

We show that the retailer can increase the demand for NB and SB products by using a dynamic discount strategy. This will increase SB sales. At the same time, the profit margin of NB for the retailer is reduced. The increase in the sales of NB also increases the growth of the producer's profit. On the other hand, the retailer's market share increases due to the implementation of this strategy.

The rest of this article is organized as follows. In Sect. 2, the SB and DDP-related literature are reviewed, and research hypotheses and the model are presented in Sect. 3. A numerical example to describe and validate the model is given in Sect. 4. Analyzes of the impact of important parameters and discussion of the model characteristic are explained in Sect. 5. This study's managerial implications and conclusion are put forward in Sects. 6 and 7, respectively.

2 Literature review

This study's literature review section consists of two main streams. The first stream is related to SB entry and SC members' strategies to face it. The second stream investigates the literature of dynamic discount pricing as an operational strategy.

2.1 Store brand introduction literature

The literature on SB introduction shows that SB entry can make retailers get more profit by expanding product categories and receiving higher margins (Chintagunta et al. 2002). SBs expand product categories by better serving the NB or attracting new customers (Pauwels et al., 2004). Also, it has an important role in making service and retail classification rich to bring differentiation strategies (Rubio et al. 2017). Customers usually assume that SBs have low quality compared to NBs with high quality and enormous customer popularity (González Mieres et al. 2006). In some cases, SBs can have quality the same as NB, and even better than it (Chung and Lee 2017). Introducing SB by retailers expands the retailer's store by attracting new customers and increasing revenue. The retailers can acquire the SB from either an unbranded third-party manufacturer or the manufacturer of the NB(Kumar et al. 2010). the retailer can make more profit margins from selling SBs because an unknown manufacturer often supplies them. In contrast, the retailer has to pay extra costs for the brand and market of NBs to renowned manufacturers. The manufacturer can produce the SBs to the retailer, improving profits and diversifying income streams.

Despite these advantages, the introduction of SB has not always been successful. SB growth is driven by factors such as price sensitivity and customer preferences for NB, as well as the retailer's strategic positioning against the NB in the market (Nasser, et al. 2013; Scott-Morton & Zettelmeyer 2004). Some researchers showed that entrance of the SB can suffer retailers despite being profitable for manufacturers under some conditions (Amrouche and Yan 2012). Brand awareness of NBs is better than store brands due to their widely national scope. This issue disadvantaged SBs because of advertising lack (De Wulf et al. 2005). Although SBs have some risks and disadvantages over NBs in terms of quality and brand awareness, consumers still attract more profit due to their lower prices compared with NBs (Liu et al. 2018).

Many researchers have addressed the effect of store brand introduction comprehensively. Interested readers are referred to Sethuraman (2009), Pauwels and Srinivasan (2009), and Sayman and Raju (2017). Retailers are improving their store brands to leverage bargaining with manufacturers to get options from themes (Richardson 1997). Also, retailers try to increase bargaining power and change the SC leadership structure by introducing store brands (Chung and Lee 2018). Therefore, they can obtain a better wholesale price from the NB manufacturer (Narasimhan and Wilcox 1998). NB's product quality will be affected by the introduction of store brands (Heese 2010). Wang (2005) stated that the manufacturers of NBs can cooperate with retailers who want to offer the SB to customers. The NB manufacturer tries to have a favorable position about the entrance of SB to market by the retailer (Chintagunta et al. 2002). Choi and Fredj (2013) recommended that it be good for the manufacturer to cut over his collaboration with the retailer who has entered the SB in the market and develop a new relationship with a weaker retailer. Fang et al. (2013) indicated that the SC could be coordinated by the NB manufacturer through a contract by considering SBs cooperation. The NB's manufacturer can propose a collaboration scheme with the retailer to introduce a new SB (Hara and Matsubayashi 2017). In fact, the SB entrance may cause damage to NB manufacturers' profit because there are significant similarities between NB and SBs, and SBs are less expensive than NB ones. For example, Cheng et al. (2018) examined the SB entrance when there was incomplete information in the market. They found that powerful NB manufacturers will hurt more than less powerful NB manufacturers from SB introduction while the retailer will always benefit from it.

Many kinds of research have been done to address how NB manufacturers can use various methods to prevent SB from being offered to customers by opportunistic retailers (Amrouche and Yan 2015; Fang et al. 2013; Jin et al. 2017; Quelch and Harding 1996). A study has examined the solution that the manufacturer of NB can encourage the retailer to sell only NBs by paying a certain amount of the total revenue (Ailawadi 2001). Other research has shown that NB manufacturers can compete with SB by introducing a new product (Gielens 2012). Quelch and Harding (1996) stated that different price strategies, innovation, and brand value management are other ways to deal with SBs introduction that the manufacturer can use. Nasser et al. (2013) have shown that manufacturers can benefit from accommodating, displacing, and buffer strategies against store brands and determining their incentives. They found out that if the manufacturer can leverage SB introduction correctly, he can exploit it. They suggested designing an optimal portfolio for the manufacturers, including the prices of all its offerings and the quality levels (positioning). On the other hand, Ru et al. (2015) presented the results that the SB introduction can be used by the NB manufacturer to his advantage. They showed that when a Stackelberg game's leader is the retailer, the manufacturer may profit in this situation. Jin et al. (2017) stated that different strategies of the channel would be useful to the manufacturer in deterring the retailer's SB introduction and studied the interaction between retailer's decisions and channel strategy. They examined the situation in which the manufacturer of the NB selects one or two retailers to sell his products to customers. In contrast, the retailer may want to compete with the NB manufacturer by introducing the SB in her store. They found out that the retailers in the single channel have less incentive to introduce the SB in front of NB. Also, their research showed that the retailers under dual channel strategy with a different wholesale price at each channel have more motivation to propose the SB than the situation in which the wholesale price of NB at each channel of the dual channel is the same. Another study examined that the NB manufacturer could use the advertising and pricing strategy to prevent the SB entry (Karray et al., 2019). Their results showed that the producer of the NB could effectively barricade customers from buying the SB by changing the sequence of SC strategic decisions (advertising and pricing) before or after SB enters. Zhe Zhang et al. (2021) developed a game-theoretic model to study the SB introduction and manufacturer's encroachment interactions. They pointed out that the manufacturer cannot hamper a competitive SB introduction by encroachment strategy. However, the retailer might prevent encroachment of the manufacturer by introducing the SB.

Despite traditional wisdom, they showed that the retailer could threaten the manufacturer more if SB's low cost. However, the manufacturer can decrease the retailer's profit by encroaching. Ganesh Balasubramanian et al. (2021) studied the manufacturer's encroachment effect in which the product of the manufacturer and retailer have partial replacement between their own. They found out that if the retailer does not offer the SB in-store, she will benefit from the encroachment strategy of the manufacturer. In contrast, they concluded that if the NB and the SB have a close replacement coefficient, the manufacturer's encroachment strategy will harm the retailer. Also, the effect of the SB replacement can hamper the manufacturer's encroachment or cut down the sales of his product quantity. In addition, the symbiosis of the SBs and encroachment of the manufacturer might be profitable for whole supply chain members such as the manufacturer, the retailer, and customers. Scheana et al. (2023) addressed the effect of the signal of Euro-leaf's on SBs and NBs competition. They examined the effect of an eco-label as an ecological signal on consumer behavior on various food packaging. Cascio et al. (2023) considered consumers' evaluation from NBs and SBs under dual branding rumer. Sometimes manufacturers create SB in secret to compete with NB. Consumers will revise their evaluation of NB and SB if they find out about dual branding. Also, The increase of environmental concerns in the last decade led Yu et al. (2023) to study a dynamic cooperative game in a competitive supply chain with manufacturer NB and retailer SB, considering the carbon trading policy, using cooperative differential game theory.

Brüggemann and Schultz (2023) investigated the role of the emergence of Online Grocery Shopping(OGS) on the market share of NBs and SBs. The results showed that online shopping has increased the sales of NBs and decreased the sales of SBs. In other words, buying food online by consumers is beneficial for NBs. Taleizadeh et al. (2023) investigated the possibility of buying products through the website considering the cash-back in a dynamic supply chain. In this supply chain, if consumers buy products online, some of the total purchase amount is returned to the consumer to motivate them. This feature will be effective especially when the consumer feels dissatisfied with the price of the products. Also, consumers can receive all or part of their money from the seller if they are not satisfied with the products. Volles et al. (2023) addressed the effect of recommending the purchase of SB versus NB in online grocery shopping. They showed that if the online shopping offer of SB versus NB is presented, consumers prefer to change their product unless the consumer has high brand loyalty. Therefore, online advertising can have a significant effect on the sale of SB products. Taleizadeh et al. (2022) have studied the supply chain network in which two producers produce products with different qualities. On the other hand, the retailer's demand in a certain period is considered certain. In this supply chain, the producer of a high-quality product borrows from the peer-to-peer lending platform at a certain rate. While the producer of low-quality products pre-sells his products to attract capital. Guo et al. (2023) studied the issue of supply strategy determination by NB manufacturers in a competitive supply chain between NB and SB. In this supply chain, retail sales of the SB products are offered to consumers with packaging similar to NB. This issue has confused consumers. They showed that consumer confusion can be a win–win game for the manufacturer and the retailer. Cao et al. (2023) designed an optimal contract for a NB manufacturer. Manufacturer NB sells its products to consumers through a retailer. The retailer may also offer its SB product to consumers in the store. The retailer keeps confidential information related to the production cost of SB. They showed that under certain conditions, producers and retailers can have a better situation.

2.2 Dynamic discount pricing literature

Li et al. (2018) examined the effect of DDP on Word-of-Mouth (WOM) marketing. They modeled the dynamic discount pricing as an optimal control problem. Also, Xiang Zhong et al. (2018) studied viral marketing campaigns to develop cost-effective DDP strategies for its problems. A study showed that the DDP could be employed in food delivery and surplus food redistributing, such as Too Good To Go or UberEats (Sakaguchi et al. 2018). Jian et al. (2019) examined an effective DDP strategy as a marketing tool in a competitive circumstance. They used optimal control theory to solve the word-of-mouth propagation problem using a DDP strategy. Their research proved that the DDP strategy positively affects the manufacturer's profits in a competitive market environment. They considered demand as probable. Buratto et al. (2019) studied mechanisms such as a price discount and a cooperative advertising program that members of the supply chain can exploit to supply chain coordination goals. They studied a revenue-sharing agreement with a consignment contract in which the manufacturer determines the quality investment and the product's retail price. At the same time, the retailer only can decide on the advertising effort level of the own store. Buratto et al. (2019) considered that the manufacturer uses product pricing and quality decisions to promote goodwill as the brand owner. They proposed a game-theoretic solution in dynamic concept in which the Stackelberg leader is the manufacturer, and his follower is the retailer. They assumed that the leader of the market (manufacturer) always decides on the channel coordination mechanism. Considering cooperative programs in the channel by the manufacturer is always profitable to the retailer. Thus, the manufacturer's coordination mechanism has profit Pareto. While their results revealed that the manufacturer's price discount mechanism permanently harmed the retailer because discounts decreased the product's margins. The price discount causes the retail price of products to fall and increases the demand for products. As a result of this, the retailer prefers an uncoordinated channel. Rubi Das et al. (2021) studied how the retailer can be motivated by incentive programs to change its strategies to improve the whole channel. They suggested that the companies can coordinate their pricing and ordering strategies in the SC by using the price discount mechanism. They analyzed the decentralized model under the Stackelberg game approach, in which the manufacturer leads the channel, and the product's retail price affects the demand. Also, it found that the price discount mechanism improves the profit of SC and its members compared to there being no discount whether the channel is being centralized or decentralized.

