Optimal Financial Decisions and Pricing Strategies in Competitive Manufacturing Supply Chains

Seyed Parsa Parvasi, Ata Allah Taleizadeh, Arijit Bhattacharya, and Rojin Moradi

***Abstract*—This study investigates the impact of financing methods and pricing competition on supply chain operations. It focuses on a domestic manufacturer competing with a foreign competitor to maximise retail market gains, with options for financing including banks, bonds, and crowdfunding. Game-theoretic models are used to explore participants' behaviour in the supply chain, considering three power structures: a Nash game and two Stackelberg games with alternating leadership. Results reveal that domestic manufacturers prefer financing options with flexible interest rates, such as crowdfunding, or low-interest alternatives like bonds, when facing rising production costs or reduced competitiveness (when the foreign manufacturer holds a leader position). This preference impacts retailers, potentially leading to reduced product prices, benefiting retailers. Also, increasing initial capital prompts the domestic manufacturer to prefer bank methods. Interestingly, a higher budget and quality do not always guarantee higher profitability and can result in additional costs (for instance, in Nash game structure), depending on power structure type and market size. Furthermore, with increased price sensitivity, crowdfunding becomes less viable, leading to a preference for bank and bond financing. This can conflict with retailers' optimal financial choices, highlighting the complexity of financial decisions in supply chains and their crucial role in global competition.**

***Managerial relevance statement:* This study equips decision-makers with actionable strategies for optimising financing and pricing decisions, enhancing their competitive positions and profitability in the global market. It emphasizes the importance of monitoring market conditions to balance product price, product quality, production costs and financial strategies. For domestic manufacturers, it elucidates the importance of choosing suitable financing methods based on cost structures and competitive positions. For example, domestic manufacturers benefit from bonds or crowdfunding to secure market share and enhance financial stability when facing high globalization costs. Foreign manufacturers benefit from maintaining lower production costs. Tariff policies also significantly influence their costs and pricing strategies, and suitable tariff policies benefit all parties through improved profits. From the retailer's perspective, intensified competition among manufacturers leads to higher profits, allowing them to obtain products at lower prices. Decision-makers can use the developed models to formulate optimal pricing policies and select suitable financing methods.**

***Index Terms*—Manufacturing supply chain; Competitive pricing; Optimal decision-making; Game theory; Financing methods.**

I. Introduction

A competitive market exerts price pressure on every manufacturer/supplier. Since each competitor wishes to make as much profit as possible, they try to keep competitive pricing. For example, Intel tries to maximise their customer base and profits by offering competitive pricing strategies [1]. Another example is Nike which sets the price of its products according to the competitor's price. This strategy allows Nike to remain competitive [2]. Coca-Cola and Pepsi follow competitive pricing strategies [3]. Thus, manufacturers keep an eye on their product costs and watch their competitors' product pricing. In Japan, a fierce competition unfolds between Japanese and foreign car brands. The latter, including Volkswagen, Mercedes-Benz, BMW, and Tesla, are aggressively pursuing market dominance through the introduction of affordable, fuel-efficient, and eco-friendly models. Additionally, they focus on expanding their dealership networks and enhancing customer service. As a consequence, Japanese car manufacturers find themselves compelled to devise innovative pricing and financing strategies to secure a larger market share in the face of this intense competition [4].

Competitive manufacturers with capital constraints often encounter challenges in obtaining loans from banks [5]. Bank financing involves acquiring a loan from a financial institution and repaying it, along with interest, over a specified period. Borrowers are obligated to adhere to the bank's repayment plan, encompassing both the principal and the interest [6]. Sometimes the banks may withhold credit for high-risk projects, and they

Manuscript received 25 Sep 2023; revised 26 Nov 2024, 08 Mar 2024, and 21 Jun 2024; accepted 20 Aug 2024. Review of this manuscript was arranged by Department Editor A. Solis. (Corresponding author: Arijit Bhattacharya.)

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may not be able to support the projects fully. Nowadays, some investors are interested in venture investments with the expectation of making profits. Some lending platforms finance capital-constrained manufacturers by establishing a relationship between them and the investors [7]. Most of these platforms operate online. These platforms receive service fees from the manufacturers. In this form of financing, communication between the investor and manufacturer occurs through an online lender-borrower platform. Repayment of the loan follows a schedule established by the platform [8]. One of the most important advantages of these platforms is their risk-taking ability while investing in various ventures. These platforms are more risk-tolerant and offer flexible service rates. A study demonstrated that these online lending platforms determine an optimal service rate considering the competitive space between the supply chain (SC) participants, the platform's profitability, and the capability of the investors and manufacturers [9].

