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A game theoretic approach for analyzing the competition between national and store brands by considering store loyalty

Parisa Assarzadegan *, Seyed Reza Hejazi

Department of Industrial and Systems Engineering, Isfahan University of Technology, Isfahan, 84156-83111, Iran

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ABSTRACT

This study considers a supply chain with a National Brand (NB) manufacturer and a retailer under three scenarios. In the first scenario, the retailer sells both the NB product and its own the Generic Store Brand product (GSB), in the second scenario, he introduces its own the Premium Store Brand product (PSB), and in the third scenario, he introduces both GSB and PSB products. NB loyalty and PSB loyalty are both modeled based on customer satisfaction and quality. But the model of NB loyalty particular emphasizes the role of innovation and advertising. We assumed that there is a non-monotonic (an inverted U-shaped) relationship between the loyalty to the GSB product and Store Loyalty and a positive linear relationship between the loyalty to the PSB product and Store Loyalty. A Stackelberg game theoretic model with two cases for the leader (Stackelberg-Manufacturer and Stackelberg-Retailer) is provided to solve the problem. Finally, numerical analysis and managerial implications are presented. The results indicate that: 1) The NB manufacturer considers the PSB product as a threat, and tries to increase customers' satisfaction and loyalties to the NB product by the increase in innovation and advertising; 2) The retailer competes with the NB manufacturer by positioning the quality of the PSB near the quality of the NB, but at a lower price to increase customers' satisfaction and loyalties to the PSB; 3) When customers loyalty to the store increases (store loyalty), their loyalties to SB products increases too; 4) Customers loyalty to SB products (both GSB and PSB) plays a greater role in building store loyalty than customers loyalty to the NB product; 5) It is more profitable for the retailer to introduce both GSB and PSB products simultaneously, and also be the leader of the game.

1. Introduction

Store Brand (SB), or Private Label (PL) product refers to the product owned, controlled, and sold by the retailer. Due to the sustainable growth of private labels, large retailers, such as Atlantic and Pacific Tea (A&P), Safeway, and Kroger, have introduced brands as private labels in a variety of categories (Raju et al., 1995). Kumar (2007) identified Generic, Standard, and Premium Store Brand strategies that ranked in ascending order of focus on quality but descending order of focus on price. Examples of introducing store brands include *Number 1* (as Generic Store Brand for *Carrefour*), *Carrefour* (as Standard Store Brand for *Carrefour*), *Carrefour Selección* (as Premium Store Brand for *Carrefour*) (González-Benito and Martos-Partal, 2012; González-Benito et al., 2015; Kumar, 2007).

As the Private Label Manufacturers Association (PLMA) declared, components of PL products are as good as those with National Brand (NB) products (if not better). But, in fact, unfamiliarity with private label products can be caused by cheap packaging and lack of appealing brand image due to strategic positioning and poor communication. Thereby, focusing on SBs' quality can provide a better understanding of store brand products and increase customer loyalty to these products (Richardson et al., 1994). From the outside perspective, store brand products have more deficiencies than national brand products. Store brand products with lower prices have relatively weaker packaging, lack of recognition as a strong brand, and lower advertising levels than national brand products (Cunningham et al., 1982). Typically, store brand products are options for customers who look for lower quality and more affordable prices. However, some retailers introduce high-quality store brand products to compete directly with NB products (Verhoef et al., 2002).

Corstjens and Lal (2000) maintained that SBs could serve as tools for retailers to make their stores distinct. High-quality store brand products would increase customer loyalty to retailers, thereby creating store loyalty. Loyalty is one way of expressing customer satisfaction with a

* Corresponding author.
E-mail addresses: p.assarzadegan@in.iut.ac.ir (P. Assarzadegan), rehejazi@cc.iut.ac.ir (S.R. Hejazi).

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product or service (Bloemer and Kasper, 1995; Collins-Dodd and Lindley, 2003). Increasing customer acceptance of store brands has led to reducing the loyalty of well-known brands. Buyers who are loyal to particular stores are more familiar with the services and products offered by that store. Loyal shoppers to the store may want to try and buy brands that the store is exclusively offering (Ailawadi et al., 2001; De Wulf et al., 2005; Dick et al., 1996; Mishra et al., 2020).

Steiner (2004) maintains that NB manufacturers should invest in product innovation to compete with SB products. Continuous product improvement programs for NB products can reduce private label growth (Quelch and Harding, 1996). Moreover, the entry of SB products in a product group influence positively on creating innovation in the national brand products, since the NB manufacturers will use product innovations (in the form of new products or new packaging, etc.) to protect their brand against others (Hoch, 1996). Most companies are involved in continuous efforts to enhance their product quality through product innovation. On the other hand, Bello et al. (2004) defined "supply chain innovation" as a combination of technology development, new logistics, and marketing processes that will improve the performance efficiency and increase revenue and profitability for supply chain members. Wong and Ngai (2019) reviewed articles in supply chain innovation through 1996–2016 in three main categories (technology development, logistics, and marketing), and described product innovation as one of the activities related to technology development that will lead to supply chain innovation.

In this paper, the research questions are as follows:

1) What are the manufacturer's optimal decisions for pricing, levels of innovation, and advertising of the NB product? What are the optimal decisions of the retailer for the pricing of GSB and PSB products?
2) What is the quality decision of the retailer for the PSB product in competition with the NB product?
3) What are the effects of customer satisfaction and loyalty of the NB and PSB products on the supply chain?
4) What effect does store loyalty have on the retailer and manufacturer decisions?
5) Under what conditions is it profitable for the manufacturer (the retailer) to be the leader? And under what conditions is it profitable for the manufacturer (the retailer) to be the follower?

The rest of the paper is structured as follows: Section 2 provides a literature review. The definition of the problem is in Section 3. Section 4 describes the solving procedure, and Section 5 presents the numerical example and parametric analysis. Section 6 provides managerial implications, and the last Section is the conclusion.

2. Literature review

We organize the literature review in three related research fields, including (1) game theory models, (2) brand loyalty, and (3) store loyalty. Finally, we present the research gaps and contributions of the present article.

2.1. Game theory models

Hara and Matsubayashi (2017) studied the collaboration between a NB manufacturer and a retailer to create a PSB product. Results showed that collaboration with the manufacturer was not necessarily profitable for both parties. Rather, it would have been successful had several premium store brand products been introduced. Chung and Lee (2017) considered a supply chain composed of one or two NB manufacturers and one retailer who defined the quality of its own SB product(s) and analyzed the best position for the SBs' quality relative to the NB's quality.

Choi and Fredj (2013) proposed a game theoretic model to study pricing policies in a supply chain with two retailers and a NB manufacturer. They assumed that retailers had their own SB products. The authors concluded that both retailers would gain more profits if they differentiated their stores from each other and increased the similarity of their SB products to that of the national brand product. Karray and Martín-Herrán (2009) examined the competition between a NB product and a PL product. They also investigated the relationship between decisions on pricing and advertising. Their results showed that the relationship depended on the nature of advertising.

Amrouche and Yan (2012) considered a supply chain including a retailer and a NB manufacturer. The following three situations were studied: 1) there is only one NB product in the supply chain, 2) the retailer introduces the PL product, and 3) the NB product is sold through an online store. Shi (2019) studied a supply chain including a contract manufacturer and an Original Equipment Manufacturer (OEM). She assumed that the contract manufacture can produce a private label product and provided a Stackelberg game to study pricing and quality decisions. Chen (2015) considered a dual-channel supply chain including a retailer and a NB manufacturer to study pricing and advertising decisions. They divided customers into two groups, including 1) brand-loyal customers, 2) retailer-loyal customers. A game-theory model is used to solve the problem.

Kurata et al. (2007) studied a dual-channel supply chain involving a NB manufacturer and a retailer with a SB product. They assumed that the NB product was distributed through both online and retailer channels, while the SB product was distributed only through the online channel. They also analyzed pricing decisions in their research. Karray and Zaccour (2005) developed a game theoretic model in a supply chain with a NB manufacturer and a retailer that might introduce a private label product against the NB product. They evaluated the impacts of PL introduction as well as cooperative advertising decisions. Karray and Zaccour (2006) proposed a game theory model and investigated the impacts of PL introduction on the supply chain profits. Amrouche and Zaccour (2007) considered a supply chain composed of a retailer with a PL product and a NB manufacturer. They applied a Stackelberg game model and analyzed the impacts of the decisions on shelf space allocation for both brands.

Karray and Martín-Herrán (2019) provided six sequential game theory models to examine the impacts of decisions of advertising and pricing timing in a supply chain which the retailer introduced a store brand product. They found that sequential and simultaneous timings had significant effects on the profitability of store brand products. Li et al. (2018) used a game theory model to study the strategic interaction between one NB manufacturer and one retailer to decide on the introduction of the SB product and the online channel. Cui et al. (2016) considered a supply chain with a risk-averse retailer and a NB manufacturer. The retailer sells both the NB product and its SB product. They provided a game theory model and studied the retailer's decision for introducing the SB product.