2.3 Gap analysis

The literature review of the SB introduction reveals that researchers have studied various methods which the manufacturer can use to prevent SB introduction by the retailer (Sayman & Raju 2017). Nonetheless, there is no research investigating whether the retailer can use tools such as DDP strategy to improve SB and confront NB's manufacturer strategies. In this research, a dynamic game model is formulated to configure a mixed DDP strategy with NB and SB competitive market. The retailer can benefit from DDP at fighting against the manufacturer's pressure while providing a trade-off analysis suite in achieving different levels of discount. In the past decade, as a part of a trading ecosystem and a link between the manufacturer and the customer, the retailers had a significant role in offering the product in target markets (Ranjbar et al. 2021). Most manufacturers market their products through large retailers because the retail position is established among the customers, increasing sales and success of the products. For example, Walmart, the second retailer globally after Amazon, has a worldwide SC that includes almost 2800 suppliers for its vastly different goods (Walmart 2022). Any manufacturer wants to be one of Walmart's supplier network because it is profitable and improve their market share. Walmart's supplier network is getting bigger because its operations have grown all over the world in which it had 11,501 stores in about 30 different countries in January 2020. Walmart ‘s revenue was $510 billion in 2019 that had an about 2.3% compared to 2018. Therefore, the retailer’s strategic decisions, such as advertising decisions, can significantly impact customers’ purchasing decisions. So, the manufacturer’s decisions strengthen brand image and affect the demand for products. For example, the advertising of the manufacturer and the retailer strengthen brand awareness, attracts new customers to store, and stimulates demand for NB and SBs products. The goodwill of the product consists of the advertising effect of the manufacturer and the retailer. The spillover effect is the indirect effect of one thing on another. Having well-known products in a shop attracts customers and buyers to the store. Increasing the number of customers entering the store due to the availability of known products inadvertently affects the demand for other products (Karray & Martin-Herran 2019). Nevertheless, this subject has not been clearly investigated in the related literature review. Therefore, in this article, the spillover of the manufacturer NB product on the SB is considered a mathematical expression in the model different from related research.

The specification of this research compared to previous related studies has been summarized in Table 1. It will indicate the contribution of this research. This study assumes that goodwill affects demand for both NB and SBs. In this way, this study’s main contributions are proposed as follows: (1) This is the first paper that uses the DDP strategy by the retailer to improve SB introduction and prevent the manufacturer from using his strategies to deter SB entry. Using this mechanism causes the retailer and the manufacturer to increase profits by SB entry. Thus, the proposed mechanism results in a Pareto-optimal solution for channel members; and (2) To the best of our knowledge, this is the first study that considers the spillover effect of the NB product’s goodwill on the SB as a mathematical expression in the problem model and the profit function of the retailer. The spillover effect causes the retailer to use the customer’s utility of NB products to increase sales of other store products such as SB.

3 Problem description

This study considers a supply chain channel with two members consisting of a manufacturer (M, he) that produces the NB and a retailer (R, she) that purchases the manufacturer’s product and proposes them to the customers in her store. In addition, besides providing NB, she can offer another product to customers, such as the SB. The NB has a higher quality than the SB, which a third party supplies to the retailer. The introduction of SB by the retailer in the market shrinks the profit of the manufacturer and his market share. As the market leader, the manufacturer makes decisions to compensate for the damage and puts pressure on the retailer to deter or even avoid introducing the SB. On the other hand, to create economic stability for SB and improve her profit and sales of products, the retailer decided to use the DDP strategy to frustrate the manufacturer’s measures. Using the DDP strategy can be profitable for both parties since it stimulates demand and attracts new customers to her store.

Table 1 Brief literature review

Article	Decision policy			Discount policy		Competitive products	Preemptive	Solution method
	Pricing	Advertis-ing level	Discount	Static	Dynamic			
Karray and Martin-Herran (2009)	✓	✓	✓	✓		✓		Dynamic Game Theory
Groznik and Heese (2010)	✓		✓	✓		✓		Game Theory
Heese (2010)	✓	✓	✓	✓		✓		Game Theory
Amrouche and Yan (2011)	✓					✓		Game Theory
Ngobo and Jean (2012)	✓	✓				✓		Exploratory Factor Analysis
Fang et al. (2013)	✓					✓		Game Theory
Nasser et al. (2013)	✓					✓		Game Theory
Chen and Dimitrov (2014)	✓	✓				✓		Game Theory
Ru et al. (2015)	✓					✓		Game Theory
Amaldoss and Shin (2015)	✓		✓	✓		✓		Game Theory
Jin et al. (2017)	✓					✓		Game Theory
Oblrich et al. (2017)	✓					✓		Empirical Methodologies
Karray and Martin-Herran (2018)	✓	✓				✓		Game Theory
Cheng et al. (2018)	✓					✓		Game Theory
Buratto et el. (2019)	✓	✓	✓		✓			Dynamic Game Theory
Zhang et al. (2021)	✓					✓		Game Theory
Balasubramanian and Maruthasalam (2021)	✓					✓		Game Theory
Cao et al. (2021)	✓					✓		Game Theory
Karray and Martin Herran, (2022)	✓	✓				✓		Game Theory
This study	✓	✓	✓		✓	✓	✓	Dynamic Game Theory

All variables in this paper are considered dynamic. Therefore, optimal control theory has been used to solve the problem. Optimal control theory is a subset of mathematical optimization science that seeks to calculate a control for dynamic systems in a certain time to optimize the objective function. The Hamilton–Jacobi–Bellman (HJB) equation in optimal control theory concerning loss function provides a necessary and sufficient condition for control optimality. In general, this is a nonlinear partial differential equation in the value function, which means that its solution is the value function itself (Yong et al. 1999).

The channel leader (manufacturer) determines the NB products' wholesale price (W(t)) and also his advertising effort level (A_m(t)) on them. The retailer, as the follower of the leader, decides on the NB's retail price(P_n(t)). Also, the retailer can offer some services as a value-add, like an advertising activity to promote the NB products (A_r(t)). Moreover, she sets the retail price for SB(P_s(t)).

In this study, The retailer determines the discount on NB ($\lambda_{(t)}$). In other words, $\lambda_{(t)}$ represents the dynamic discount pricing. The effect of the proposed discount on the problem variables occurs by changing the demand function of the NB.

Note that the advertising levels conducted by the manufacturer are a national effort, and the retailer's advertising is local efforts or non-price promotions that are implemented to stimulate sales of NB and SB quickly. Considering that the model is non-linear, to reduce the complexity of the problem, the dynamic discount value has been considered as a parameter. A summary of all notations is represented in Table 2.

Three scenarios are presented to examine the impact of proposing the SB and the mutual reactions of each party to maintain or promote their profit. In the first scenario(Benchmark), the NB products are offered to customers by the retailer, and there is no competitor product in the market. In the second scenario(SWAD), a competitor product called SB is offered to customers besides proposing the NB. We analyze the SB introduction effects on the NB's market share and each SC party's profit. Finally, in the third scenario(SWDD), based on our observation from the second scenario, the possible reactions of each party have been proposed. The concept of all scenarios is shown in Fig. 1. The paper's model has main assumptions usually used in the literature of marketing channel and SB introduction (Cai et al., 2012; Sethuraman 2009; Ingene & Parry, 2007). First, the production costs of NB and SB are considered equal to zero for decreasing the problem complexity and calculation. Second, the supply chain member's advertising costs are supposed to be quadratic to show an increased marginal cost of advertising. Third, procurement and inventory decisions are considered exogenous in this problem. Forth, the NB products have a spillover effect on the SB products. These assumptions are used widely in NBs and SBs related literature (for extra study, see Sethuraman 2009).

After obtaining the HJB equation, the solution process is similar to Stackelberg game. a Stackelberg game sequence play is a valuable tool for the supply chain's pricing decisions, which was proved by empirical evidence (Sudhir, 2001). First, the manufacturer (channel's leader) announces his decision(s), then the retailer reacts to the leader's decision(s) announcement and, after evaluating them, decides on her variables. On the other hand, the retailer follows the manufacturer by making the same decision(s).

Table 2 Summary of all notations

Wholesale price of the NB
Retail price of the NB
Retail price of the SB
Advertising effort level of the manufacturer on the NB
Advertising effort level of the retailer on the NB
The amount of dynamic discount
Demand for the NB
Demand for the SB
Baseline demand parameter of the NB
Baseline demand parameter of the SB
Effect of the NB's retail price on its demand
Effect of the SB's retail price on its demand
Effect of the manufacturer's advertising effort level on NB's goodwill
Effect of the retailer's advertising effort level on NB's goodwill
Diminishing level of the accumulated goodwill of the NB due to consumers' forgetful behavior, $\delta \in (0, 1)$
Positive parameter of the manufacturer's advertising cost on the NB
Positive parameter of the retailer's advertising cost on the NB
Effect of competing product's price on demand (replacement coefficient)
Discount rate
The NB's demand elasticity for the NB's goodwill
The SB's demand elasticity for the NB's goodwill
The goodwill of the NB
Profit of the manufacturer
Profit of the retailer

In the following, the three scenarios will be modeled, and the equilibriums of each scenario will be obtained.

3.1 The first scenario-benchmark

Only the NB products are proposed to customers in the retailer's store in this scenario. The manufacturer of the NB product announces the wholesale price (W(t)) and advertising effort level on the NB (A_m(t)). Then, the retailer determines the NB's retail price (P_n(t)), and advertising level effort on the NB (A_r(t)). The demand for the NB can be written as follows:

$$d_{n(t)} = (g_n - \beta_n P_{n(t)})k_1 G \tag{1}$$

where g_n represents the baseline demand for the NB when it is not advertised, P_n represents the NB products' retail price, and G is the NB's goodwill. Note that β_n and k_1 are the NB's demand elasticity for the NB's retail price and goodwill, respectively. According to expression 1, decreases of the NB products' retail price will

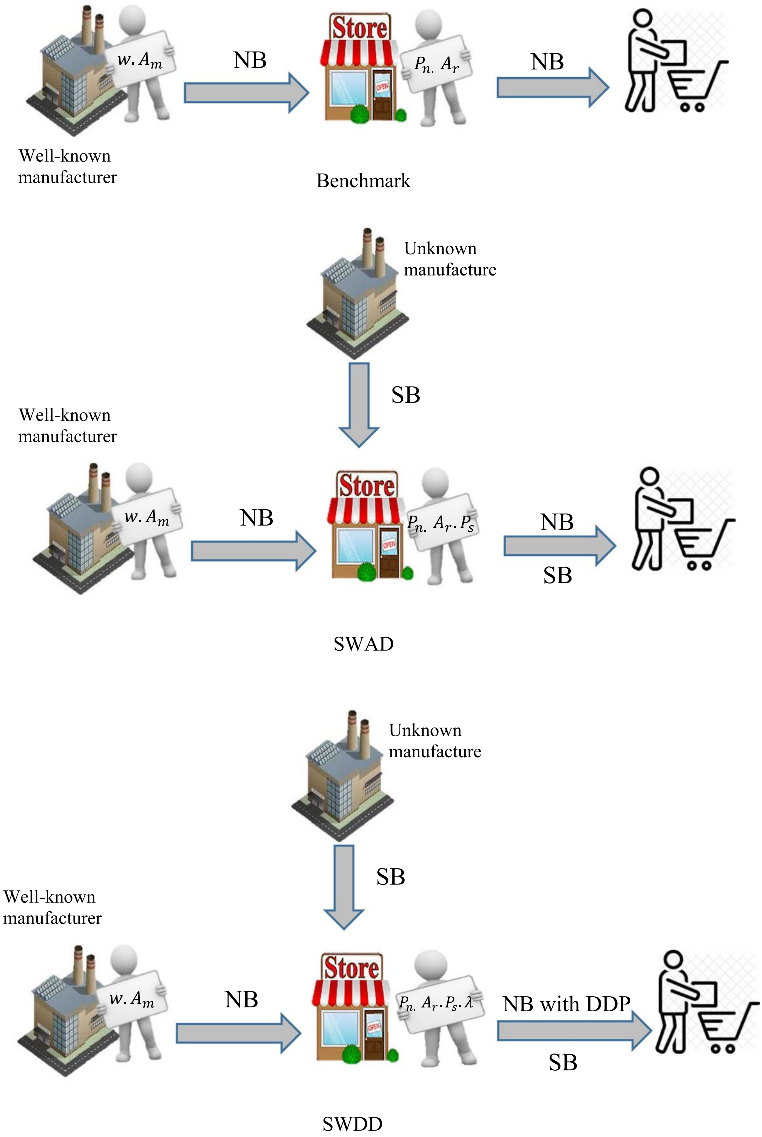

Fig. 1 Concept of model

increase the NB product's demand and conversely. According to our assumptions, goodwill takes the following form:

$$\dot{G} = L_m A_m + L_r A_r - \delta G \tag{2}$$

where first and second terms show the effect of the advertising effort level on the goodwill which the manufacturer and the retailer consider promoting the NB, respectively. The last decay term corresponds to the natural decrease of goodwill stock because of the consumers' forgetful behavior. This study uses a common multiplicative function of goodwill and demand (e.g., Xie & Wei, 2009; Zhimin Guan, 2020; El Ouardighi, 2014).