A bond serves as an alternative financing avenue for manufacturers facing capital constraints [10]. In this process, manufacturers or organisations issue payment-backed instruments to investors, establishing a direct engagement. Regular interest payments, along with a portion of the principal, are disbursed to investors at specified intervals, typically semi-annual or annual, throughout a predetermined duration. The company concludes the process by repurchasing the bonds from investors at the end of this period [11]. To secure financial resources, companies explore various financing methods. Poor decision-making in SCs and improper pricing strategy selection can lead to bankruptcy for domestic companies. To avoid bankruptcy and compete against foreign competitors, domestic companies should adopt suitable pricing strategies and financing methods to maintain their position in domestic markets and compete globally. However, these strategies should be designed based on the competitive power of the domestic manufacturer, which can be lower, equal to, or higher than that of foreign manufacturers, depending on the product type in the real environment. This framework can be effectively implemented through the Game theory approach. Game theory serves as a theoretical framework, offering valuable insights into the dynamics of decision-makers interactions and the potential outcomes of their strategic engagements. To cover all possibilities of competition between manufacturers based on their competitive power, we utilize different types of game theory structures in this paper, including a Nash equilibrium and two Stackelberg games. In a Nash game, decision-makers (both domestic and foreign manufacturers) make decisions simultaneously. Conversely, in a Stackelberg game, one player plays a leadership role based on their decision-making power, while the other becomes a follower [12]. We consider two Stackelberg games: in one, the domestic manufacturer assumes the leadership position, and in the other, the foreign manufacturer takes the lead. Driven by the background, this study answers the following key research questions:

- How do disparate manifestations of competition among manufacturers and their decision-making power affect the domestic manufacturer in selecting an appropriate financing method?
- What is the impact of the financing method selected by the domestic manufacturer on the profitability of the SC participants and their decision-making processes?
- What are the optimal product pricing strategies of the competing manufacturers for maximising their profits in the retail market and how do the costs of importing products impact the foreign manufacturer's optimal pricing strategy and profitability?

To answer these research questions, in this study, we explore an SC comprising a domestic manufacturer, a foreign manufacturer and a retailer. The domestic manufacturer faces capital constraints. They can use any of the three financing methods, namely, bank, bond or online crowdfunding platform. We examine how optimal financing method selection and pricing decisions, particularly in the context of competition with foreign manufacturers, can enhance decision-making for domestic manufacturers. Employing game theory, we analyse the strategic interactions and outcomes among the SC members, aiming to identify an optimal decision structure.

The contribution of this study is many folds. Our study investigates the interaction between financing methods and SC entities and examines how it affects the pricing decisions of the entities. Our study proposes game-theoretic models to examine disparate competition between the SC entities (such as competition between online crowdfunding and the domestic manufacturer, between two manufacturers, and between manufacturers with the retailer). Our objective is to enhance the competitive advantage of domestic products in global markets by recommending suitable financing methods for manufacturers.

To achieve this, we employ a comprehensive game-theoretic framework that encompasses a wide array of competitive scenarios. This framework takes into account a spectrum of financing methods, such as bank loans, bonds, and the emerging field of crowdfunding. Our analysis includes a series of sensitivity analyses on key performance indicators, such as globalisation costs, customs tariff rates, budget, and price sensitivity, examining the profitability of various power structures within the SC. We assess how these indicators fluctuate under different levels of competition and financing targets, drawing upon a comprehensive range of data from relevant literature. The wide range of intervals considered in our sensitivity analysis allows the findings to be adaptable to different cases based on the varied conditions and goals of each organization. Importantly, our results point out the significant impact of the domestic manufacturer's optimal decision in selecting financial resources on the profitability of all SC members and their pricing strategies. We emphasise the necessity for careful evaluation of trade-offs and benefits associated with different financing methods to maximise both individual profit and overall SC performance. By considering factors such as price sensitivity parameters, consumer preferences for foreign and domestic products, and the nature of competition between manufacturers, our study provides valuable insights for optimal decision-making in pricing strategies. Our study provides operational solutions for