Yang et al. (2018) studied decisions of pricing and cooperative advertising and provided the five game models including Centralized (C), Nash-Retailer (NR), Nash-Manufacturer (NM), Stackelberg-Manufacturer (SM), and Stackelberg-Retailer (SR) in a dual-channel supply chain with a retailer that introduced a SB product and a NB manufacturer. Groznik and Heese (2010) considered a Stackelberg game theoretic model to study the retail competition between one manufacturer and two retailers in a supply chain, each of whom had their own store brand products. Nasser et al. (2013) provided a game theoretic model to study pricing and positioning (level of quality) decisions of an NB manufacturer with the response to the introduction of a SB product. Amrouche and Yan (2017) studied competition between NB and PL products and provided a game model to solve the problem. They used the utility function that including prices, quality of brands, and valuation of consumers about brands. They considered cooperative advertising and wholesale incentive to enhance the relationship between the retailer and the manufacturer. Zhao et al. (2017) considered a supply chain with two manufacturers with complementary products and

a retailer. They proposed four pricing models and studied the impacts of the market power, loyalty of channel, and the level of complementary on the pricing.

Fang et al. (2013) studied a two-level supply chain that the retailer was able to offer a SB product and to compete with a NB product. Their model would make decisions on the introduction of the SB product, its pricing policy, and the production rates of both brands. They provided a game theory model to solve the problem. Assarzadegan et al. (2020) provided an evolutionary game theoretic model for analyzing decisions of the population of retailers to introduce generic and premium store brand products. They concluded that the introduction of generic and premium store brand products is profitable for retailers. Milberg et al. (2019) used a game model to analyze conditions that are better for a leading brand manufacturer to produce high-quality store brand products. Kienzler and Kowalkowski (2017) reviewed the pricing strategies among the marketing research and mentioned that most of the theoretical articles used game theory for modeling of pricing strategies.

2.2. Brand loyalty

Yıldız and Koçan (2018) found that product quality and innovation had positive effects on brand loyalty. Nemati et al. (2010) examined the influence of mobile phone innovations on brand loyalty and customer satisfaction in Pakistan. They collected relevant data through a questionnaire and concluded that innovation had a positive influence on customer satisfaction and brand loyalty. Pappu and Quester (2016) carried out an empirical study to study the relation between innovation and brand loyalty. They confirmed the role of product quality as an intervening variable. Seyyed Amiri et al. (2017) used Structural Equation Modeling (SEM) and concluded that both innovation and marketing communications had significant effects on the three brand equity, including perceived quality, brand image, and brand loyalty. Aktepe et al. (2015) also used the SEM and classification algorithm to examine the relationship between customer satisfaction and loyalty.

Ha et al. (2011) revealed the positive effects of advertising, store image, and the perceived quality on loyalty in both retail service and banking. Labeaga et al. (2007) studied factors related to store brand products, including price, shopping behavior, and socio-demographic to model store brand loyalty. Juan Beristain and Zorrilla (2011) proposed two theoretical models to study the impacts of SB product price and store image on SB loyalty, awareness, and perceived quality of SB products. They also analyzed the impacts of price and different dimensions of store image (marketing, social, and strategic) on SB equity. He et al. (2012) studied the impacts of trust, brand identity, perceived value, and customer satisfaction on brand loyalty empirically. Koklic et al. (2017) studied the impacts of service quality on customer satisfaction and customer satisfaction on the purchase intention of customers in the airline industry. Cho et al. (2015) revealed that consumer awareness about the manufacturer's name on the packaging of SB products effects negatively on NB loyalty and positively on SB loyalty. They concluded that the impact of favorable attitude to the SB product on SB loyalty is stronger than the impact of store brand attitude on store loyalty. Roy et al. (2019) examined the effects of perceived value, satisfaction, service quality, and service experience on loyalty. Darmawan et al. (2020) studied the effects of factors including brand loyalty, advertising, wholesale price, retail price, promotion, and markup on demand. Many studies have confirmed the positive effects of advertising on brand loyalty (Baye and Morgan, 2009; Buil et al., 2013; Chioveanu, 2008; Jiang et al., 2018; Shanahan et al., 2019).

2.3. Store loyalty

Corstjens and Lal (2000) used a game model and studied the role of store branding in creating store loyalty. Their results showed that the SB's quality could be a key tool for creating not only a storefront distinction but also store loyalty and profitability. Martos-Partal and González-Benito (2011) proposed a non-uniform relation to capturing the relationship between SB loyalty (both Generic and Copycat Store Brand) and store loyalty, whereby SB loyalty establishes a positive relationship with a certain level of store brand purchases before it declines (inverted U). While researchers such as Ailawadi et al. (2008), González-Benito and Martos-Partal (2012), and Koschate-Fischer et al. (2014) has been confirmed this inverted U-shaped relation between SB loyalty and store loyalty, Seenivasan et al. (2015) proposed both linear and non-linear relationships between store loyalty and SB loyalty.

Rubio et al. (2017) applied a theoretical model to examine the effects of store brand name, customer satisfaction with the price, store brand loyalty, and perceived image of assortment on store loyalty and trust in the retailer. Coelho do Vale et al. (2016) studied the role of PLs on store loyalty empirically. They considered PL characteristics (SB image, trust, quality, and price), in-store characteristics (service quality, merchandising, convenience, employees, social group, environment, and appearance), and economic factors (promotions, costs of switching store, loyalty schemes, and pricing). İpek et al. (2016) provided a conceptual model to study the effect of PL usage on store loyalty by considering the moderating effect of shopping value. Their results showed that the utilitarian shopping value leads to a positive relationship between store loyalty and PL usage.

2.4. Research gaps and contributions

Based on the articles reviewed in the previous sections, decisions such as pricing, quality, and advertising have been studied in articles like Amrouche and Yan (2017), Chung and Lee (2017), and Karray and Martín-Herrán (2019), which have examined the competition between NB and SB products by the game theory approach. In fact, no article has studied the competition between national and store brand products by considering brand loyalty, store loyalty, and the relationship between store loyalty and SB loyalty by the game theory approach.

The characteristics of articles in the literature review and the present article are shown in Table 1.

Table 1
Summary of literature review.

Author(s)	P[a]	I[b]	Q[c]	A[d]	S[e]	BL[f]	SL[g]	GT[h]
Karray and Zaccour (2006)	*			*				*
Ailawadi et al. (2008)						*	*	
Karray and Martín-Herrán (2009)	*			*				*
Nemati et al. (2010)		*			*	*		
Martos-Partal and González-Benito (2011)						*	*	
He et al. (2012)					*	*		
Nasser et al. (2013)	*		*					*
Fang et al. (2013)	*		*					*
Aktepe et al. (2015)	*		*		*	*		
Seenivasan et al. (2015)			*			*	*	
Pappu and Quester (2016)		*	*			*		
Hara and Matsubayashi (2017)	*							*
Chung and Lee (2017)	*		*					*
Koklic et al. (2017)			*		*	*		
Yıldız and Koçan (2018)		*	*			*		
Li et al. (2018)	*							*
Yang et al. (2018)	*			*				*
Karray and Martín-Herrán (2019)	*			*				*
This study	*	*	*	*	*	*	*	*

[a] Price.
[b] Innovation.
[c] Quality.
[d] Advertising.
[e] Satisfaction.
[f] Brand Loyalty.
[g] Store Loyalty.
[h] Game Theory.

3. Definition of the problem

We consider a retailer and a manufacturer who produces a NB product at the cost of c_{NB} and delivers it to the retailer at the price of w. The manufacturer uses innovation (μ) to enhance the quality of the NB product (q_{NB}). We assumed that customer satisfaction with the NB product (*NBS*) increases by the enhanced quality of the NB product, while the loyalty of national brand product (*NBL*) increases by customer satisfaction (*NBS*) and advertising (*A*).

The retailer sells the NB product to customers at the price of p_{NB}. In the first scenario, the retailer, in competition with the NB manufacturer, produces a GSB product at the cost of c_{GSB} and introduces it together with the NB product to customers, and sells it at the price of p_{GSB}. The level of loyalty for the GSB product is *GSBL*. In the second scenario, the retailer introduces a PSB product at the cost of c_{PSB} and sells it to customers at the price of p_{PSB}. It is assumed that the level of customer satisfaction with the PSB product (*PSBS*) rises as its quality (q_{PSB}) is improved, and customer loyalty to the PSB product (*PSBL*) will grow as a result of increasing customer satisfaction. In the third scenario, the retailer introduces both GSB and PSB products at the cost of c_{GSB} and c_{PSB} and sells them to customers at the price of p_{GSB} and p_{PSB}, respectively.

Fig. 1, Fig. 2, and Fig. 3 show the problem solving procedures in the first, the second, and the third scenarios, respectively.

3.1. Problem notations

In this sub-section, the notations used in the paper are defined:
Parameters.

q_{NB}^0 The initial quality for the NB product.
φ The influence of innovation on quality of NB product.
τ_0 The initial level of customer satisfaction with the NB product.
τ_1 The influence of quality of NB product on customer satisfaction.
n_1 The influence of customer satisfaction with the NB product on the loyalty of NB product.
n_2 The influence of advertising on the loyalty of NB product.
v_0 Fixed coefficient of store loyalty function.
v_1 First power coefficient of store loyalty function.
v_2 Second power coefficient of store loyalty function.
k_0 The initial level of customer satisfaction with the PSB product.
k_1 The influence of PSB quality on customer satisfaction.
θ The influence of customer satisfaction with the PSB product on the loyalty of PSB product.
α_N The market potential for the NB product.
$\alpha_{G\ (P)}$ The market potential for the GSB (PSB) product.
β_N Self-price sensitivity of NB's demand.
$\beta_{G\ (P)}$ Self-price sensitivity of GSB's (PSB's) demand.
b_1 Cross-price sensitivity between NB and PSB products.
γ_N The influence of loyalty of NB product on NB demand.
$\gamma_{G\ (P)}$ The influence of store loyalty on GSB (PSB) demand.
c_{NB} Cost of production for the NB product.
c_{GSB} Cost of production for the GSB product.
c_{PSB} Cost of production for the PSB product.
ξ The sensitivity coefficient of manufacturer profit function to innovation.
δ The sensitivity coefficient of manufacturer profit function to advertising.
ζ The sensitivity coefficient of retailer profit function to PSB quality.