Let index "A" indicate the equilibrium under the first scenario. This scenario considers the following members' playoffs:

$$\Pi_M^A = \int_0^\infty e^{-rt}\pi_M(t)dt$$
$$\pi_M(t) = w(t)d_n - \frac{1}{2}C_m A_m^2(t) \tag{3}$$

$$\Pi_R^A = \int_0^\infty e^{-rt}\pi_R(t)dt$$
$$\pi_R(t) = \left(P_{n(t)} - w_{(t)}\right)d_n(t) - \frac{1}{2}C_r A_r^2(t) \tag{4}$$

Both members aim to maximize their profit functions through a dynamic game. The retailer determines the retail price of the NB and SB and advertising effort level; after becoming aware of the NB product's wholesale price and advertising effort level which, the manufacturer decides about them. The following Proposition characterizes the solutions for scenario 1:

Proposition 1 *Under the first scenario, the firms' solutions are as follow:*

$$w^A = \frac{0.5g_n}{\beta_n} \tag{5}$$

$$P_n^A = \frac{0.75g_n}{\beta_n} \tag{6}$$

$$A_m^A = \frac{0.0125g_n^2 K_1 L_m}{\beta_n C_m(\delta + r)} \tag{7}$$

$$A_r^A = \frac{0.0625g_n^2 K_1 L_r}{\beta_n C_r(\delta + r)} \tag{8}$$

Proof See in Supplementary material 1.

3.1.1 The second scenario-SB without any discount (SWAD)

In this scenario, the retailer introduces the SB and offers them along with the NB to consumers. The demand functions for NB and SBs are given by d_n and d_s such as:

$$d_n(t) = (g_n - \beta_n P_n(t) + t(P_s(t) - P_n(t)))k_1 G \tag{9}$$

$$\mathrm{d_s(t) = (g_s - \beta_s P_s(t) + t(P_n(t) - P_s(t)))k_2 G} \tag{10}$$

In the above demand functions, each product's demand is affected by retail price and the difference between retail prices of two competing products. k_2G represents the spillover effect of the NB on the SB's demand. Note that t is the replacement coefficient. For example, t = 1 means NB and SBs are totally replaceable. Let index "B" indicate the equilibrium under the second scenario. The profit functions of the supply chain's members are shown in Eqs. (11) and (12):

$$\begin{gathered}\Pi_{\mathrm{M}}^{\mathrm{B}} = \int_0^\infty \mathrm{e}^{-\mathrm{rt}} \pi_{\mathrm{M}}(\mathrm{t})\,\mathrm{dt} \\ \pi_M(t) = w(t)d_n(t) - \frac{1}{2}C_m A_m^2(t)\end{gathered} \tag{11}$$

$$\begin{gathered}\Pi_R^B = \int_0^\infty e^{-rt} \pi_R(t) dt \\ \pi_R(t) = \left(P_n(t) - w(t)\right)d_n(t) + P_s(t)d_s(t) - \frac{1}{2}C_r A_r^2(t)\end{gathered} \tag{12}$$

where the manufacturer's profit function under this scenario is similar to the Benchmark scenario. However, the retailer's profit function is different from the Benchmark scenario because of the introduction of the SB. So the retailer's revenue from selling the SB is considered in the second term of the retailer's profit function. The following Proposition characterizes the solutions for this game:

Proposition 2 Under the second scenario, the firms' solutions are as follow:

$$W^B = -\frac{1}{c_3 K_1 (c_2 c_3 - t^2)}\left(0.25(t(c_3 g_s (K_2 - K_1) + g_n t(K_1 + K_2)) - 2c_2 c_3 g_n K_1)\right) \tag{13}$$

$$A_m^B = \frac{0.03 K_2 L_m (t(c_3 g_s (K_2 - K_1) + g_n t(K_1 + K_2)) - 2c_2 c_3 g_n K_1)^2}{c_3 c_m (\delta + r)(c_2 c_3 - t^2)(c_2 c_3 c_{10} + t^2(-0.25 c_9 - 0.5 c_{10}))} \tag{14}$$

$$\begin{aligned}\mathrm{P_n^B} = {} & \frac{1}{(\mathrm{c_3(c_2c_3 - t^2)(c_{10}c_2c_3 + t^2(-0.5c_{10} - 0.25c_9)))}} \\ & ((0.75\mathrm{c_{10}c_2^2c_3^2g_n + c_2c_3t(g_nt(-0.75c_{10} - 0.13c_9)} \\ & + \mathrm{c_3g_sk_2(0.38k_1 + 0.13k_2)) + t^3(c_3g_s(-0.25c_{10} - 0.06k_1^2 - 0.19k_2^2)} \\ & + \mathrm{g_nt(0.13c_{10} + 0.06c_9))))}\end{aligned} \tag{15}$$

$$P_s^B = \frac{1}{\left(c_2c_3 - t^2\right)\left(c_2c_3c_{10} + t^2\left(-0.25c_9 - 0.5c_{10}\right)\right)}(c_2c_3k_1(0.5c_3g_sk_2 + g_nt(0.16k_1 + 0.38k_2)) + t^2(c_3g_s(-0.06c_9 - 0.38c_{10}) + g_nt(-0.19c_9 - 0.25C_{10} + 0.16k_2^2))) \tag{16}$$

$$A_r^B = \frac{1}{c_3c_n(\delta + r)\left(c_2c_3 - t^2\right)\left(c_2c_3c_{10} + t^2\left(-0.25c_9 - 0.5c_{10}\right)\right)}(0.06k_2L_r(c_2c_3g_n^2k_1t^2(k_1 - 3k_2) + c_4 + 4c_5 + c6(k_1 + 7k_2) + c_7 + c_8 + g_n^2t^4(-0.75c_9 - 1.5c_{10}))) \tag{17}$$

Proof See in Supplementary material 2.

3.1.2 The third scenario-SB with dynamic discount (SWDD)

In the first and second scenarios, the optimal solutions for SC parties' decisions are obtained where the retailer proposes only the NB and both NB and SB, respectively. Intuitively, when the SB is introduced, the market shares of the NB product will reduce. Therefore, the manufacturer seeks ways to compensate for this market loss. Several strategies have been considered for the manufacturer in the literature to regain its market share (Nasser et al. 2013; Zhang et al. 2021). All these strategies contribute to reconstructing the demand for the NB by reducing that of the SB. Under this situation, the profit of the retailer will be less than SWAD, while that of the manufacturer will be less than the first scenario. In other words, neither the manufacturer nor the retailer reaches their optimal profit in this situation. To avoid this, we consider a preemptive strategy for the retailer.

Being aware of the effects of introducing the SB on the NB's market share, she designs a dynamic discount for the NB. Using this strategy attracts more consumers for the NB while the market share of the SB will not reduce. The retailer uses this practice as an effective marketing tool to stimulate customers' preferences and increase sales. In some circumstances, this tool allows the retailer to preserve her business against the manufacturer's anticompetitive decisions (Sacco and De Giovanni, 2019). The NB's demand raising will compensate for a decrease in the manufacturer's market share, so the manufacturer will not implement strategies to prevent the SB entry. Under this situation, the NB's advertising effort level and the wholesale price are set by the manufacturer. Then, the retailer determines the retail price of the NB, the amount of discount, and at last sets the advertising effort level for the SB. The retailer specifies appropriate discount on the NB related to her margins at each period of T. Consequently, $\lambda(t) < P_n(t)$. This strategy has an impact on products' demands, which become:

$$\mathbf{d_n(t) = \left(g_n - \beta_n P_n(t) + t\left(P_s(t) - P_n(t)\right) + \lambda(t)\right)k_1 G} \tag{18}$$

$$d_s(t) = (g_s - \beta_s P_s(t) + t(P_n(t) - P_s(t)))k_2 G \tag{19}$$

Let index "C" indicate the equilibrium under SWDD. In this scenario, the profit function of the manufacturer (Π_M^C) and the retailer (Π_R^C) is given by:

$$\Pi_{M}^{C} = \int_{0}^{\infty} e^{-rt}\pi_{M}(t) \cdot dt$$
$$\pi_{M}(t) = w(t)\, d_{n}(t) - \frac{1}{2}C_{m}A_{m}^{2}(t) \tag{20}$$

$$\mathbf{\Pi_{R}^{C}} = \int_{0}^{\infty} \mathbf{e^{-rt}\pi_{R}(t) \cdot dt}$$
$$\mathbf{\pi_{R}(t) = \left[\left(P_{n}(t) - \lambda(t)\right) - w(t)\right]d_{n}(t) + P_{s}(t)d_{s}(t) - \frac{1}{2}C_{r}A_{r}^{2}(t)} \tag{21}$$

The backward induction is used to determine the best response of the retailer in the following Lemma:

Lemma 1 *Given the contract (W and A_m) offered by NB's manufacturer, the retailer's optimal values for both NB and SB retail prices ($P_n \cdot P_s$), advertising effort level for NB products (A_r), and dynamic discount policy per period (λ) are:*

$$P_{n} = \frac{2C_{2}(C_{3}-1)k_{1}(g_{n}-w)+t\left((C_{3}-1)g_{s}k_{1}+k_{1}t(w-g_{n})-2g_{s}k_{2}\right)}{2C_{2}(C_{3}-1)^{2}k_{1}+2t^{2}(-C_{3}k_{1}+k_{1}+k_{2})}$$

$$P_{s} = \frac{(C_{3}-1)k_{1}\left((C_{3}-1)g_{s}+t(g_{n}-w)\right)}{2C_{2}(C_{3}-1)^{2}k_{1}+2t^{2}(-C_{3}k_{1}+k_{1}+k_{2})}$$

$$A_{r} = \frac{x_{1}l_{r}}{C_{r}}$$

$$\begin{aligned} x_{1} = &-((0.047k_{2}(-1.34C_{2}^{2}C_{3}^{2} - g_{n}^{2}k_{1}^{2} + C_{2}C_{3}k_{1}(C_{3}^{2}k_{2}(-5.34g_{s}^{2} - 10.6g_{s}\lambda t - 5.34\lambda^{2}t^{2}) \\ &+ C_{3}g_{n}(-1.34g_{s}k_{1} - 9.34g_{s}k_{2} - 34k_{1}\lambda t - 9.34k_{2}\lambda t) + g_{n}^{2}t^{2}(1.34k_{1} - 4k_{2})) + t^{2}(C_{3}^{2}(g_{s}^{2}(k_{1}^{2} + 3.34k_{1}k_{2} + k_{2}^{2}) \\ &+ g_{s}\lambda t(2k_{1}^{2} + 6.6k_{1}k_{2} + 2k_{2}^{2}) + \lambda^{2}t^{2}(k_{1}^{2} + 3.34k_{1}k_{2} + k_{2}^{2})) + C_{3}gnt(3.34k_{1}^{2} + 5.34k_{1}k_{2} + 2k_{2}^{2})(g_{s} + \lambda t) \\ &+ g_{n}^{2}t^{2}(k_{1}^{2} + 2k_{1}k_{2} + k_{2}^{2}))))/(CC_{3}(\delta + r)(C_{3}C_{2} - t^{2})(C_{3}C_{2}k_{1}k_{2} + t^{2}(-0.25k_{1}^{2} - 0.5k_{1}k_{2} - 0.25k_{2}^{2})))) \end{aligned}$$

$$\lambda = \frac{2C_{2}(C_{3}-1)k1(g_{n}-C_{3}w)+t\left(-t\left(w(-2C_{3}k_{1}+k_{1}+k_{2})+g_{n}(k_{1}+k_{2})\right)+(C_{3}-1)g_{s}k_{1}-(C_{3}+1)g_{s}k_{2}\right)}{2C_{2}(C_{3}-1)^{2}k_{1}+2t^{2}(-C_{3}k_{1}+k_{1}+k_{2})}$$

The main takeaways offered by this lemma is that the retailer, knowing the decision variables of the national brand manufacturer, determines the optimal amount of his variables in a way to maximize his profit. According to the Stackelberg game, the retailer as a follower makes its decisions after announcing strategic decisions (pricing, advertising) by the manufacturer as the leader. The retailer's profit function is derived concerning its variables in this part. Then, the retailer's variables are written based on the variables of the national brand producer and other parameters of the problem in closed form.