manufacturers and retailers to make optimal pricing decisions. Optimal decision-making before market entry, considering factors like pricing parameters, consumers' preferences, the nature of competition between manufacturers (power structure type), and financing methods, is key to enhancing competitiveness and profitability. For instance, if the foreign manufacturer reduces production costs, it alleviates competition, leading to improved profits not only for itself but also for the domestic manufacturer. On the other hand, when competition decreases, the domestic manufacturer may shift to bank financing, which leads to a boost in the foreign manufacturer's profits. Consequently, reduced production costs enhance profitability for all manufacturers involved in SC. The results show that stakeholders should carefully evaluate the aspects associated with different financing methods, especially when domestic manufacturers face heightened competition (the foreign manufacturer has the leading position) and cost pressures. Opting for an appropriate financing method significantly improves the competitive edge of the domestic manufacturer. Moreover, our findings highlight the significant impact of tariff policies on the production costs and profits of all chain members. Policymakers must make informed decisions to benefit all players in the chain, as incorrect policies can harm both foreign and domestic manufacturers. Hence, tariff implementation can have far-reaching consequences on profitability within the industry.

We organise the rest of this article as follows. Section 2 examines the extant literature and identifies knowledge gaps. Section 3 defines the problem. Section 4 presents the mathematical models, the case settings of the proposed models, and the optimal strategies for the SC. Section 5 analyses the results. Section 6 provides discussion and examines managerial implications. Section 7 concludes the study and provides recommendations for future research. We have provided proofs of all propositions and lemmas in the supplementary file.

II. Literature review

Manufacturers use different financing methods to address their financial requirements. Thus, this section critically reviews the literature on SC financing and manufacturers' pricing strategies. Given the significance of financing in SCs, we examine relevant articles and identify research gaps. We focus on the literature pertaining to bank credit, crowdfunding and bonds as financing methods. We review pricing strategy literature for both domestic and foreign manufacturers, recognising its impact on profitability and customer relations.

A. Supply Chain Finance (SCF)

Given the increasing significance of financial aspects in SCs and the expanding knowledge base in this field [13], this section reviews articles published in the 21st century. Traditional finance primarily examines financial performance and creditworthiness of individual companies, while SCF emphasises optimising financial transactions within a network of multiple SC companies [14]. SCF improves financial performance, fosters stronger trade partner relationships, and eliminates SC inefficiencies, leading to reduced operating costs [15]. The design of a supply chain model that accounts for budget constraints, particularly the capital required for facility relocation in strategic decision-making, has been previously addressed [16]. The optimization of financial, physical, and information flows within supply chain networks has also garnered significant attention, with comprehensive considerations of these elements in past studies [17]. However, the influence of initial capital on producer financing methods and choices remains relatively unexplored. Addressing this concern entails consideration of the producer's initial capital, developing effective plans to attract financial resources, and selecting suitable financing methods aligned with the producer's goals. Bank loan is a traditional and widely used method of financing, while online lending platforms emerge as a new financing option, particularly for startups and businesses with limited access to bank loans [18]. Bonds offer a flexible financing alternative that helps companies avoid bankruptcy. Their usage has seen significant growth since 2000, with major companies like Walmart, Lowe's and McDonald's issuing bonds to address funding gaps [19]. We explore the extant literature on three financing methods, namely bank credit, online crowdfunding, and bonds.

1) Bank credit

The 2008 credit crisis had a global impact, leading to the collapse or takeover of major financial institutions in the US, Europe, and Asia [20]. This resulted in businesses facing difficulties in obtaining loans from banks. As a result, academia became more interested in financing companies that aim for profitability [21]. Leveraging the resources of banks can help SCs achieve their goals [22], but it can also lead to bankruptcy if the received amounts are not sufficient to repay [17]. Some advantages of using bank funds in SCs include reliable loan disbursement [23]. In a market characterized by information asymmetry, the impact of various financing strategies, such as bank financing and crowdfunding, on the optimal choices and earnings of a capital-constrained manufacturer and a capital-abundant supplier has been evaluated [6]. Additionally, the interaction between trade credit strategies and a direct channel in a model involving capital constraints between a manufacturer and retailer has been examined, with a comparison of firms' preference for a direct channel versus trade credit and bank credit [24]. While newer methods offered on online platforms are considered, bank credit remains a suitable option in the literature as a traditional method for solving financing problems, despite its pros and cons.