Decision variables.

w Wholesale price for the NB product.
p_{NB} Retail price for the NB product.
p_{GSB} Retail price for the GSB product.
p_{PSB} Retail price for the PSB product.
q_{NB} NB product quality.
q_{PSB} PSB product quality.
μ Innovation level.
A Advertising level.
NBS Customer satisfaction with the NB product.
PSBS Customer satisfaction with the PSB product.
NBL Customer loyalty to the NB product.
GSBL Customer loyalty to the GSB product.
PSBL Customer loyalty to the PSB product.
SL Store Loyalty.

Demand and Profit Functions.

D_{NB} Demand of NB product.
D_{GSB} Demand of GSB product.
D_{PSB} Demand of PSB product.
π_M Profit function of the manufacturer.
π_R Profit function of the retailer.

3.2. Problem assumptions

The following assumptions are taken:

1) All demand functions and prices are positive; i.e., $p_{NB} > 0, p_{GSB} > 0, p_{PSB} > 0, w > 0, D_{NB} > 0, D_{GSB} > 0, D_{PSB} > 0$.
2) The self-price sensitivity coefficient is more than the cross-price sensitivity coefficient; i.e., $\beta_N > b_1$ and $\beta_P > b_1$.
3) The wholesale price for the NB product is greater than the cost of production; $w > c_{NB}$, the retail price for the GSB (PSB) product is greater than the cost of production; $p_{GSB}(p_{PSB}) > c_{GSB}(c_{PSB})$.
4) Following Chen et al. (2017), Giri et al. (2017), Song et al. (2017), He et al. (2019), and Malekian and Rasti-Barzoki (2019), the PSB's quality, advertising, and innovation costs are considered as a quadratic function.
5) PSB and NB products are substitutable due to their equally high quality, but GSB and NB products are not substitutable.
6) In agreement with Martos-Partal and González-Benito (2011) and Ailawadi et al. (2008), an inverted U-shaped relationship is assumed to hold between Generic Store Brand Loyalty and Store Loyalty, because GSB customers are more sensitive to price rather than PSB customers and if their loyalty to the store brand is high, shows that

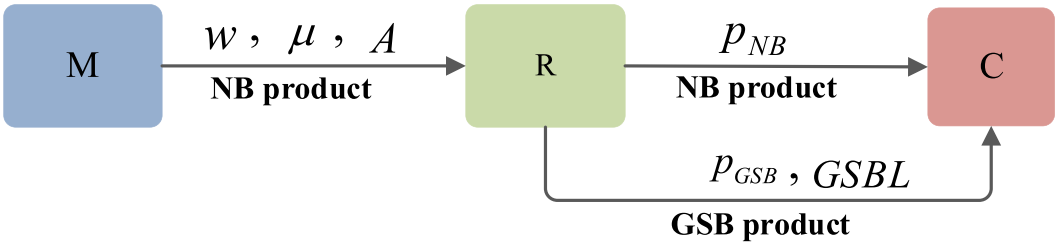

Fig. 1. The structure of the supply chain under the first scenario (Generic Store Brand product).

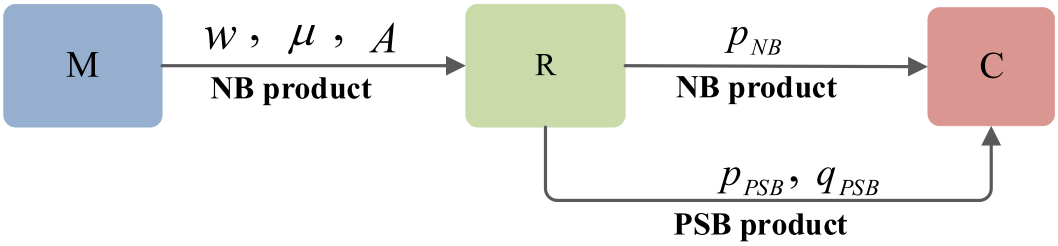

Fig. 2. The structure of the supply chain under the second scenario (Premium Store Brand product).

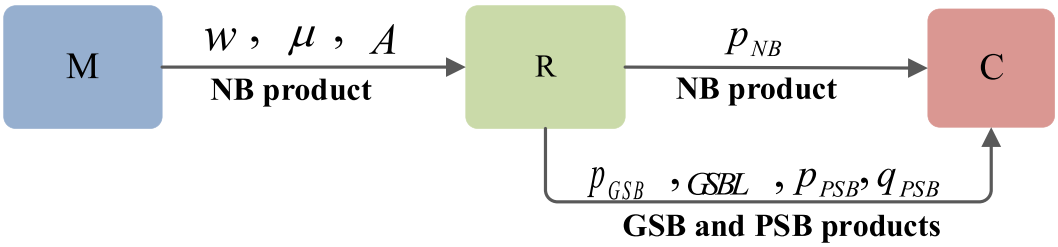

Fig. 3. The structure of the supply chain under the third scenario (both Generic and Premium Store Brand products).

they are highly price-sensitive and may switch to another store to buy a cheaper generic store brand product, therefore, store loyalty is reduced. So, store loyalty has an increasing trend to a point and then decreases (inverted U). While that between Premium Store Brand Loyalty and Store Loyalty is considered to be a linear one consistent with Seenivasan et al. (2015) because PSB consumers are quality-sensitive, and if their loyalty to PSB products increases, their loyalty to the store increases too.

4. Stackelberg game model

We consider three scenarios and two cases for each scenario to solve the problem. In the first case of each scenario, the manufacturer is taken to act as the leader and the retailer as the follower (Stackelberg-Manufacturer (SM)), while in the second case, the retailer is taken to act as the leader and the manufacturer as the follower (Stackelberg-Retailer (SR)). First, a brief description of Stackelberg games is given.

Game theory uses mathematical models to analyze methods of cooperation or competition of rational and intelligent beings. Game theory attempts to model the mathematical behavior of a strategic situation (conflict of interest). This situation arises when a person's success depends on the strategies that others choose. The goal of this knowledge is to find the optimal strategy for the players. Stackelberg game is a strategic game in economics and a sequential competition. The game has two players, and the competition between them is not about achieving a common goal, and players compete to increase their profits. The names of the players in this game are the leader and the follower who play in order. The leader is in a higher position than the follower, so it is his turn to decide first, and after observing the leader's decision, the follower determines his decision (Osborne, 2004).

To find Nash equilibrium in this game, the backward induction method is used. In the backward induction method, the direction of movement in the game is from the end to the beginning. The process of this analysis is that the leader first considers what the best response of the follower will be and examines his decision. In other words, the leader examines what the best response of the follower will be for each move. The leader then chooses the strategy that maximizes his profit based on the follower's best responses. The follower also observes the leader's decision and adopts the best response for his decisions (Barron, 2013).

In the following, the relevant scenarios and Nash equilibrium solutions are given. All proofs of theorems are provided in the Appendix.

4.1. The first scenario: the retailer introduces a generic store brand product (S_1)

In this scenario, the manufacturer produces the NB product and sells it to the retailer, and the retailer introduces a GSB product and sells both NB and its own GSB products to customers:

$$q_{NB} = q_{NB}^{0} + \varphi\mu \tag{1}$$

$$NBS = \tau_0 + \tau_1 q_{NB} \tag{2}$$

$$NBL = n_1 NBS + n_2 A \tag{3}$$

$$SL = v_0 + v_1(GSBL) - v_2(GSBL)^2 \tag{4}$$

$$D_{NB} = \alpha_N - \beta_N p_{NB} + \gamma_N NBL \tag{5}$$

$$D_{GSB} = \alpha_G - \beta_G p_{GSB} + \gamma_G SL \tag{6}$$

$$\pi_M = (w - c_{NB})D_{NB} - \frac{\xi\mu^2}{2} - \frac{\delta A^2}{2} \tag{7}$$

$$\pi_R = (p_{NB} - w)D_{NB} + (p_{GSB} - c_{GSB})D_{GSB} \tag{8}$$

Relation (1) shows the positive effect of innovation (μ) on the quality of NB product (q_{NB}), and it is adopted in the researches of Chenavaz (2012) and Wang et al. (2019). As the quality of the NB product increases, customer satisfaction increases, too (Relation (2)), and it is adopted in studies such as Gök (2019), Guru and Paulssen (2020), and Shin et al. (2020). As customer satisfaction (*NBS*) and advertising (A) increase, NB loyalty (*NBL*) also increases (Relation (3)) (El-Adly, 2019; Ji and Prentice, 2021; Rodríguez et al., 2020; Ruiz Díaz, 2017; Shanahan et al., 2019). Relation (4) expresses an inverted U that captures the relationship between store loyalty and generic store brand loyalty.