As seen in the formulas above, the retailer's decision variables only depend on the wholesale price of national brand products. It is interesting that they are independent of the manufacturer's advertising level. Therefore, according to this lemma, if the wholesale price of the national brand product increases or decreases, the retailer's decision variables may increase or decrease. This can also be seen in the result of the numerical example mentioned in Sect. 4. All the strategic decisions of the retailer, including the pricing of national and local brand products, the level of advertising effort on NB products and the amount of dynamic discount in the period in question, depend on the wholesale price of NB products announced by the NB manufacturer. The reason behind this is that the wholesale price of the NB directly affects its retail price. Other decision variables of the retailer are affected by the retail price of the NB. Therefore, the influence of the NB's retail price from its wholesale price causes the influence of other decision variables from NB's wholesale price. As a result, due to the fact that the manufacturer's advertising level does not directly affect the retail price of the national brand product, other variables of the retailer's decision are not affected by the manufacturer's advertising level. The manufacturer's advertising affects the demand and profit of the retailer through the goodwill of the national brand product.

The following Proposition characterizes the solutions for this game:

Proposition 3 Under the third scenario, the solutions of the decisions are as follow:

$$W^c = \frac{0.5\left(\left(C_3 - 1\right)g_s + g_n t\right)}{t} \tag{22}$$

$$A_m^C = \frac{0.125 k_1 k_2 L_m \left(\left(C_3 - 1\right)g_s + g_n t\right)^2}{C_M(\delta + r)\left(C_2\left(\left(C_3 - 2\right)C_3 + 1\right)k_1 + t^2\left(-C_3 k_1 + k_1 + k_2\right)\right)} \tag{23}$$

$$P_n^C = \frac{C_2 k_1 \left(g_n t\left(0.5 - 0.5C_3\right) + 0.5 g_s \left(1 - C_3\right)^2\right) + t^2\left(g_s\left(-0.75C_3 k_1 + 0.75k_1 + k_2\right) + 0.25 g_n k_1 t\right)}{t^3\left(\left(C_3 - 1\right)k_1 - k_2\right) - C_2 k_1 t\left(1 - C_3\right)^2} \tag{24}$$

$$P_s^C = \frac{0.25\left(C_3 - 1\right)k_1\left(\left(C_3 - 1\right)g_s + g_n t\right)}{C_2\left(\left(C_3 - 2\right)C_3 + 1\right)k_1 + t^2\left(-C_3 k_1 + k_1 + k_2\right)} \tag{25}$$

$$A_r^C = \frac{0.0625 k_1 k_2 L_r \left(\left(C_3 - 1\right)g_s + g_n t\right)^2}{C_r(\delta + r)\left(C_2\left(\left(C_3 - 2\right)C_3 + 1\right)k_1 + t^2\left(-C_3 k_1 + k_1 + k_2\right)\right)} \tag{26}$$

$$\lambda = \frac{C_2 k_1 \left(C_3 g_n t\left(1.5 - 0.5C_3\right) - 0.5C_3 g_s \left(1 - C_3\right)^2 - g_n t\right) + t^2((0.5c3 - 0.75)g_n k_1 t + ((0.5c3 - 0.25)c3 - 0.25)g_s k_1 - \left(0.75C_3 + 0.25\right)g_s k_2 - 0.75 g_n k_2 t)}{C_2 k_1 t\left(1 - C_3\right)^2 + t^3\left(k_1\left(1 - C_3\right) + k_2\right)} \tag{27}$$

while the trajectory for goodwill is: $G(t) = \left(G_0 - G_{ss}^C\right)e^{-rT} + G_{ss}^C$, and the present value of the retailer's and the Mnaufacturer's total profit is:

$$\pi_R = \frac{k_1 k_2\left((C_3-1)g_s+g_n t\right)^2\left(0.0625G_0 r(\delta+r)\left(C_2\left((C_3-2)C_3+1\right)k_1+t^2\left(k_1(1-C_3)+k_2\right)\right)+\frac{0.002k_1k_2\left((C_3-1)g_s+g_n t\right)^2\left(C_M L_r^2+4C_r L_m^2\right)}{C_M C_r}\right)}{(\delta+r)^2\left(C_2\left((C_3-2)C_3+1\right)k_1+t^2\left(k_1(1-C_3)+k_2\right)\right)^2}$$

$$\pi_M = \frac{k_1 k_2\left((C_3-1)g_s+g_n t\right)^2\left(0.125G_0 r(\delta+r)\left(C_2\left((C_3-2)C_3+1\right)k_1+t^2\left(k_1(1-C_3)+k_2\right)\right)+\frac{0.008k_1k_2\left((C_3-1)g_s+g_n t\right)^2\left(C_M L_r^2+C_r L_m^2\right)}{C_M C_r}\right)}{(\delta+r)^2\left(C_2\left((C_3-2)C_3+1\right)k_1+t^2\left(k_1(1-C_3)+k_2\right)\right)^2}$$

where $G_{ss}^{C} = \frac{(0.0625k_1k_2(2C_rL_m^2+C_ML_r^2)(C_3g_s-g_sg_nt)^2)}{C_rC_M(\delta+r)(C_2k_1+(k_1+k_2)t^2-C_3k_1t^2-2C_2C_3k_1+C_2C_3^2k_1)}$ *denotes the steady state of accumulatedgoodwill.*

Proof See in Supplementary material 3.

The concavity of the retailer's and manufacturer's objective function is presented in Supplementary material 4. The manufacturer's NB product and the SB product that is offered to customers by the retailer have relationship with each other, they are a threat to each other in terms of market share. The decision variables of supply chain members in this case are according to the following lemma:

Lemma 2 *If the two products(NB and SB) are compeletly dependent of each other, i.e.* $t=1$. *In this situation, the NB manufacturer does have Maximum retaliatory action against the retailer. In this case, the value of the producer and retailer decision variables is as follows:*

$$W = 0.5\left(\left(C_3 - 1\right)g_s + g_n\right)$$

$$P_n = \frac{C_2k_1\left(g_n\left(0.5 - 0.5C_3\right) + 0.5g_s\left(1 - C_3\right)^2\right) + \left(g_s\left(-0.75C_3k_1 + 0.75k_1 + k_2\right) + 0.25g_nk_1\right)}{\left(\left(C_3 - 1\right)k_1 - k_2\right) - C_2k_1\left(1 - C_3\right)^2}$$

$$P_s = \frac{0.25(C_3 - 1)k_1((C_3 - 1)g_s + g_n)}{C_2((C_3 - 2)C_3 + 1)k_1 + (-C_3k_1 + k_1 + k_2)}$$

$$A_m = \frac{0.125k_1k_2L_m((C_3 - 1)g_s + g_n)^2}{C_M(\delta + r)(C_2((C_3 - 2)C_3 + 1)k_1 + (-C_3k_1 + k_1 + k_2))}$$

$$A_r = \frac{0.0625k_1k_2L_r((C_3 - 1)g_s + g_n)^2}{C_r(\delta + r)(C_2((C_3 - 2)C_3 + 1)k_1 + (-C_3k_1 + k_1 + k_2))}$$

$$\lambda = -((0.25(g_nk_1\left(3 + 4C_2 - 2C_3 - 6C_2C_3 + 2C_2C_3^2\right) + g_sk_1(1 + C_3 + 2C_2C_3 - 2C_3^2 - 4C_2C_3^2 + 2C_2C_3^3) + 3g_nk_2 + g_sk_2 + 3C_3g_sk_2))/(k_1 + C_2k_1 - C_3k_1 - 2C_2C_3k_1 + C_2C_3^2k_1 + k_2))$$

Lemma 3 *If the coefficient of influence of good will on the demand of the NB products of the national manufacturer and also of the SB products of the retailer is considered equal to one* ($k_1=k_2=1$). *then the decision variables related to the manufacturer and retailer are as follows:*

$$
\begin{aligned}
W &= \frac{0.5C_3 g_s - (g_n t + g_s)}{t} \\
P_n &= -\frac{3.C_2 C_3 g_n g_s^2 - \left(C_2 (4C_3 + 2) g_s + 2C_2 g_n t + t^2 (g_n t + 7g_s)\right)}{2C_2 C_3 + C_2 + 2t^2} \\
P_s &= \frac{0.25 g_s (g_n t + g_s)}{C_2 C_3 t^2 (\delta + r)(2C_2 C_3 + C_2 + 2t^2)} \\
A_m &= \frac{0.125 g_s^2 L_m (g_n t + g_s)^2}{C_2 C_3 C_m t^2 (\delta + r)(2C_2 C_3 + C_2 + 2t^2)} \\
A_r &= \frac{0.0625 g_s^2 L_r (g_n t + g_s)^2}{C_2 C_3 C_r t^2 (\delta + r)(2C_2 C_3 + C_2 + 2t^2)} \\
\lambda &= -\frac{C_2 C_3^5 g_s^{2\_2} (0.5 g_n t + g_s)(C_2 C_3 g_n + g_s t)\left(C_2 C_3 (3g_n t + g_s) + 2C_2 g_n t + t^2 (3g_n t + g_s)\right)}{C_2 C_3 + 0.5C_2 + t^2}
\end{aligned}
$$

Lemma 4 *If the coefficient of influence of the retail price of NB and SB products on the demand function of each product is considered the same and equal to one. then the decision variables related to the manufacturer and retailer are as follows*:

$$
\begin{aligned}
W &= (g_n + g_s) \\
P_n &= \frac{0.25\left(g_n k_1 (t + 2) + g_s k_1 (t - 2) - 4 g_s k_2\right)}{t(k_1 + k_2)} \\
P_s &= \frac{0.25 k_1 (g_n + g_s)}{(k_1 + k_2)} \\
A_m &= \frac{0.125 k_1 k_2 L_m (g_n + g_s)^2}{C_m (\delta + r)(k_1 + k_2)} \\
A_r &= \frac{0.0625 k_1 k_2 L_r (g_n + g_s)^2}{C_r (\delta + r)(k_1 + k2)} \\
\lambda &= \frac{g_n k_1 (0.5 - 0.25t) - 0.75 g_n k_2 t + g_s k_1 (-0.25t - 0.5) + g_s k_2 (-0.75t - 1)}{t(k_1 + k_2)}
\end{aligned}
$$

Lemma 5 *If NB and SB products are completely independent from each other, there will be no reason for the national producer to oppose the entry of SB products into the market. In other words, the value of t will be zero. In this case, the decision variables related to the manufacturer and retailer are as follows*:

$$
\begin{aligned}
\boldsymbol{W} &= 0 \\
P_n &= \frac{g_n}{\beta_1 - 1} \\
P_s &= \frac{\mathbf{0.5} g_s}{\beta_2} \\
A_m &= \mathbf{0} \\
A_r &= \frac{\mathbf{0.25} g_s^{\mathbf{2}} k_2 L_r}{\beta_2 C_r (\boldsymbol{\delta} + \boldsymbol{r})} \\
\lambda &= \frac{g_n}{\beta_n - 1}
\end{aligned}
$$

The NB and SB products are considered completely independent of each other. In other words, these two products are completely different from each other and have no effect on each other. In this context, the decision variables for the manufacturer and the retailer were obtained. The results show that the retailer in this situation adopts the decision variables related to eBay products without being influenced by the manufacturer's decisions.