2) Online lending platforms and bonds

Online platform services, including crowdfunding and peer-to-peer (P2P) lending, have become crucial financing options for companies [18]. In a study, the advantages and disadvantages of crowdfunding platforms versus banks for companies seeking financial resources have been compared, with findings indicating that P2P lending primarily increased credit accessibility for borrowers already eligible for bank loans [25]. The impact of crowdfunding platforms on financing decisions, particularly for entrepreneurs, banks, and large investors, has also been analyzed, emphasizing the success of raising capital through crowdfunding for knowledge-based

companies [26]. Additionally, P2P lending platforms have been explored as a financing method in supply chains, focusing on models where both manufacturers and retailers face investment constraints [9]. The competition within P2P lending, particularly the effectiveness of risk control on equilibrium prices and market share, has also been modeled [27]. Furthermore, a hybrid model combining the newsvendor and Stackelberg game has been presented, analyzing a retailer with budget limitations and uncertain demand while utilizing a P2P lending platform [28]. This body of literature underscores the growing attention toward online P2P financing, especially for applicants who are ineligible for bank loans.

For bonds financing, the impact of internal liquidity risk (ILR) in supply chains on the profitability of bonds issued by firms has been examined [29]. It has been reported that SMEs in China often face a shortage of investment funds within their supply chains, and financing methods such as bonds can be effective strategies to address this lack of financial resources [10]. Additionally, the relationship between banks' credit concerns and bond pricing has been analyzed using data on corporate bonds issued by Chinese companies between 2007 and 2019 [30]. The literature highlights bonds as a suitable financing method in recent years.

B. Pricing strategies

Setting optimal product pricing structure is one of the crucial factors in sales strategies because the price attracts customers [31]. Additionally, the growing competition between domestic and foreign manufacturers has intensified competition in the pricing of goods [32]. Accordingly, SC pricing and yield management have experienced significant growth [33]. The impact of competition between two retailers on pricing and sourcing strategies under disruption risk has been analyzed, considering the option to source products from either an expensive but reliable domestic manufacturer or a cheaper but less reliable foreign manufacturer [34]. Moreover, the influence of pricing and warranty on the optimal choices of a retailer and two competing manufacturers in a market has been investigated [35]. Furthermore, using game theory, the effects of supply disruptions on the optimal pricing and sourcing strategies of competing retailers in a market have been examined [36]. Most of the studies in this domain have explored different pricing methods. However, the optimal pricing strategies of competing manufacturers in retail markets require further exploration.

1) Pricing strategies of foreign and domestic manufacturers

A game-theoretic model was developed to analyze a local supply chain and a foreign manufacturer, considering competitive factors such as product prices and delivery time [37]. Examining product transportation costs and pricing within a global supply chain, focusing on a specific commodity, has also been explored [38]. Additionally, the researcher investigated a two-stage supply chain model comprising a supplier distributing products to two rival multi-channel retailers, each catering to consumers with varying channel preferences [39]. A game theory-based model for global supply chains was introduced, incorporating competition based on product quality, price, and the possibility of production outsourcing [40]. A bi-level programming model was proposed, where the domestic manufacturer acts as the leader and the foreign manufacturer as the follower, aiming to maximize profitability and market share in different local market settings [41]. Furthermore, a game-theoretic model was introduced to analyze price competition and optimize retail prices for domestic and international companies, considering potential reactions from competitors [42]. Another study examined the interplay between supply chain pricing decisions and online crowdfunding, developing strategies to enhance domestic manufacturers' competitiveness against foreign competitors [43]. The literature emphasises intense competition in product pricing between domestic and foreign manufacturers. However, certain factors, such as import costs and customer behaviour towards domestic and foreign products, and their prices, have received less attention in this competition.