The market potential for the NB product is α_N when both the price and loyalty of the NB product (p_{NB} and *NBL*) are zero. However, the demand decreases when p_{NB} increases, but it increases as NBL increases (Relation (5)). Moreover, Relation (6) shows that the market potential for the GSB product is α_G. However, the GSB demand decreases when p_{GSB} increases, but it increases as Store Loyalty (*SL*) increases. The first

term of Relation (7) represents the manufacturer's profits related to sales of the NB product, while its second and third terms show the costs of innovation and advertising, respectively. Meanwhile, the first and second terms of Relation (8) indicate the retailer's profits related to NB and GSB sales, respectively.

- **Stackelberg-Manufacturer (SM)**

Theorem 1. *The optimal decisions of the retailer and the NB manufacturer when the manufacturer is the leader, are as follows*:

$$p_{NB}^{S_1(SM)} = \frac{\alpha_N + w^{S_1(SM)}\beta_N + \gamma_N\left(A^{S_1(SM)}n_2 + n_1\left(\tau_0 + \left(q_{NB}^0 + \mu^{S_1(SM)}\varphi\right)\tau_1\right)\right)}{2\beta_N} \quad (9)$$

$$p_{GSB}^{S_1(SM)} = \frac{v_1^2\gamma_G + 4v_2(\alpha_G + c_{GSB}\beta_G + v_0\gamma_G)}{8v_2\beta_G} \quad (10)$$

$$GSBL^{S_1(SM)} = \frac{v_1}{2v_2} \quad (11)$$

$$w^{S_1(SM)} = c_{NB} + \frac{2\delta\xi\left(\alpha_N - c_{NB}\beta_N + n_1\gamma_N\left(\tau_0 + q_{NB}^0\tau_1\right)\right)}{4\delta\xi\beta_N - \gamma_N^2(\xi n_2^2 + \delta\varphi^2 n_1^2\tau_1^2)} \quad (12)$$

$$\mu^{S_1(SM)} = \frac{\delta\varphi n_1\gamma_N\tau_1\left(\alpha_N - c_{NB}\beta_N + n_1\gamma_N\left(\tau_0 + q_{NB}^0\tau_1\right)\right)}{4\delta\xi\beta_N - \gamma_N^2(\xi n_2^2 + \delta\varphi^2 n_1^2\tau_1^2)} \quad (13)$$

$$A^{S_1(SM)} = \frac{\xi n_2\gamma_N\left(\alpha_N - c_{NB}\beta_N + n_1\gamma_N\left(\tau_0 + q_{NB}^0\tau_1\right)\right)}{4\delta\xi\beta_N - \gamma_N^2(\xi n_2^2 + \delta\varphi^2 n_1^2\tau_1^2)} \quad (14)$$

- ***Stackelberg-Retailer (SR)***

Theorem 2. *The optimal decisions of the NB manufacturer and the retailer when the retailer is the leader, are as follows*:

$$w^{S_1(SR)} = \frac{p_{NB}^{S_1(SR)} + c_{NB}}{2} \quad (15)$$

$$\mu^{S_1(SR)} = \frac{\varphi n_1\tau_1\gamma_N\left(w^{S_1(SR)} - c_{NB}\right)}{\xi} \quad (16)$$

$$A^{S_1(SR)} = \frac{n_2\gamma_N\left(w^{S_1(SR)} - c_{NB}\right)}{\delta} \quad (17)$$

$$p_{NB}^{S_1(SR)} = c_{NB} + \frac{\delta\xi\left(\alpha_N - c_{NB}\beta_N + n_1\gamma_N\left(\tau_0 + q_{NB}^0\tau_1\right)\right)}{2\delta\xi\beta_N - \gamma_N^2(\xi n_2^2 + \delta\varphi^2 n_1^2\tau_1^2)} \quad (18)$$

$$p_{GSB}^{S_1(SR)} = \frac{v_1^2\gamma_G + 4v_2(\alpha_G + c_{GSB}\beta_G + v_0\gamma_G)}{8v_2\beta_G} \quad (19)$$

$$GSBL^{S_1(SR)} = \frac{v_1}{2v_2} \quad (20)$$

4.2. The second scenario: the retailer introduces a premium store brand product (S_2)

In this scenario, the manufacturer produces the NB product and sells it to the retailer, and the retailer introduces a Premium Store Brand product and sells both the NB and its own PSB products to customers:

$$q_{NB} = q_{NB}^0 + \varphi\mu \quad (21)$$

$$NBS = \tau_0 + \tau_1 q_{NB} \quad (22)$$

$$NBL = n_1 NBS + n_2 A \quad (23)$$

$$PSBS = k_0 + k_1 q_{PSB} \quad (24)$$

$$PSBL = \theta\, PSBS \quad (25)$$

$$SL = v_0 + v_1 PSBL \quad (26)$$

$$D_{NB} = \alpha_N - \beta_N p_{NB} + b_1 p_{PSB} + \gamma_N NBL \quad (27)$$

$$D_{PSB} = \alpha_P - \beta_P p_{PSB} + b_1 p_{NB} + \gamma_P SL \quad (28)$$

$$\pi_M = (w - c_{NB})D_{NB} - \frac{\xi\mu^2}{2} - \frac{\delta A^2}{2} \quad (29)$$

$$\pi_R = (p_{NB} - w)D_{NB} + (p_{PSB} - c_{PSB})D_{PSB} - \frac{\zeta q_{PSB}^2}{2} \quad (30)$$

Relation (21) shows the positive effect of innovation (μ) on the quality of NB product (q_{NB}), and it is adopted in the researches of Chenavaz (2012) and Wang et al. (2019). Clearly, customer satisfaction increases as the quality of NB product increases (Relation (22)) and it is adopted in studies such as Gök (2019), Guru and Paulssen (2020), and Shin et al. (2020), and NB loyalty (*NBL*) rises as both customer satisfaction (*NBS*) and advertising (*A*) increase (Relation (23)) (El-Adly, 2019; Ji and Prentice, 2021; Rodríguez et al., 2020; Ruiz Díaz, 2017; Shanahan et al., 2019). Relations (24) and (25), respectively, reveal the positive effect of PSB quality on customer satisfaction and customer satisfaction on loyalty. Relation (26) is a linear one capturing the relationship between store loyalty and premium store brand loyalty and it is consistent with Seenivasan et al. (2015) and Coelho do Vale and Verga Matos (2017).

The market potential for the NB product is α_N for zero values of NB price (p_{NB}), PSB price (p_{PSB}), and NB loyalty (*NBL*). However, demand decreases by increasing p_{NB} and increases by increasing p_{PSB} (note that NB and PSB products are interchangeable) and that NB demand increases when NBL increases (Relation (27)). The market potential for the PSB product is equal to α_P, PSB demand decreases when p_{PSB} increases, but increases when p_{NB} increases. Moreover, PBS demand increases as Store Loyalty (*SL*) increases (Relation (28)). The first term of Relation (29), represents the manufacturer's profits related to sales of NB product to the retailer, while its second and third terms denote the costs of innovation and advertising, respectively. This is while the first term of Relation (30) shows the retailer's profits related to sales of NB product, the second part denotes the profits from the sales of the PSB product, and the third term represents the cost of improving PSB quality.

- **Stackelberg-Manufacturer (SM)**

Theorem 3. *The optimal decisions of the retailer and the NB manufacturer when the manufacturer is the leader, are as follows*:

$$p_{NB}^{S_2(SM)} = \frac{A_1}{2\left(2\zeta b_1^2 + \beta_N\left(-2\zeta\beta_P + k_1^2\theta^2 v_1^2\gamma_P^2\right)\right)} \quad (31)$$

$$p_{PSB}^{S_2(SM)} = \frac{A_2}{2\zeta b_1^2 + \beta_N\left(-2\zeta\beta_P + k_1^2\theta^2 v_1^2\gamma_P^2\right)} \quad (32)$$

$$q_{PSB}^{S_2(SM)} = \frac{A_3}{2\zeta b_1^2 + \beta_N\left(-2\zeta\beta_P + k_1^2\theta^2 v_1^2\gamma_P^2\right)} \quad (33)$$

$$w^{S_2(SM)} = c_{NB} + \frac{2\delta\xi\left(b_1 c_{PSB} + \alpha_N - c_{NB}\beta_N + n_1\gamma_N\left(\tau_0 + q_{NB}^0\tau_1\right)\right)}{4\delta\xi\beta_N - \gamma_N^2(\xi n_2^2 + \delta\varphi^2 n_1^2\tau_1^2)} \quad (34)$$

$$\mu^{S_2(SM)} = \frac{\delta\varphi n_1\gamma_N\tau_1\left(b_1c_{PSB} + \alpha_N - c_{NB}\beta_N + n_1\gamma_N\left(\tau_0 + q^0_{NB}\tau_1\right)\right)}{4\delta\xi\beta_N - \gamma_N^2(\xi n_2^2 + \delta\varphi^2 n_1^2\tau_1^2)} \tag{35}$$

$$A^{S_2(SM)} = \frac{\xi n_2\gamma_N\left(b_1c_{PSB} + \alpha_N - c_{NB}\beta_N + n_1\gamma_N\left(\tau_0 + q^0_{NB}\tau_1\right)\right)}{4\delta\xi\beta_N - \gamma_N^2(\xi n_2^2 + \delta\varphi^2 n_1^2\tau_1^2)} \tag{36}$$