Lemma 6 *To compare the equations obtained in scenario one* (*Proposition* 1) *with the case where dynamic discount and SB products are provided by the retailer*, *it is assumed that* $t = 1$, $k_1 = k_2 =$ *and* $\beta_n = \beta_s$. *Therefore*, *the decision variables of the manufacturer and retailer in the supply chain will be as follows*:

$$
\begin{aligned}
\boldsymbol{W} &= \mathbf{0.5}\beta_n g_s + \mathbf{0.5} g_n \\
P_n &= \frac{\left(\left(\mathbf{0.5}\beta_n + \mathbf{0.5}\right)\beta_n - \mathbf{0.25}\right) g_n + \left(\beta_n\left(\left(-\mathbf{0.5}\beta_n - \mathbf{0.5}\right)\beta_n + \mathbf{0.75}\right) - \mathbf{1}\right) g_s}{\beta_n\left(\beta_n^{\mathbf{2}} + \beta_n - \mathbf{1}\right) + \mathbf{1}} \\
P_s &= \frac{\mathbf{0.25}\beta_n\left(\boldsymbol{\beta}_{\mathbf{1}} g_s + g_n\right)}{\beta_n\left(\beta_n^{\mathbf{2}} + \beta_n - \mathbf{1}\right) + \mathbf{1}} \\
A_m &= \frac{\mathbf{0.125} k_1 L_m \left(\beta_n g_s + g_n\right)^{\mathbf{2}}}{\left(\beta_n\left(\beta_n^{\mathbf{2}} + \beta_n - \mathbf{1}\right) + \mathbf{1}\right) C_{\boldsymbol{m}} (\boldsymbol{\delta} + \boldsymbol{r})} \\
A_r &= \frac{\mathbf{0.0625} k_1 L_r \left(\beta_n g_s + g_n\right)^{\mathbf{2}}}{\left(\beta_n\left(\beta_n^{\mathbf{2}} + \beta_n - \mathbf{1}\right) + \mathbf{1}\right) C_r (\boldsymbol{\delta} + \boldsymbol{r})} \\
\lambda &= -\frac{\mathbf{0.5}\left(\left(\beta_n^{\mathbf{3}} - \mathbf{2}\beta_n + \mathbf{2}\right) g_n + \left(\left(\beta_n + \mathbf{2}\right)\beta_n^{\mathbf{3}} + \mathbf{2}\right) g_s\right)}{\beta_n\left(\beta_n^{\mathbf{2}} + \beta_n - \mathbf{1}\right) + \mathbf{1}}
\end{aligned}
$$

Despite the simplifications made in the parameters of the problem, it is still not possible to analyze the decision variables parametrically due to the complexity and dependence of the decision variables on the parameters. Therefore, to examine the changes made in the decision variables of the supply chain, manufacturer and retailer when offering dynamic discounts on NB products and also offering SB, a numerical example according to Sect. 4 has been used.

For simplicity, the below abbreviations are used in the third scenario's solutions.

It is interesting to compare decision variables in three scenarios to understand the effect of introducing SB product and DDP strategy on them. In this regard, corollary 1 characterizes the effect of DDP on the wholesale price:

Corollary 1 *Utilizing DDP will increase the wholesale price. In other words, the wholesale price in the SWDD is always higher than the SWAD.*

Proof Based on the obtained solutions we know:

$$W^B = -\frac{1}{C_3k_1(C_2 \cdot C_3 - t^2)}\left\{\frac{1}{4}\left[t\left(C_3g_s\left(k_2 - k_1\right) + g_nt(k_1 + k_2)\right) - 2C_2 \cdot C_3g_nk_1\right]\right\} \tag{28}$$

$$\boldsymbol{W^C} = \frac{\left(\left(\boldsymbol{C_3} - \mathbf{1}\right)g_s + g_n\boldsymbol{t}\right)}{\mathbf{2}\boldsymbol{t}} \tag{29}$$

So we can write:

$$W^C - W^B = \frac{\left(C_3g_s + g_nt\right)\left(2C_2\left(C_3 - \mathbf{1}\right)C_3k_1 + \boldsymbol{t^2}\left(-\mathbf{2}C_3k_1 + k_1 + k_2\right)\right)}{\mathbf{4}\boldsymbol{t}C_3k_1(C_2 \cdot C_3 - t^2)} \tag{30}$$

we have:

$$\beta_n > 0 \cdot t > 0 \rightarrow C_3 = \beta_n + t > 0. \tag{31}$$

$$\beta_s > 0 \cdot t > 0 \rightarrow C_2 = \beta_s + t > 0. \tag{32}$$

$$C_2 \cdot C_3 > 0 \cdot C_2 > 1 \cdot \boldsymbol{C_3} > 1 \rightarrow C_2 \cdot C_3 > 1. \tag{33}$$

$$t < 1 \rightarrow t^2 < 1, \quad C_2 \cdot C_3 > 1 \rightarrow C_2 \cdot C_3 - t^2 > 0. \tag{34}$$

Because $k_1 > 0$. we can write:

$$C_3k_1\left(C_2 \cdot C_3 - t^2\right) > 0 \tag{35}$$

Therefore, we need to prove the below equation

$$\left\{2C_2\left(C_3 - 1\right)C_3k_1 + t^2\left(-2C_3k_1 + k_1 + k_2\right)\right\} > 0 \tag{36}$$

On the other hand, if:

$$2C_2\left(C_3 - \mathbf{1}\right)C_3k_1 + \mathbf{t}^2\left(k_1 + k_2\right) > \mathbf{2}C_3k_1\mathbf{t}^2 \tag{37}$$

Then

Table 3 Abbreviations used in the solutions

Abbreviations	
$c_2 = \beta_s + t$	$c_3 = \beta_n + t$
$c_4 = c_2^2 c_3^2 g_n^2 k_1^2$	$c_5 = c_2 c_3^3 g_s^2 k_1 k_2$
$c_6 = c_2 c_3^2 g_s g_n k_1 t$	$c_7 = c_3 g_s g_n t^3 (-2.5k_1^2 - 4k_1k_2 - 1.5k_2^2)$
$c_8 = c_3^2 g_s^2 t^2(-0.75k_1^2 - 2.5k_1k_2 - 0.75k_2^2)$	$c_9 = k_1^2 + k_2^2$
$c_{10} = k_1 k_2$	$c_{11} = c_2 c_3$
$c_{12} = c_3 g_n t$	$c_{13} = g_n t$

Table 4 Numerical example results

Decision variable		First scenario	Second scenario	Third scenario
Wholesale price	W	5	3.46	3.71
Manufacturer's advertising effort	A_m	60	47.9	55.2
Retailer's advertising effort	A_r	10	14.5	29.8
Demand of the NB	d_n	632.5	607	805.35
Demand of the SB	d_s	–	149.14	461.95
Retail price of the NB	P_n	7.5	5.75	16.5
Amount of discount	λ	–	–	10
Retail price of the SB	P_s	–	3.47	5.7
Manufacturer's profit	Π_M	1962.5	1334.99	1971.68
Retailer's profit	Π_R	1548.75	1842.79	4553.04

$$W^c - W^B > 0, \quad \text{or} \quad W^c > W^B.$$

4 Numerical illustration

This section shows the validity of the equilibriums characterization in Propositions 1, 2, and 3 through a real case study. Softlan is a well-renowned NB that produces tissue in Iran. This manufacturer sells its products through a retail chain. In recent years, the demand spikes due to the Covid-19 pandemic panic buying have led the retail chain to provide more tissues from a local brand in order to avoid tissue shortages.[1] After consulting with the sales department of the NB manufacturer, we received the needed information.

Note that some parameters were not available so we applied the opinions of the managers of that department. The NB manufacturer produces a type of 6-m tissue roll that has a base demand of 10 (g_n). It advertises this product at the community level, and its advertising has an impact factor of 2 (L_m) and a cost factor of 0.65

[1] https://refah.ir/en/.

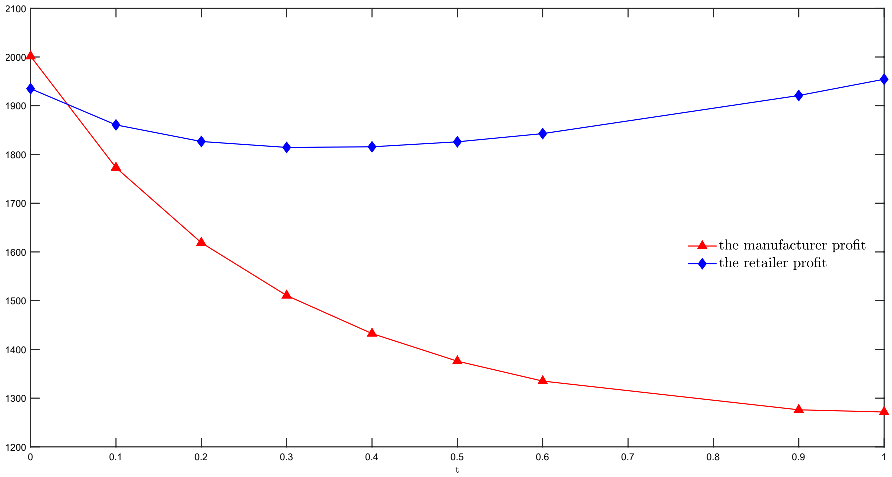

Fig. 2 Impacts of t on Π_M and Π_R in SWAD

(C_m). Also, the impact factor of goodwill (k_1) resulting from advertising is equal to 0.8, and the impact factor of retail price (β_n) on customer demand is 1 (Table 3).

In addition to this NB, the retail chain company offers a local brand product in its stores, which has exactly the specifications of the Softlan brand. The SB tissue's based demand was estimated to (g_s) 1. The retail chain advertises the SB tissue in its store to attract customers, which has an impact factor of 1 (L_r) and a cost factor of 0.67 (C_r). The spillover effect of the SB tissue in the retail chain on NB demand (k_2) is 0.3 and the impact factor of retail price (β_s) on customer demand is 1. The NB tissue has a replacement coefficient of 0.6 with SB tissue. Customer forgetfulness behavior coefficient (δ) equals 0.4, and discount rate (r) is 0.1. By using solutions obtained through the Propositions, the advertising effort levels, the wholesale price of the NB, the profit of the manufacturer and retailer, the NB's and SB's retail price are presented in Table 4.

By comparing the equilibrium under the three scenarios, we can observe the following results: Due to the competition between NB and SB products, in SWAD, the manufacturer reduces the wholesale price of the NB to make NB more appealing for consumers, so by decreasing the wholesale price of the NB product, their retail price is diminishing consequently. Moreover, comparing the supply chain members' profits in the Benchmark and SWAD scenarios reveals that the advent of the SB will decrease the market share and demand for the NB. Thus the manufacturer's profit decreases, while the retailer's profit increases compare to the Benchmark. However, in the SWAD, more products (NB and SB) are sold. Hence, her profits are more than in the Benchmark.