- ***Stackelberg-Retailer (SR)***

Theorem 4. *The optimal decisions of the NB manufacturer and the retailer when the retailer is the leader, are as follows*:

$$w^{S_2(SR)} = \frac{p_{NB}^{S_2(SR)} + c_{NB}}{2} \tag{37}$$

$$\mu^{S_2(SR)} = \frac{\varphi n_1\tau_1\gamma_N\left(w^{S_2(SR)} - c_{NB}\right)}{\xi} \tag{38}$$

$$A^{S_2(SR)} = \frac{n_2\gamma_N\left(w^{S_2(SR)} - c_{NB}\right)}{\delta} \tag{39}$$

$$p_{NB}^{S_2(SR)} = \frac{B_1}{9\delta\zeta\xi b_1^2 - 2\left(2\zeta\beta_P - \theta^2k_1^2v_1^2\gamma_P^2\right)\left(2\delta\xi\beta_N - \gamma_N^2(\xi n_2^2 + \delta\varphi^2 n_1^2\tau_1^2)\right)} \tag{40}$$

$$p_{PSB}^{S_2(SR)} = \frac{B_2}{9\delta\zeta\xi b_1^2 - 2\left(2\zeta\beta_P - \theta^2k_1^2v_1^2\gamma_P^2\right)\left(2\delta\xi\beta_N - \gamma_N^2(\xi n_2^2 + \delta\varphi^2 n_1^2\tau_1^2)\right)} \tag{41}$$

$$q_{PSB}^{S_2(SR)} = \frac{B_3}{9\delta\zeta\xi b_1^2 - 2\left(2\zeta\beta_P - \theta^2k_1^2v_1^2\gamma_P^2\right)\left(2\delta\xi\beta_N - \gamma_N^2(\xi n_2^2 + \delta\varphi^2 n_1^2\tau_1^2)\right)} \tag{42}$$

4.3. The third scenario: the retailer introduces both generic and premium store brand products (S_3)

In this scenario, the manufacturer produces the NB product and sells it to the retailer, and the retailer introduces both GSB and PSB products and sells NB, GSB, and PSB products to customers:

$$SL = v_0 + v_1(PSBL + GSBL) - v_2\left(GSBL^2\right) \tag{43}$$

$$\pi_R = (p_{NB} - w)D_{NB} + (p_{GSB} - c_{GSB})D_{GSB} + (p_{PSB} - c_{PSB})D_{PSB} - \frac{\zeta q_{PSB}^2}{2} \tag{44}$$

The Relations related to the NB product including the NB quality, customer satisfaction, and NB loyalty (q_{NB}, *NBS*, and *NBL*), Relations related to the PSB product including customer satisfaction and loyalty (*PSBS* and *PSBL*), demand functions of NB, PSB, and GSB products (D_{NB}, D_{PSB}, and D_{GSB}), and the manufacturer's profit function (π_M) are similar to Relations (21)–(23), (24)–(25), (27)–(28), (6), and (29) respectively, which are not rewritten in this scenario to avoid duplication. Relation (43) shows that the relationship between store loyalty and premium store brand loyalty (*PSBL*) is linear, and the relationship between store loyalty and generic store brand loyalty (*GSBL*) is non-monotonic (an inverted U-shaped). The first term of Relation (44) shows the retailer's profits related to sales of NB product, the second part denotes the profits from the sales of GSB product, the third term presents the profits from the sales of PSB product, and the last term is the cost of improving the PSB quality.

- **Stackelberg-Manufacturer (SM)**

Theorem 5. *The optimal decisions of the retailer and the NB manufacturer when the manufacturer is the leader, are as follows*:

$$p_{NB}^{S_3(SM)} = \frac{C_1}{4v_2\left(\left(b_1^2 - \beta_N\beta_P\right)\left(2\zeta\beta_G - \theta^2k_1^2v_1^2\gamma_G^2\right) + \theta^2k_1^2v_1^2\beta_G\beta_N\gamma_P^2\right)} \tag{45}$$

$$p_{GSB}^{S_3(SM)} = \frac{C_2}{4v_2\left(\left(b_1^2 - \beta_N\beta_P\right)\left(2\zeta\beta_G - \theta^2k_1^2v_1^2\gamma_G^2\right) + \theta^2k_1^2v_1^2\beta_G\beta_N\gamma_P^2\right)} \tag{46}$$

$$GSBL^{S_3(SM)} = \frac{v_1}{2v_2} \tag{47}$$

$$p_{PSB}^{S_3(SM)} = \frac{C_3}{4v_2\left(\left(b_1^2 - \beta_N\beta_P\right)\left(2\zeta\beta_G - \theta^2k_1^2v_1^2\gamma_G^2\right) + \theta^2k_1^2v_1^2\beta_G\beta_N\gamma_P^2\right)} \tag{48}$$

$$q_{PSB}^{S_3(SM)} = \frac{C_4}{4v_2\left(\left(b_1^2 - \beta_N\beta_P\right)\left(2\zeta\beta_G - \theta^2k_1^2v_1^2\gamma_G^2\right) + \theta^2k_1^2v_1^2\beta_G\beta_N\gamma_P^2\right)} \tag{49}$$

$$w^{S_3(SM)} = c_{NB} + \frac{2\delta\xi\left(b_1c_{PSB} + \alpha_N - c_{NB}\beta_N + n_1\gamma_N\left(\tau_0 + q^0_{NB}\tau_1\right)\right)}{4\delta\xi\beta_N - \gamma_N^2(\xi n_2^2 + \delta\varphi^2 n_1^2\tau_1^2)} \tag{50}$$

$$\mu^{S_3(SM)} = \frac{\delta\varphi n_1\gamma_N\tau_1\left(b_1c_{PSB} + \alpha_N - c_{NB}\beta_N + n_1\gamma_N\left(\tau_0 + q^0_{NB}\tau_1\right)\right)}{4\delta\xi\beta_N - \gamma_N^2(\xi n_2^2 + \delta\varphi^2 n_1^2\tau_1^2)} \tag{51}$$

$$A^{S_3(SM)} = \frac{\xi n_2\gamma_N\left(b_1c_{PSB} + \alpha_N - c_{NB}\beta_N + n_1\gamma_N\left(\tau_0 + q^0_{NB}\tau_1\right)\right)}{4\delta\xi\beta_N - \gamma_N^2(\xi n_2^2 + \delta\varphi^2 n_1^2\tau_1^2)} \tag{52}$$

- ***Stackelberg-Retailer (SR)***

Theorem 6. *The optimal decisions of the NB manufacturer and the retailer when the retailer is the leader, are as follows*:

$$w^{S_3(SR)} = \frac{p_{NB}^{S_3(SR)} + c_{NB}}{2} \tag{53}$$

$$\mu^{S_3(SR)} = \frac{\varphi n_1\tau_1\gamma_N\left(w^{S_3(SR)} - c_{NB}\right)}{\xi} \tag{54}$$

$$A^{S_3(SR)} = \frac{n_2\gamma_N\left(w^{S_3(SR)} - c_{NB}\right)}{\delta} \tag{55}$$

$$p_{NB}^{S_3(SR)} = \frac{D_1}{D_2} \tag{56}$$

$$p_{GSB}^{S_3(SR)} = \frac{D_3}{4D_2} \tag{57}$$

$$GSBL^{S_3(SR)} = \frac{v_1}{2v_2} \tag{58}$$

$$p_{PSB}^{S_3(SR)} = \frac{D_4}{D_2} \tag{59}$$

$$q_{PSB}^{S_3(SR)} = \frac{D_5}{4D_2} \tag{60}$$

Table 2 *shows the Nash equilibrium solutions obtained in all scenarios.*

5. Analysis

5.1. Numerical analysis

In this section, a numerical example with the related charts are presented for all scenarios.

Example: Consider a supply chain consisting of a national brand manufacturer and a retailer with three scenarios, including 1) Introducing only the GSB product, 2) Introducing only the PSB product, 3) Introducing both GSB and PSB products. Table 3 and Table 4 report the values of parameters and variables, respectively.

Table 2
Nash equilibrium solutions in all scenarios.