The comparisons between the values under SWAD and SWDD illustrate the role of dynamic discount. By implementing the dynamic discount, the manufacturer increases the wholesale price since the dynamic discount can compensate for the lost market share of the NB. So, the wholesale price is increased by manufacturer, which it leads to an increase in the retail price by the retailer. Subsequently, with the

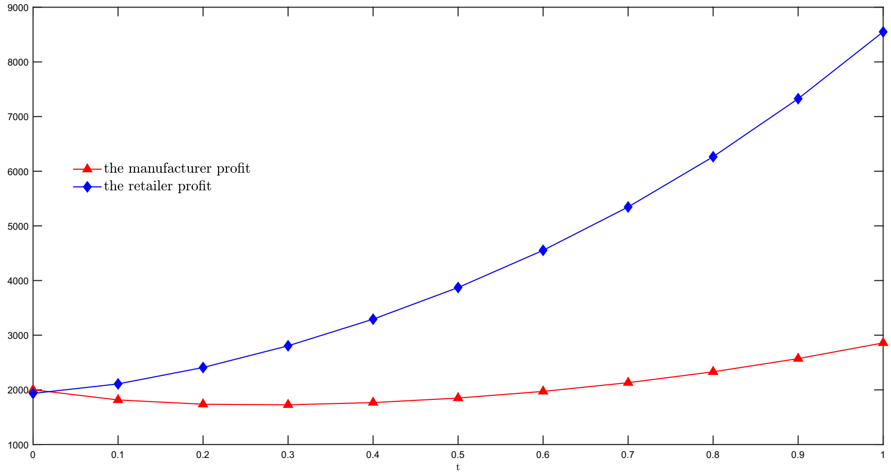

Fig. 3 Impacts of t on Π_M and Π_R in SWDD

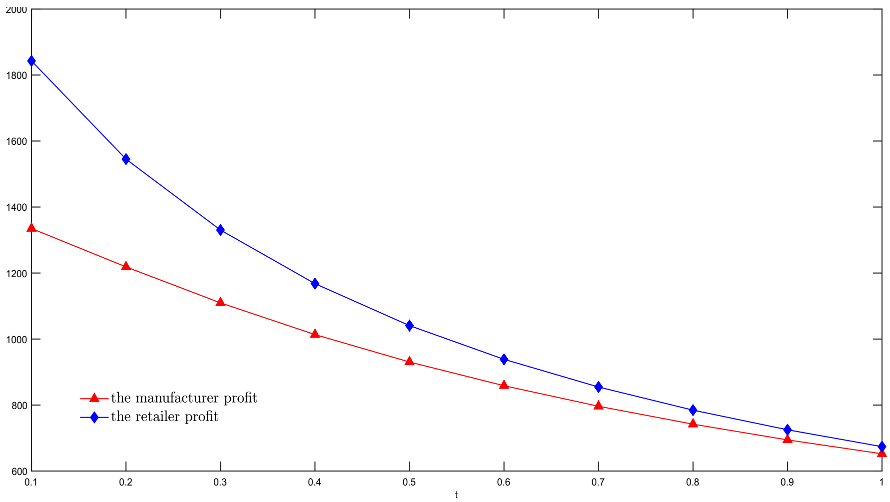

Fig. 4 Impacts of r on Π_M and Π_R in SWAD

increase in the retail price of NB products, due to the level of competition between these products and SB products, the retail price of NB products will also increase.

Furthermore, the NB's goodwill consists of the combined effects of the supply chain members' advertising effort level. Naturally, the higher the goodwill for a specific product, the more consumers go to the store where the product is proposed. Hence, increased goodwill will bring more consumers to that store. This higher rate of consumer entrance will also affect the demand for other commodities in that store. As a result, in the SWDD, the demand for the SB will increase so, with the SB's higher demand and retail price, the profit of the retailer will increase.

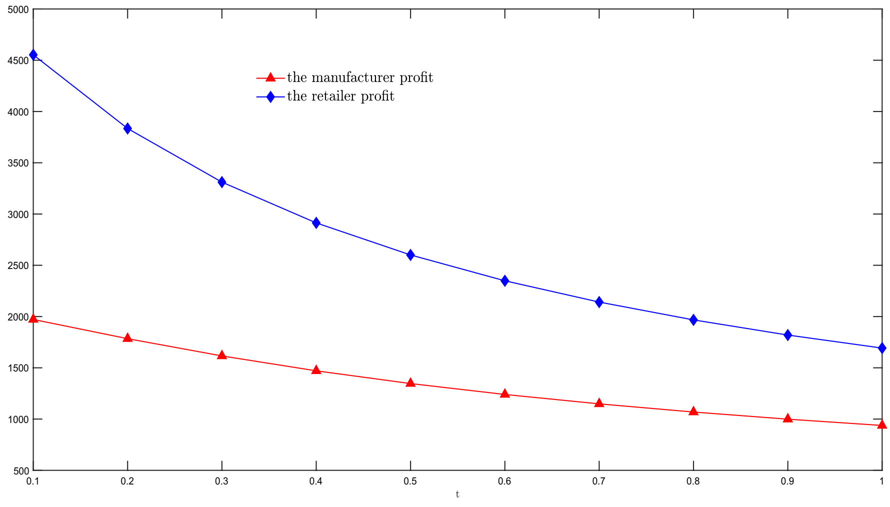

Fig. 5 Impacts of $\boldsymbol{r}$ on $\boldsymbol{\Pi_M}$ and $\boldsymbol{\Pi_R}$ in SWDD

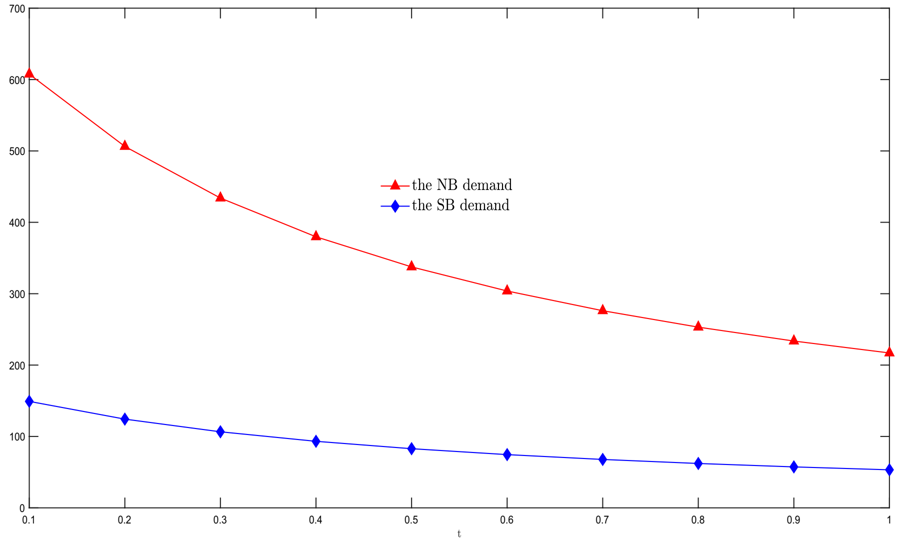

Fig. 6 Impacts of r on d_n and d_s in SWAD

The above results indicate that designing and implementing the dynamic discount is an effective strategy conducted by the retailer to prevent the manufacturer from impeding the introduction of the SB, this is because the manufacturer achieves higher profit by the dynamic discount (SWDD) than before the SB's advent (Benchmark). On the other hand, due to the direct effects of the DDP strategy on the demand of the SB, the profit of the retailer will increase as well. Hence, the

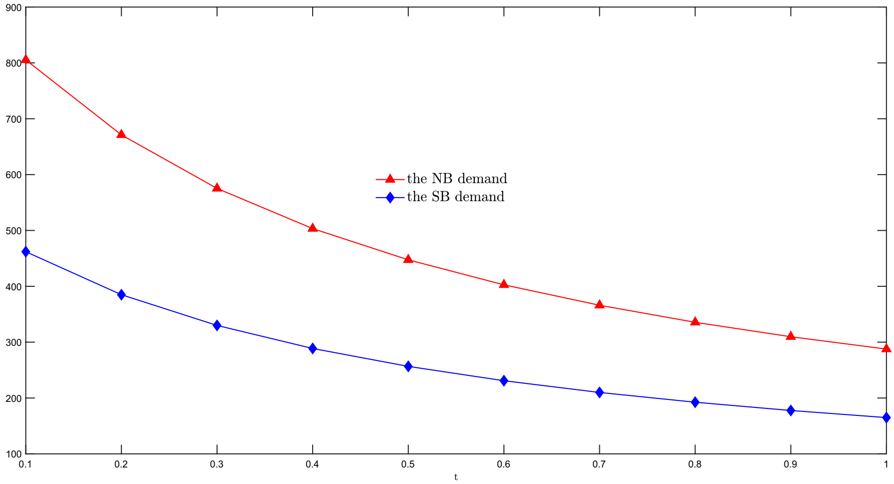

Fig. 7 Impacts of r on d_n and d_s in SWDD

Table 5 Impact of δ on Π_m and Π_r in the second and third scenario

Δ	Second scenario		Third scenario	
	Π_M	Π_R	Π_M	Π_R
0.1	16,216.21	18,685.33	23,530.38	46,614.94
0.2	4874.612	6180.774	7137.243	15,337.47
0.3	2304.608	3078.47	3392.067	7618.527
0.4	1334.993	1842.791	1971.68	4553.041
0.5	868.7639	1226.621	1286.205	3027.327
0.6	609.7131	875.1849	904.3052	2158.278
0.7	451.1915	655.8414	670.1218	1616.403
0.8	347.2407	509.7679	516.3016	1255.807
0.9	275.4335	407.6024	409.9025	1003.753
1	223.7754	333.3511	333.2736	820.6551

proposed strategy provides a win–win situation for SC parties in which both of them profit more.

5 Sensitivity analysis

To assess the parameters' impact on the results, we conduct a sensitivity analysis on replacement coefficient, consumers' forgetful behavior, and discount rate in this section. The results of this analysis are shown in Figs. 2, 3, 4, 5, 6 and 7 and Table 5.

5.1 Impact of the replacement coefficient

According to Fig. 1, in the SWAD, an increase of the t causes the profit of the manufacturer totally decrease. However, the profit of the retailer first decreases and then increases, and it depends on the amount of the replacement coefficient. A higher replacement coefficient means there is a more negligible difference between the two products in terms of quality and function. Hence, it encourages more consumers to choose the SB over the NB since it gives them the same satisfaction with a lower price. It is evident that higher demand leads to more profit for the retailer. In another way, in the competitive situation, the manufacturer decreases the NB products' selling price, following that the retailer decreases the NB's retail price, which in turn reduces its profit. Figure 2 illustrates that the effect of the lower price is higher before $t = 0.3$, while the effect of the higher demand is higher after that point.

On the other hand, the manufacturer's profit decreases with a lower market share. Figure 2 also indicates that the quality and function of the new product (SB) directly affects the manufacturer's decisions since the higher the replacement coefficient, the more compelling threat he feels. Figure 3 illustrates that both members' profits increase with the replacement coefficient (t) in SWDD. The increase in the profit of the retailer stems from the same reasons of the SWAD. However, a higher replacement coefficient leads to a higher discount; thus, more consumers would be attracted to the NB with a higher replacement coefficient, which increases the manufacturer's profit. Comparing Figs. 2 and 3, one can realize the effects of the dynamic discount strategy, which helps the manufacturer avoid experiencing a loss and provides a higher demand and a higher subsequent profit for him.

5.2 Impact of the discount rate

Considering Figs. 4 and 5, one can say that both SC parties' profits decrease with a higher discount rate under both second and third scenarios. The rationale behind this is that consumers' purchasing power will be reduced with a higher inflation rate. The main takeaway from the above figures is the effectiveness of the dynamic discount strategy in an inflationary condition. In other words, on each point of the horizontal line, the profit of the manufacturer under SWAD is lower than his profit under SWDD. Thus, the NB's manufacturer does not deter the SB introduction.

As shown by Figs. 6 and 7, the demand for both products will decrease because of the higher inflation. The demand for the NB decreases more because of its higher retail price. In fact, the SB is more appealing for consumers in an inflationary condition due to its lower price. Hence, its demand experiences a lower decrease.

5.3 Impact of the consumers' forgetful behavior

The decrease in the forgetful behavior coefficient of customers represents popularity of the NB products among consumers. Thus, it is obvious that the higher the

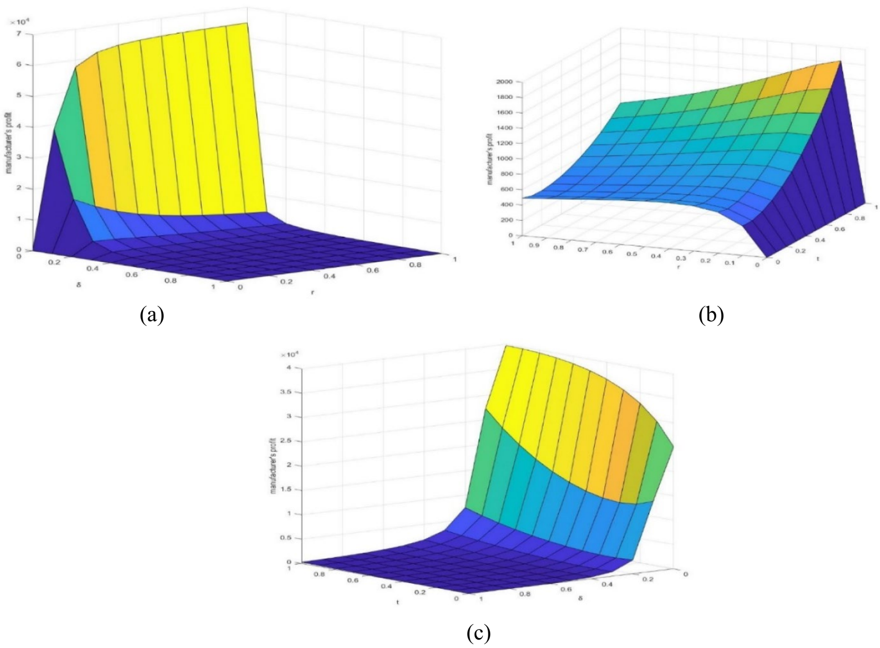

Fig. 8 Simultaneous effect of key parameters

forgetful behavior coefficient, the manufacturer's profit decreases due to the diminishing of products demands. In addition, because of the NB's goodwill effect on the SB products, an increase in the consumers' forgetful behavior coefficient results in lower profits for the retailer. In other words, fewer consumers go to the retailer store with lower goodwill for the NB, which decreases the SB's exposure to them. Hence, the demand for the SB decreases and brings about a lower profit for the retailer.

It is worth mentioning that the lower popularity for the NB damages the retailer's benefit since the NB and the SB products are not completely substitutable (i.e., $t \neq 1$). Hence, strategies that reduce the goodwill or popularity of the NB are not beneficial for her. This indicates that designing and implementing the dynamic discount strategy by the retailer is worthwhile because it is effective no matter to what extent NB and SB are substitutable (for all amounts of t).

5.4 Simultaneous effect of key parameters

In this section, the effect of simultaneous change of the problem's key parameters on the profit of the manufacturer will be investigated. These analyzes will help the retailer to make a broad and integrated view when deciding to introduce an SB and design how to implement the DDP strategy optimally and ultimately make the optimal decision.

The analyzes presented in Sects. 5.1–5.3 each examine the effect of the key parameters of the problem separately. While each of these parameters affects the effect of other parameters. Failure to consider this effect will cause a computational error in retail decisions and jeopardize the introduction of SB. The simultaneous effect of the parameters in pairs is as follows:

5.4.1 Simultaneous effect of r and δ

Examining and analyzing the effect of these two key parameters will help the retailer get an accurate estimate of the manufacturer's profit increase if the retailer implements the DDP strategy. This correct estimate influences the SB introducing decision, the retailer, and customers. An increase in the profit of the manufacturer due to the implementation of the DDP strategy by the retailer in market conditions should be in a way that discourages the manufacturer from using deterrent strategies.

Figure 8a shows the change in the manufacturer's profit if the DDP strategy is implemented under different r and δ values. A separate analysis of each key parameter is discussed under any value for each of the key parameters the DDP execution will increase the manufacturer's profit. The important question is that if the key parameters have different values, what is the increase in producer profit? Furthermore, in what case does the increase in manufacturer's profit reach a maximum?. From Fig. 8a, it can be concluded that in any economic situation, in terms of profit rate and inflation (different values for r), the greatest impact on the increase of the profit the manufacturer is made by the δ parameter (customers' forgetful behavior coefficient). Therefore, before introducing SB to the market or before choosing the SB product category, the retailer needs to have an accurate and logical estimate of the customers' forgetful behavior to obtain the most benefit from executing DDP.

5.4.2 Simultaneous effect of r and t

Examining the relationship between the two key parameters of the discount rate and the replacement coefficient will show what level of competition and the replacement coefficient between SB and NB cause the maximum increase in the profit of the supply chain's members if the DDP is implemented in different economic conditions. In other words, this analysis will help the retailer introduce its SB product to the market with a replacement coefficient against NB by evaluating the economic conditions of the market and customers. Figure 8b shows how the two parameters r and t simultaneously affect the increase in manufacturer's profits.

Therefore, it can be concluded from Fig. 8b that in the case with good economic conditions, mean low inflation and high replacement coefficient, entry of SB into the market, and the implementation of DDP by the retailer will cause the NB manufacturer to experience the largest increase in profits. It can also be inferred that as economic conditions worsen, mean inflation rises, the increase in manufacturer's profits from implementing the DDP decreases. That may be due to a decrease in the purchasing power of customers throughout the market. Finally, it can be said that the level of competition and the alternative coefficient of SB against NB have a more significant impact on the producer's profit than economic conditions.

5.4.3 Simultaneous effect of t and δ

Simultaneous review of the SB replacement coefficient parameter and customer forgetting behavior effects will help the retailer properly evaluate the SB type and quality before introducing the SB. This analysis will also increase the probability of the retailer succeeding in introducing SB and implementing the DDP strategy to increase the manufacturer's profit. Suppose the retailer introduces an inappropriate SB product to the market. In that case, implementing the DDP strategy may not help increase the profit of the manufacturer. As a result, the retailer will face coercive actions by the manufacturer, and his business will be harmed. The result of the simultaneous effect of t and δ parameters is shown in Fig. 8c. According to Fig. 8c, it can be stated that in order to gain more benefits from the implementation of DDP, the retailer must focus on choosing the type of SB product. The lower the customer forgetful behavior associated with the introduced SB product category, the higher the manufacturer's profit due to DDP execution. In other words, more customers have a good experience from buying the NB, and if these products are also discounted, more customers go to the retail store to purchase them. Increasing the retailer store customers cause the greater spillover effect on other store products, including SBs, and their sales will be affected. However, suppose the forgetful behavior of customers related to a product category is high. It indicates that the customer has not had a good shopping experience from the product category, and the retailer discount does not significantly attract the customer's attention.

6 Managerial implications

Our study provides SC managers and policymakers with several recommendations and managerial insights. According to our results, in line with previous research, it can be concluded that the entry of SB into the market always has a negative impact on the profit and market share of the manufacturer and harms his business (Karray & Martin-Herran 2019). The NB manufacturer also takes measures to deal with SB entering the market in the face of damage to its business. Therefore, it is important for the retailer to consider strategies that, in addition to supporting the introduced SB product, also prevent the repressive reactions of the NB manufacturer.

As a powerful strategy, the DDP strategy allows the retailer to keep the NB manufacturer somewhat satisfied by compensating for the profit damage caused by the SB entering (Chen et al. 2019). Considering the DDP strategy for the NB products may make up for some of the manufacturer's lost profits, but it can never make up for a lost market share. Unlike other strategies discussed in the relevant subject literature, this strategy can be beneficial to both the retailer and the manufacturer. Also, the DDP execution mechanism causes many customers to go to the retail store to buy goods, in which case the demand for the store's products is strongly affected. So that the implementation of this operational strategy will increase the store's overall sales, including the NB and the SB products, and will generate a large profit for the retailer.

In addition, the introduction of the SB product is not always successful and depends on various conditions and factors (Pauwels & Srinivasan 2004). According to the study conducted in this research, it can be concluded that the type of SB product category is highly effective in the success of SB and the effectiveness of the DDP strategy. SB product category also affects customer forgetfulness behavior coefficient. In other words, the coefficient of forgetfulness behavior in each category of products is different from the other category of products. Therefore, the lower the forgetful behavior coefficient of the introduced SB product category helps the DDP strategy's success, and the manufacturer profit will more increase and vice versa. For example, it seems that the forgetful behavior of customers in the food group is higher than in the technological products group.

On the other hand, coefficient of substitution between NB and SB products also affects the success of the SB product and the impact of the DDP strategy on customer demand. Therefore, the lower the replacement factor between the NB and SB products, the less likely the DDP strategy will increase the manufacturer's profit. In other words, the low replacement rate between NB and SB indicates that customers are less inclined to buy SB product if NB product is not available. Therefore, the higher the replacement coefficient between the two competing products, NB and SB, the more effective it will be with implementing the DDP strategy, and the manufacturer's profit will increase greatly.

In general, the type of SB product category and the amount of quality that the retailer considers for it are the main factors influencing the success of SB and DDP strategy. The retailer can increase its success rate in introducing SB to the market by carefully examining this issue and making appropriate decisions before introducing SB.

7 Conclusion

The popularity of the SB has been increasingly growing for a few decades. They have large market shares in supermarkets, retail stores, retail chains, and others. The success of these products has become a major concern for manufacturers whose national brands experienced shrinking market shares. While the related literature concentrated on different strategies used by manufacturers to combat the introduction of the SB, this study designs a strategic tool proposed by the retailer to provide a higher profit after SB introduction to the manufacturer and thus prevent him from implementing his strategies. This preemptive strategy results in a Pareto optimal solution as both members profit more.

We modeled this problem and obtained channel members ' optimal decisions under three scenarios to address the entry effects and the proposed preemptive strategy. In the first scenario (Benchmark), a dynamic game has been developed where the advertising effort level on the NB and the wholesale price are determined by the manufacturer, so then the retailer makes decisions about the retail price of the NB and her advertising effort level. In the second scenario (SWAD), the SB product will be introduced by the retailer with her own brand, which increases her profit but decreases the profit of the manufacturer due to NB's diminished market share. On the other hand being aware of the manufacturer's possible reactions to regain his market share, the opportunistic retailer designs and implements a Dynamic Discount Pricing (DDP) strategy for the NB. Using a DDP strategy is a smart strategy because it stimulates the NB's and the SB's demand. DDP strategy success is that increasing customer entrance to store will increase both commodities' sales due to more exposure. As a result, with higher demand, both SC parties enjoy higher profits in the third scenario (SWDD). Moreover, our analysis reveals that the proposed strategy can make the manufacturer economically satisfied even under critical situations, such as the complete competition level and high inflation rate.

Despite the significant results obtained in the study, this study also had limitations. Here, to motivate, several suggestions for future studies are presented as follows:

First, in today's competitive market, some manufacturers also create SB for themselves to cover all market segments. In future studies, it can be investigated how the retailer can use the dynamic discount strategy to support SB in the situation where the manufacturer has SB.