TheFirstscenario		TheSecondScenario		TheThirdScenario	
SM	***SR***	***SM***	***SR***	***SM***	***SR***
w^N	$w^{S_1(SM)}$	$\frac{p_{NB}^{S_1(SR)}+c_{NB}}{2}$	$w^{S_2(SM)}$	$\frac{p_{NB}^{S_2(SR)}+c_{NB}}{2}$	$w^{S_3(SM)}$
μ^N	$\mu^{S_1(SM)}$	$\frac{\delta\varphi n_1\gamma_N\tau_1 E_1}{2E_3}$	$\mu^{S_2(SM)}$	$\frac{\delta\varphi n_1\gamma_N\tau_1 E_8}{E_9}$	$\mu^{S_3(SM)}$
A^N	$A^{S_1(SM)}$	$\frac{\xi n_2\gamma_N E_1}{2E_3}$	$A^{S_2(SM)}$	$\frac{\xi n_2\gamma_N E_8}{E_9}$	$A^{S_3(SM)}$
p_{NB}^N	$\frac{c_{NB}E_2+3\delta\xi E_1}{E_2}$	$p_{NB}^{S_1(SR)}$	$\frac{E_4}{E_5}$	$p_{NB}^{S_2(SR)}$	$\frac{E_{10}}{E_{11}}$
p_{GSB}^N	$p_{GSB}^{S_1(SM)}$	$p_{GSB}^{S_1(SR)}$ -	-	$\frac{E_{12}-\frac{E_{13}}{E_2}}{E_{11}}$	$p_{GSB}^{S_3(SR)}$
$p_{PSB\_}^N$	-	$\frac{E_6}{E_5}$	$p_{PSB}^{S_2(SR)}$	$\frac{E_{14}-\frac{E_{15}}{E_2}}{E_{11}}$	$p_{PSB}^{S_3(SR)}$
$GSBL^N$	$\frac{v_1}{2v_2}$	$\frac{v_1}{2v_2}$	-	$\frac{v_1}{2v_2}$	$\frac{v_1}{2v_2}$
$q_{PSB\_}^N$	-	$\frac{E_7}{E_5}$	$q_{PSB}^{S_2(SR)}$	$\frac{\theta k_1 v_1\left(E_{16}-\frac{E_{17}}{E_2}\right)}{E_{11}}$	$q_{PSB}^{S_3(SR)}$

5.2. Effect of v_1 on quality and loyalty

Corollary 1. As seen in Relations (33), (42), (49) and (60), when the effect of PSB loyalty on store loyalty (v_1) is increased, the retailer increases the quality of PSB product, because he wishes to increase sales and the number of visits to the store by improving the quality of its own brand (both cases SM and SR). However, v_1 does not affect the quality of the NB product; it means that store loyalty does not affect the decision of the manufacturer for the quality of the NB product. Both PSB and GSB loyalties rise with increasing v_1 (*PSBL* and *GSBL*), and for high values of v_1, the loyalty to the GSB product is more than the PSB product. To better understanding Corollary 1, Fig. 4 and Fig. 5 are shown as examples.

5.3. Effects of c_{PSB} and c_{NB} on quality, innovation, and advertising

Corollary 2. According to Relations (33), (42), (49), and (60), as the cost of production for the PSB product (c_{PSB}) increases, the retailer decreases the quality of the PSB product (in both cases SM and SR), but as the cost of production for the NB product (c_{NB}) increases, the retailer decreases the PSB's quality in case SM, and increases in case SR. According to Relations (35), (36), (51), and (52), when the manufacturer is the leader (case SM) as c_{PSB} increases, the manufacturer increases the levels of innovation and advertising. According to Relations (38), (39), (54), and (55), when the retailer is the leader (case SR), the manufacturer decreases the levels of innovation and advertising. This means that when the retailer has more power than the manufacturer, and the production costs of its brand increase, it can negatively affect the manufacturer's decisions about innovation and advertising. Figs. 6-9 are examples of this Corollary.

5.4. Effects of τ_1 on innovation and loyalty

Corollary 3. *As seen in Relations* (13), (16), (35), (38), (51), *and* (54), *when the influence of NB quality on NB's customer satisfaction* (τ_1) *increases, the manufacturer is encouraged to raise innovation in all three scenarios. This leads to enhanced customer loyalty to the NB product in all three scenarios. Also, NB's innovation and NB loyalty are greater than other scenarios when the retailer is the leader* (*case SR*).

5.5. Effect of b_1 on quality, prices, demands, and profits

Corollary 4. According to Relations (33), (42), (49), and (60), when the cross-price elasticity between NB and PSB products (b_1) increases, the retailer improves the quality of the PSB product and decreases the quality gap with the NB product. The manufacturer also improves the quality of the NB product. Hence, as the NB quality is improved, the manufacturer raises the wholesale price of the NB product (Relations (34), (37), (50), and (53)), and the retailer also increases the retail prices of both NB (Relations (31), (40), (45), and (56)) and PSB products (Relations (32), (41), (48), and (59)). Moreover, the demands for NB and PSB products increase as their qualities are improved. Accordingly, both profits of the retailer and the manufacturer will increase. But the

Table 4
Equilibrium decisions for the example.

The First Scenario		The Second Scenario		The Third Scenario	
SM	SR	SM	SR	SM	SR
w907.83	667.63	995.43	770.16	995.43	771.96
μ1.71	1.8	2.00	2.49	2.00	2.50
A9.52	10.03	11.16	13.88	11.16	13.95
p_{NB}1161.74	935.26	1370.93	1140.33	1373.04	1143.91
p_{GSB}140.07	140.07	_	_	147.24	146.97
$p_{PSB\_}$	_	733.35	703.47	739.69	709.95
q_{NB}9.19	9.26	9.4	9.74	9.4	9.75
$q_{PSB\_}$	_	4.36	3.8	5.36	4.8
*NBS*0.87	0.87	0.88	0.89	0.88	0.89
*NBL*0.82	0.85	0.91	1.04	0.91	1.05
*GSBL*0.58	0.58	_	_	0.58	0.59
*PSBS*_	_	0.72	0.69	0.77	0.74
*PSBL*_	_	0.57	0.55	0.61	0.59
*SL*0.4	0.4	0.6	0.59	0.83	0.82
D_{NB}76.16	144.92	89.31	159.75	89.31	159.42
D_{GSB}24.04	24.04	_	_	28.34	28.18
$D_{PSB\_}$	_	55.79	44.37	58.11	46.78
π_M36797.1	36689.7	50587.8	55123.9	50587.8	55251.1
π_R20304.9	39748.4	46272.1	67944.2	48563.4	70099.1

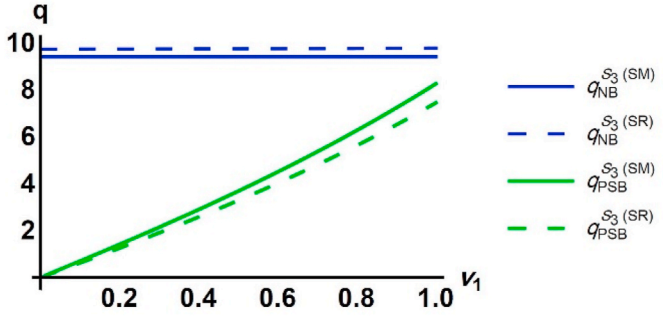

Fig. 4. The impact of v_1 on the quality in.S_3

Table 3
Data of parameters used in the example.

α_N	α_G	α_P	β_N	β_G	β_P	b_1	γ_N	$\gamma_G(\gamma_P)$	q_{NB}^0	ϕ	τ_0	τ_1	n_1
400	100	200	0.3	0.6	0.4	0.1	30	20	8	0.7	0.5	0.04	0.4
n_2	k_0	k_1	θ	v_0	v_1	v_2	ξ	δ	ζ	c_{NB}	c_{GSB}	c_{PSB}	
0.05	0.5	0.05	0.8	0.2	0.7	0.6	50	40	30	400	100	500	

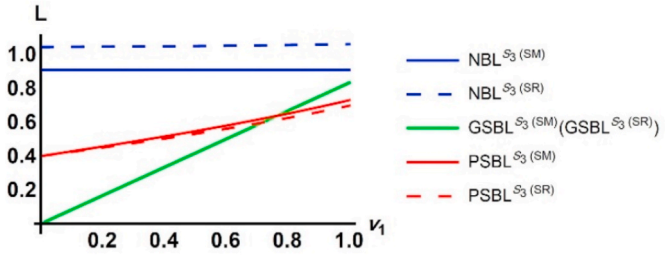

Fig. 5. The impact of v_1 on loyalty in.S_3

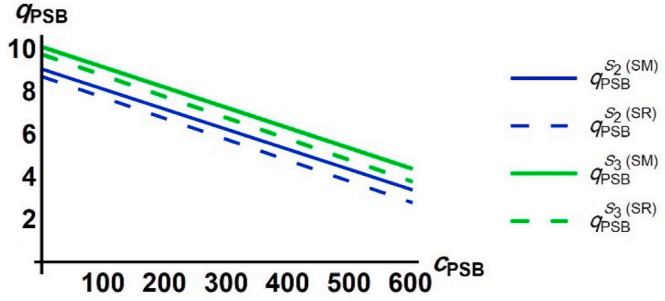

Fig. 6. The impact of c_{PSB} on the quality of PSB product in both S_2 and.S_3

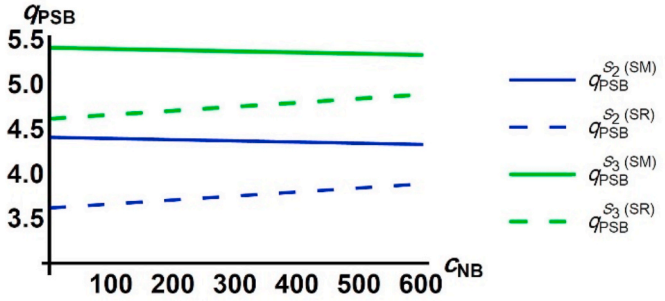

Fig. 7. The impact of c_{NB} on the quality of PSB product in both S_2 and.S_3

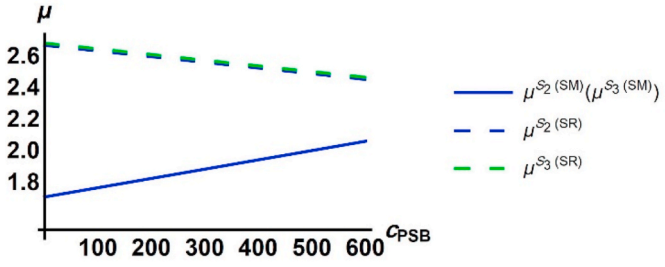

Fig. 8. The impact of c_{PSB} on innovation in both S_2 and.S_3

important thing is that when the retailer is the leader (case SR), at high levels of b_1, the NB's demand and the manufacturer's profit decrease. This means that it will not be profitable for the manufacturer to be the follower of the game when the effect of substitution between the two brands (NB and PSB) on demand is high. Figs. 10-13 are shown as examples of Corollary 4.