Second, this study was conducted in a situation where there is no hidden information between supply chain members. While in the real world, supply chain members each have information that they do not share with other members. The idea of this study can be investigated in a situation where information sharing between supply chain members is asymmetric.

Third, nowadays, retailers who have superior power in the market introduce SB, in other words, the retailer has a higher bargaining power. Therefore, in future research, we can examine the idea that if the retailer's bargaining power is equal to or greater than the manufacturer's, what effect does the dynamic discount strategy have on the market.

Fourth, the retailer can use different strategies to support their SB product. One of these strategies is digital marketing. Therefore, it is possible to check the effect of implementing other strategies such as digital marketing in supporting eBay retailers.

Fifth, today there are multiple markets in the world, in other words, in addition to retailers and manufacturers, there are other market players. Therefore, the problem can be designed and solved by considering the presence of several retailers and manufacturers.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s12351-024-00850-9.

Funding Open Access funding enabled and organized by CAUL and its Member Institutions.

Declarations

Conflict of interest No conflict of interest.

References

Ailawadi KL (2001) The retail power-performance conundrum: What have we learned? J Retail 77(3):299–318
Amrouche N, Yan R (2012) Implementing online store for national brand competing against private label. J Bus Res 65:325–332
Amrouche N, Yan R (2015) Aggressive or partnership strategy: Which choice is better for the national brand? Int J Prod Econ 166:50–63
Balasubramanian G, Maruthasalam APP (2021) Substitution effect of retailer store brand and manufacturer encroachment. Int J Prod Econ 239:108208
Buratto A, Cesaretto R, De Giovanni P (2019) Consignment contracts with cooperative programs and price discount mechanisms in a dynamic supply chain. Int J Prod Econ 218:72–82
Cao D, Meadows M, Wong D, Xia S (2021) Understanding consumers' social media engagement behaviour: an examination of the moderation effect of social media context. J Bus Res 122:835–846
Cao X, Fang X, Xiao G, Yang N (2023) Optimal contract design for a national brand manufacturer under store brand private information. Manuf Serv Oper Manag 6:66
Cascio A, Waites SF, Moore R, Moore M, Vorhies DW, Bentley JP (2023) The effects of dual branding rumors on consumers' national and store brand evaluations. J Mark Theory Pract 31(3):316–333
Chaleshtari AS, Elahi E, Fathi M, Khakifirooz M (2022) Impact of return leniency on retailers' profit and social welfare in monopoly markets. Comput Ind Eng 169:108149
Chen J, Yang LX, Huang DW, Yang X, Tang YY (2019) Dynamic discount pricing in competitive marketing. IEEE Access 7:145340–145347
Cheng R, Ma W, Ke H (2018) How does store-brand introduction affect a supply chain with uncertain information? J Intell Fuzzy Syst 34(1):189–201
Chintagunta PK, Bonfrer A, Song I (2002) Investigating the effects of store-brand introduction on retailer demand and pricing behavior. Manag Sci 48(10):1242–1267
Choi S, Fredj K (2013) Price competition and store competition: store brands vs. national brand. Eur J Oper Res 225(1):166–178
Chung H, Lee E (2017) Store brand quality and retailer's product line design. J Retail 93(4):527–540
Chung H, Lee E (2018) Effect of store brand introduction on channel price leadership: an empirical investigation. J Retail 94(1):21–32
Das R, De PK, Barman A (2021) Pricing and ordering strategies in a two-echelon supply chain under-price discount policy: a Stackelberg game approach. J Manag Anal 66:1–27
Davis D (2020) Amazon triples its private-label product offerings in 2 years. Digital commerce 360, viewed 30.08.2022, from https://rb.gy/jjjyr3
de Wulf K, Odekerken-Schroder G, Doedertier F, Ossel GV (2005) Consumer perceptions of store brands versus national brands. J Consum Mark 22(4):223–232
Fang X, Gavirneni S, Rao V (2013) Supply chains in the presence of store brands. Eur J Oper Res 224(2):392–403

Gholamian MR, Ebrahimzadeh-Afruzi M (2021) Credit and discount incentive options for two-level supply chain coordination, under uncertain price-dependent demand. Oper Res Int J 21:2283–2307
Gielens K (2012) New products: the antidote to private label growth? J Mark Res 49(3):408–423
Green D (2018) Boxed, "The Costco for Millennials," says its private label is blowing up, and it reveals a new front in the war for online shoppers. Business Insider, viewed 30.08.2022, from http://bit.ly/BI_Boxedreport
Green D (2019) Shoppers Love Costco's Kirkland signature brand, and it's turned into the retailer's biggest asset. business insider. http://bit.ly/businessinsider_s to rebrand
Guo X, Zha Y, Chen H, Liang L (2023) National brand manufacturers' supply strategy in the presence of retailers' store-branded lookalike packaging and consumer confusion about quality preference. Transp Res Part E Logist Transp Rev 175:103143
Hara R, Matsubayashi N (2017) Premium store brand: product development collaboration between retailers and national brand manufacturers. Int J Prod Econ 185:128–138
Heese HS (2010) Competing with channel partners: supply chain conflict when retailers introduce store brands. Nav Res Logist 57(5):441–459
Jin Y, Wu X, Hu Q (2017) Interaction between channel strategy and store brand decisions. Eur J Oper Res 256(3):911–923
Karray S, Martin-Herran G (2019) Fighting store brands through the strategic timing of pricing and advertising decisions. Eur J Oper Res 275(2):635–647
Kumar N, Radhakrishnan S, Rao RC (2010) Private label vendor selection in a supply chain: quality and clientele effects. J Retail 86(2):148–158
Li P, Yang X, Wu Y, He W, Zhao P (2018) Discount pricing in word-of-mouth marketing: an optimal control approach. Phys A 505:512–522
Liu RL, Sprott DE, Spangenberg ER, Czellar S, Voss KE (2018) Consumer preference for national vs. private brands: the influence of brand engagement and self-concept threat. J Retail Consum Serv 41:90–100
Liu P, Yang X, Zhang R, Liu B (2022) OEM's sales formats under e-commerce platform's private-label brand outsourcing strategies. Comput Ind Eng 173:108708
Mao Z, Duan Y, Yao Y, Huo J (2021) The moderating effect of average wage and number of stores on private label market share: a hierarchical linear model analysis. J Retail Consum Serv 60:102454
Martinelli E, De Canio F (2021) Purchasing veg private labels? A comparison between occasional and regular buyers. J Retail Consum Serv 63:102748
Mathewson F, Winter R (1998) The law and economics of resale price maintenance. Rev Ind Organ 13(1/2):57–84
Mckinsey (2020) The great consumer shift: Ten charts that show how US shopping behavior is changing, Mckinsey, viewed 30.08.2022, from https://www.mckinsey.com/business-functions/growth-marketing-and-sales/our-insights/the-great-consumer-shift-ten-charts-that-show-how-us-shopping-behavior-is-changing
Mieres CG, Martín AMD, Gutiérrez JAT (2006) Influence of perceived risk on store brand proneness. Int J Retail Distrib Manag 34(10):761–772
Moencks M, Roth E, Bohné T, Romero D, Stahre J (2022) Augmented Workforce Canvas: a management tool for guiding human-centric, value-driven human-technology integration in industry. Comput Ind Eng 163:107803
Nagare M, Dutta P, Suryawanshi P (2020) Optimal procurement and discount pricing for single-period non-instantaneous deteriorating products with promotional efforts. Oper Res Int J 20:89–117
Narasimhan C, Wilcox R (1998) Private labels and the channel relationship: a cross-category analysis. J Bus 71(4):573–600
Nasser S, Turcic D, Narasimhan C (2013) National brand's response to store brands: throw in the towel or fight back? Mark Sci 32(4):591–608
Pauwels K, Srinivasan S (2004) Who benefits from store brand entry? Mark Sci 23(3):364–390
Pauwels K, Srinivasan S (2009) Pricing of national brands versus store brands: market power components, findings and research opportunities. In: Rao VR (ed) Handbook of pricing research in marketing. Edward Elgar, Cheltenham, pp 258–282
Quelch JA, Harding D (1996) Brands versus private labels: fighting to win. Harv Bus Rev 74(1):99–109
Ranjbar A, Heydari J, Madani-Hosseini M, Yahyavi D (2021) Green channel coordination under asymmetric information. Ann Oper Res 66:1–34
Richardson PS (1997) Are store brands perceived to be just another brand? J Prod Brand Manag 6(6):388–404

Ru J, Shi R, Zhang J (2015) Does a store brand always hurt the manufacturer of a competing national brand? J Prod Brand Manag 24(2):272–286
Rubio N, Villaseñor N, Yagüe MJ (2017) Creation of consumer loyalty and trust in the retailer through store brands: the moderating effect of choice of store brand name. J Retail Consum Serv 34:358–368
Sakaguchi L, Pak N, Potts M (2018) Tackling the issue of food waste in restaurants: options for measurement method, reduction and behavioral change. J Clean Prod 180:430e436
Sarkar B, Dey BK, Sarkar M, Kim SJ (2022) A smart production system with an autonomation technology and dual channel retailing. Comput Ind Eng 173:108607
Sayman S, Raju JS (2017) Store brands: from back to the future. In: Review of marketing research, pp 132–151
Scott-Morton FM, Zettelmeyer F (2004) The strategic positioning of store brands in retailer-manufacturer negotiations. Rev Ind Organ 24(2):161–194
Sethuraman R (2009) Assessing the external validity of analytical results from national brand and store brand competition models. Mark Sci 28(4):759–781
Seyedhosseini SM, Hosseini-Motlagh SM, Johari M, Jazinaninejad M (2019) Social price-sensitivity of demand for competitive supply chain coordination. Comput Ind Eng 135:1103–1126
Shah NH, Patel DG, Shah DB (2018) EPQ model for returned/reworked inventories during imperfect production process under price-sensitive stock-dependent demand. Oper Res Int J 18:343–359
Taleizadeh AA, Safaei AZ, Bhattacharya A, Amjadian A (2022) Online peer-to-peer lending platform and supply chain finance decisions and strategies. Ann Oper Res 315(1):397–427
Taleizadeh AA, Varzi AM, Amjadian A, Noori-daryan M, Konstantaras I (2023) How cash-back strategy affect sale rate under refund and customers' credit. Oper Res Int J 23(1):19
Thaichon P, Phau I, Weaven S (2020) Moving from multi-channel to Omni-channel retailing: special issue introduction. J Retail Consum Serv 65:102311
Volles BK, Van Kerckhove A, Geuens M (2023) Triggering brand switching in online stores: the effectiveness of recommendations for private labels versus national brands. J Bus Res 164:114020
Walmart (2022) Where in the world does Walmart source its products? Walmart, viewed 30.08.2022, from https://corporate.walmart.com/askwalmart/where-in-the-world-does-walmart-source-its-products
Yu W, Hou G, He Y, Xin B (2023) Dynamic coopetition game between private label and national brand under carbon trading policy. Heliyon 9(3):66
Zhang Z, Song H, Gu X, Shi V, Zhu J (2021) How to compete with a supply chain partner: Retailer's store brand vs. manufacturer's encroachment. Omega 103:102412
Zhong X, Zhao J, Yang LX, Yang X, Wu Y, Tang YY (2018) A dynamic discount pricing strategy for viral marketing. PLoS ONE 13(12):e0208738

Authors and Affiliations

Dawood Yahyavi[1] · Ata Allah Taleizadeh[1] · Park Thaichon[2]

✉ Park Thaichon
park.thaichon@gmail.com

Dawood Yahyavi
davood.yahyavi@ut.ac.ir

Ata Allah Taleizadeh
taleizadeh@ut.ac.ir

[1] School of Industrial Engineering, College of Engineering, University of Tehran, Tehran, Iran

[2] Faculty of Business Education, Law and Arts, University of Southern Queensland, Springfield, QLD 4300, Australia