5.6. Simultaneous effects of n_1 and n_2 as well as k_1 and θ on store loyalty

Corollary 5. *Store loyalty increases with increasing the influence of NB customer satisfaction and advertising on NB loyalty (n_1 & n_2). This means that when customers are loyal to the NB product that sells in stores, they will become loyal to stores, too. In other words, NB loyalty leads to store loyalty.*

Corollary 6. *Store loyalty rises when the influence of the PSB quality on customer satisfaction of PSB product (k_1) and the effect of customer satisfaction of PSB product on PSB loyalty (θ) increase simultaneously. In other words, PSB loyalty leads to store loyalty.* Fig. 14 *shows an example of this Corollary.*

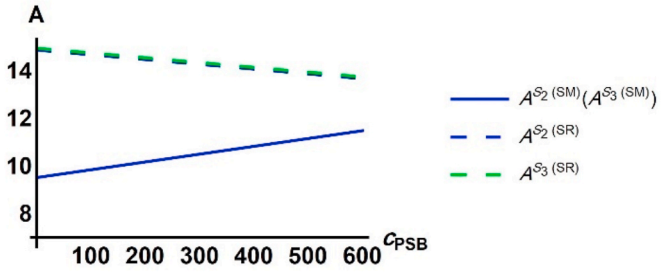

Fig. 9. The impact of c_{PSB} on advertising in both S_2 and.S_3

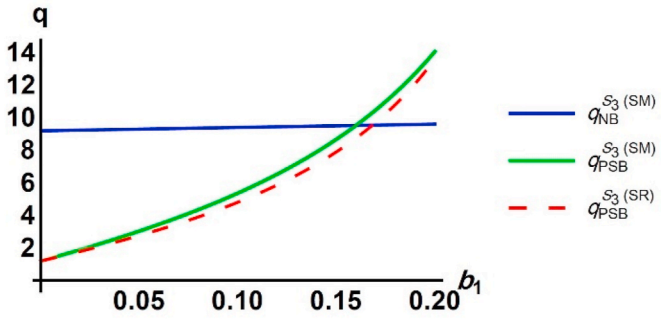

Fig. 10. The impact of b_1 on the quality in.S_3

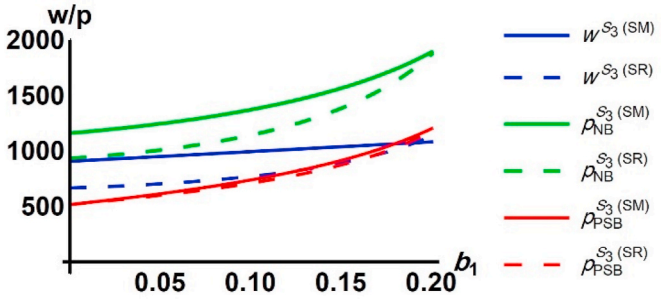

Fig. 11. The impact of b_1 on prices in.S_3

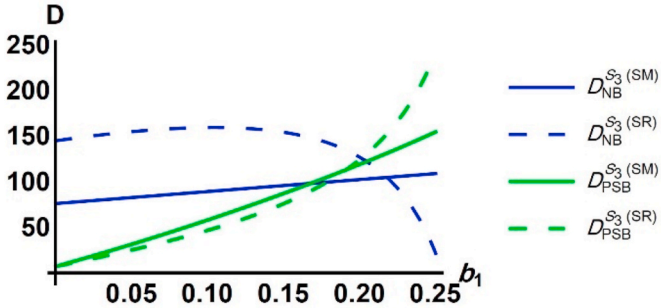

Fig. 12. The impact of b_1 on demands in.S_3

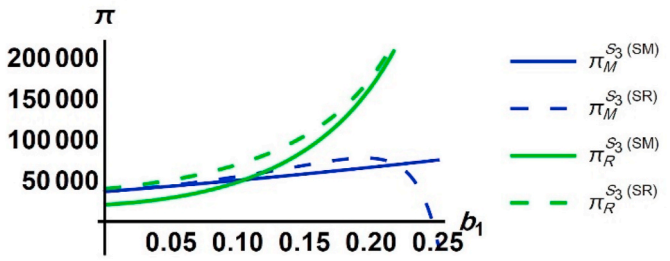

Fig. 13. The impact of b_1 on profits in.S_3

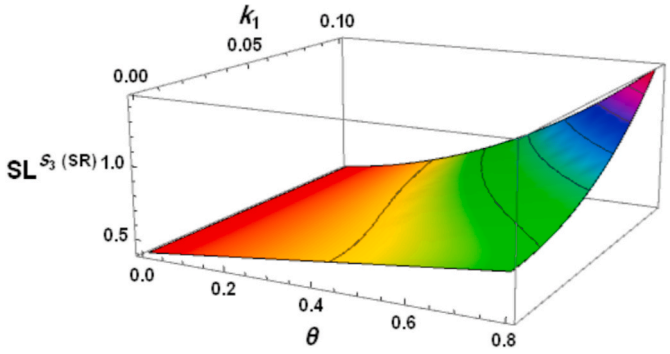

Fig. 14. ***The simultaneous impact of θ and k_1 on the store loyalty in S_3(case SR).***

5.7. Comparison of scenarios

As Relations (61) through (69) show, the wholesale and the retail price of the NB product (w and p_{NB}), innovation (μ), advertising (A), the quality of NB and PSB products (q_{NB} and q_{PSB}), the retail prices of GSB and PSB products (p_{GSB} and p_{PSB}), and the retailer's profit (π_R) are higher in the third scenario than others. This means that when the retailer introduces both GSB and PSB products, the manufacturer will improve innovation and advertising. As a result, the NB quality, the wholesale price, and the retail price of NB product rise, too. In other words, the retailer also increases the quality of the PSB product and the retail prices of GSB and PSB products.

Relation (61) shows that, when the manufacturer is the leader (case SM), he sells the NB product at a higher wholesale price to the retailer than case SR in all three scenarios. Therefore, the retail prices of the NB product in case SM are higher than case SR in all three scenarios (Relation (62)). According to Relations (63)–(65), when the retailer is the leader (case SR), the manufacturer, in competition with the PSB product, considers the level of innovation, advertising, and quality of NB product to be higher than case SM. According to Relation (66), the quality of the PSB product in the third scenario is higher than the second scenario, and the retailer considers higher retail prices for PSB and GSB products in case SM (Relations (67)–(68)). According to Relation (69), the simultaneous introduction of GSB and PSB products and case SR is more profitable for the retailer.

$$w^{S_3(SM)} = w^{S_2(SM)} > w^{S_1(SM)} > w^{S_3(SR)} > w^{S_2(SR)} > w^{S_1(SR)} \tag{61}$$

$$p_{NB}^{S_3(SM)} > p_{NB}^{S_2(SM)} > p_{NB}^{S_1(SM)} > p_{NB}^{S_3(SR)} > p_{NB}^{S_2(SR)} > p_{NB}^{S_1(SR)} \tag{62}$$

$$\mu^{S_3(SR)} > \mu^{S_2(SR)} > \mu^{S_3(SM)} = \mu^{S_2(SM)} > \mu^{S_1(SR)} > \mu^{S_1(SM)} \tag{63}$$

$$A^{S_3(SR)} > A^{S_2(SR)} > A^{S_3(SM)} = A^{S_2(SM)} > A^{S_1(SR)} > A^{S_1(SM)} \tag{64}$$

$$q_{NB}^{S_3(SR)} > q_{NB}^{S_2(SR)} > q_{NB}^{S_3(SM)} = q_{NB}^{S_2(SM)} > q_{NB}^{S_1(SR)} > q_{NB}^{S_1(SM)} \tag{65}$$

$$q_{PSB}^{S_3(SM)} > q_{PSB}^{S_3(SR)} > q_{PSB}^{S_2(SM)} > q_{PSB}^{S_2(SR)} \tag{66}$$

$$p_{PSB}^{S_3(SM)} > p_{PSB}^{S_2(SM)} > p_{PSB}^{S_3(SR)} > p_{PSB}^{S_2(SR)} \tag{67}$$

$$p_{GSB}^{S_3(SM)} > p_{GSB}^{S_3(SR)} > p_{GSB}^{S_1(SM)} = p_{GSB}^{S_1(SR)} \tag{68}$$

$$\pi_R^{S_3(SR)} > \pi_R^{S_2(SR)} > \pi_R^{S_3(SM)} > \pi_R^{S_2(SM)} > \pi_R^{S_1(SR)} > \pi_R^{S_1(SM)} \tag{69}$$

Now, we want to answer the question under what conditions is it profitable for the manufacturer to be the leader (case SM), and under what conditions to be the follower (case SR)? As you can see in Figs. 15-17, at the high levels of the market base of PSB product (α_P), at the low levels of self-price sensitivity of PSB's demand (β_P), and at the low levels of cross-price sensitivity between NB and PSB products (b_1), the manufacturer's profit in case SR is more than in case SM. It means that when PSB's demand is high, the manufacturer prefers to be the follower. On the other hand, according to Fig. 18, when the level of the influence of loyalty of NB product on NB demand (γ_N) is high, the manufacturer prefers to be a leader and earns more profit from loyal customers to the NB product.

6. Results and discussions

In this section, theoretical contributions and the managerial implications are provided.

The main theoretical contributions of this study are as follows: First, this study for the first time examines the impacts of innovation, quality, and advertising on the functions of customer satisfaction and brand loyalty. NB loyalty and PSB loyalty are both modeled based on customer satisfaction and quality. But the model of NB loyalty particular emphasizes the role of innovation and advertising. Second, the NB demand function is modeled based on price and brand loyalty, GSB and PSB demand functions are modeled based on price and store loyalty. In addition, customer satisfaction and loyalty functions are modeled for NB and PSB products, and the effects of customer satisfaction and loyalty on prices, demand functions, the manufacturer's and the retailer's profit functions are examined.

Third, the relationship between store loyalty and generic store brand loyalty is considered non-monotonic (an inverted U-shaped), and the relationship between store loyalty and premium store brand loyalty is considered linearly. Finally, three scenarios including the introduction of the GSB product, the introduction of the PSB product, and the simultaneous introduction of GSB and PSB products for the retailer are studied, and for each scenario, two cases for the Stackelberg leader including the manufacturer as a leader and the retailer as a leader are considered. Also, the optimal solutions of price, levels of innovation, advertising, and NB loyalty for the NB product, price, GSB loyalty, and store loyalty for the GSB product, and price, the quality level, PSB loyalty, and store loyalty for the PSB product are calculated, and the

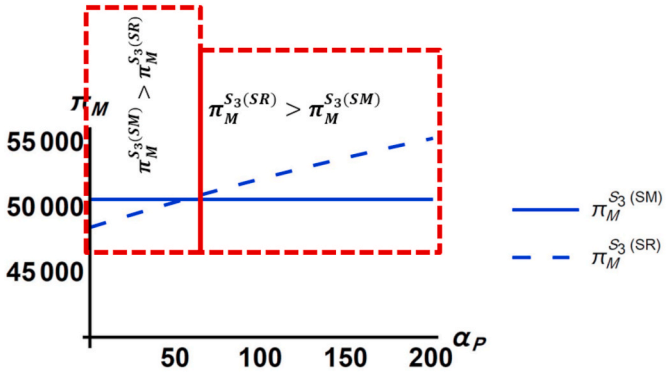

Fig. 15. The impact of α_P on the manufacturer's profit in.S_3

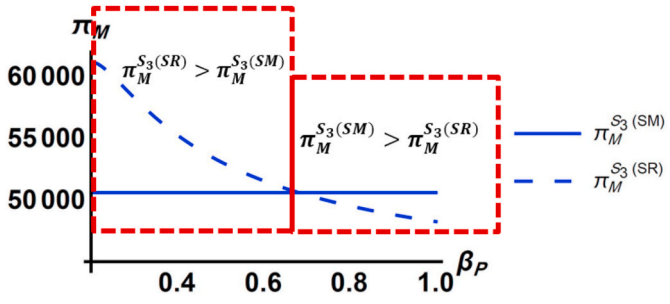

Fig. 16. The impact of β_P on the manufacturer's profit in.S_3

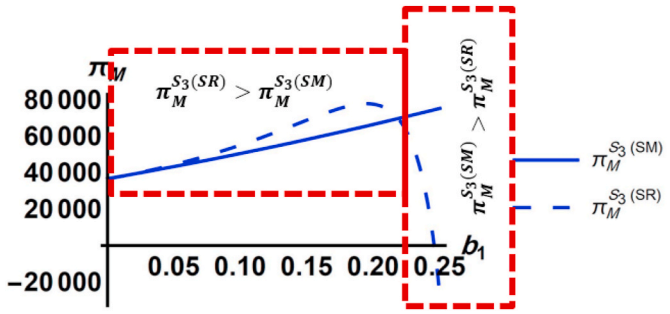

Fig. 17. The impact of b_1 on the manufacturer's profit in.S_3

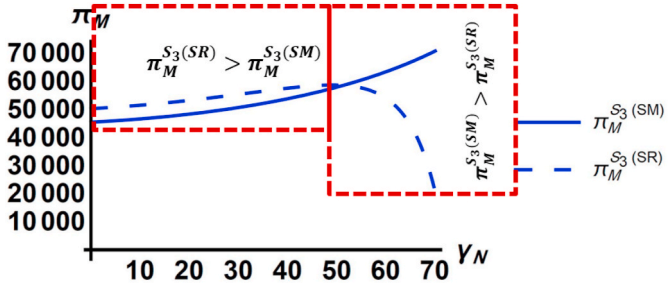

Fig. 18. The impact of γ_N on the manufacturer's profit in.S_3

following managerial implications are obtained.

Managerial implication 1. If store loyalty increases store brand loyalty will rise, too. This is because as customers visit the store more, they become more loyal to the store brands. Indeed, store loyalty and SB loyalty are mutually related (Ailawadi et al., 2008; Gomez and Rubio, 2010; Rubio et al., 2019). Also, the impact of store loyalty on the loyalty of the GSB product is more than the loyalty of the PSB product. This means that retailers can increase the sales of GSB products by using customer loyalty to the store.

Managerial implication 2. When the NB manufacturer is the leader (case SM), he considers the PSB product as a threat and tries to position the NB product on a higher quality level by increasing the innovation. But when the retailer is the leader (case SR), as PSB production costs increase and PSB's quality decreases, the manufacturer also reduces levels of innovation and advertising. So, it is more profitable for retailers to be the leader. In the real world, if the retailer is dominant enough (e.g., *Walmart*, *Costco*, *Tesco*, etc.), it can be a leader and the manufacturers will become the follower.

Managerial implication 3. Increasing customer satisfaction with the NB product encourages the manufacturer to invest more in innovation and therefore increases loyalty. So, customer satisfaction with the NB product influences the manufacturer's decisions.

Managerial implication 4. The retailer offers a PSB product at a lower price than the price of NB product to attract consumers and to provide a higher quality product at a lower price. This will lead to a higher profit gained by the retailer than that accrued by the manufacturer.

Managerial implication 5. Increasing NB and PSB loyalties will lead to enhanced store loyalty. However, the PSB product plays a more significant role than the NB product in increasing store loyalty. This means that store brand products have greater effects on store loyalty than national brand products, and so retailers can find loyal customers in their store by introducing high-quality store brand products.

Managerial implication 6. The retailer's profit is higher than other scenarios when he introduces the GSB and PSB products simultaneously, and when he is the leader. In the real world, retailers introduce both generic and premium store brand products. For example, *Tesco* introduces "*Everyday Value*" as a generic store brand and "*Tesco Finest*" as a premium store brand.

Managerial implication 7. According to Relations (34)–(36) and (50)–(52), when the manufacturer is the leader, the scenario of introducing a generic store brand product along with a premium store brand product by the retailer (the third scenario) does not make a difference in the manufacturer's decisions for the wholesale price, innovation, and advertising of national brand product compared to the scenario that the retailer introduces only the premium store brand (the second scenario). This means that NB manufacturers consider PSBs as competitors for their brand, and the introduction of GSBs has no effect on their decisions.

7. Conclusion

The competition between one NB manufacturer and one retailer who owns its own store brand product was investigated under three scenarios. According to the first, the retailer would introduce a Generic Store Brand product at the lowest price, in the second, he would introduce a Premium Store Brand product in competition with the NB product, while in the third, he would introduce both Generic and Premium Store Brand products simultaneously. A numerical example was solved, and the results and managerial insights were extracted for all three scenarios. It was shown that the introduction of a PSB product by the retailer, as the manufacturer's competitor, would lead to increased innovation and advertising for the NB product. This would, in turn, lead to enhancements in customer satisfaction, national brand loyalty, and manufacturer's profit. The results also indicate that the simultaneous introduction of GSB and PSB products, as well as being the leader of the game (case SR), is more profitable for the retailer. Store loyalty plays a key role for the retailer because when customers are loyal to the store, they are loyal to its brands (SBs) as well. We even found that under some conditions, being the follower of the game (case SR) is more profitable for the manufacturer rather than being the leader (case SM).

Suggestions for future work include considering such factors as trust and brand image in creating brand loyalty. Also, service quality and store convenience could be investigated as factors contributing to store loyalty. Using the conjoint survey similar to the work done by Choi and Koo (2019) and Park and Koo (2016) to analyze customer preferences including brand loyalty and finding real parameters are also suggestions for future work.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jretconser.2021.102449.

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