C. Research gaps

In the past decade, there has been a noticeable surge in interest within the literature towards the integration of financial and product flows in SC management. Despite this, only a limited number of studies have concurrently addressed both competitive pricing methods within global SCs and the financing methods available to SC members. While the majority of existing studies tend to concentrate on the SC network design problem, there is a notable dearth of research in the domain of competitive pricing, despite its practical relevance and theoretical significance. The real-world scenario involves an escalating competition between domestic and global SCs for product pricing, as both types strive to optimise profit and market share amid unpredictable demand and supply conditions. Adding to the complexity, domestic companies often grapple with financial constraints, curtailing their production and marketing capabilities. Recognising the interconnectedness of these two areas is crucial, as they collectively wield a substantial impact on companies' pricing decisions and overall performance.

Earlier studies have mainly focused on the use of bank funds or, in some cases, trade credit as the financing method to cope with the financial shortfall in the SCs [40]. However, these models may not reflect the current reality of the business environment, as companies have experienced rapid growth and diversified needs in the past decade. Nowadays, there are various alternative financing methods, such as bonds and investment funds on online platforms (crowdfunding), that can offer more benefits and opportunities for enterprises in financial need. These methods can enhance mutual profitability by establishing a closer collaboration between the investors and the enterprises. Therefore, there is a research gap in the literature regarding the comparison and evaluation of these financing sources in an SC context. It is essential for companies to correctly identify the available financing methods in an SC and select the most appropriate one according to their planning and objectives. Our study bridges this research gap by considering the competitive pricing problem between domestic and imported products in a global SC under different financing methods, such as banks, bonds, and crowdfunding platforms.

III. Problem Definition

As global companies venture into foreign markets, their superior financial power invariably impacts the market shares of domestic counterparts. Concurrently, domestic companies face the challenge of preserving their market share, especially those in developing countries with limited financial resources [44]. To address this challenge, it is crucial for domestic companies to implement a suitable pricing strategy for their products and utilise appropriate financing methods to secure their profitability and market share. The pricing strategy should effectively communicate the value of the product in terms of its quality and price to consumers in the target market. In light of these considerations, this study investigates the competition among manufacturers for maximum profits and retail market share. Our study designs the competition of an SC network involving a domestic manufacturer (DM), a foreign manufacturer (FM) and a retailer. Figure 1 elucidates the features of the study, where a DM competes with an FM. The DM lacks adequate financial resources to purchase raw materials from a foreign supplier and compete with the FM in the market. The DM seeks a way to optimise its profit, focusing on the rate of return on investment, budget requirements due to demands, and other factors. The DM identifies new online investment platforms, such as crowdfunding and financing methods through bonds and banks, to compete with the FM.

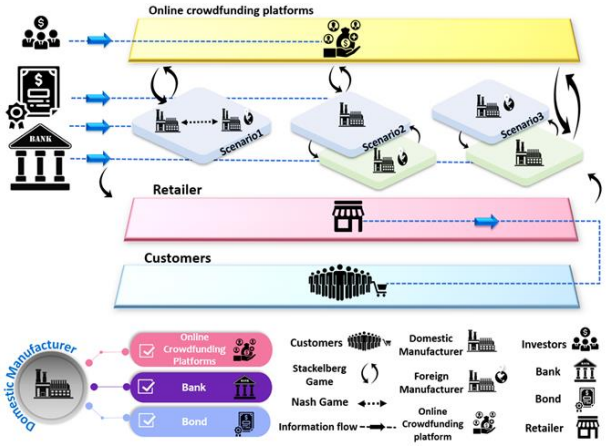


Fig. 1. The features of this study

We demonstrate competitive pricing and optimal decision-making process in Figure 2. Our study assumes three case settings describing competition between the two manufacturers. In the first setting, the two manufacturers set the price simultaneously in the form of a Nash game. The second setting involves a Stackelberg game framework, wherein the DM assumes the role of a price-setter, followed by the FM determining the prices of its products in response to the decisions made by the DM. Conversely, the third setting presents an inverse configuration to the second scenario, wherein the FM assumes the role of leader and the DM acts as the follower. The retailer buys the products based on the market demand and bids prices from FM and DM. Additionally, the retailer determines an appropriate pricing strategy to maximise profit. As illustrated in Figure 2, the retailer competes with the manufacturers following a Stackelberg game. This type of competition is logical and acceptable because manufacturers first set the products' price and then the retailer buys the products based on the promotions. The crowdfunding platform in Figure 2 strives to improve its profitability by charging reasonable service rates to its investors. The platform and the DM follow a Stackelberg game. Indeed, the platform's service rate determines the extent to which the DM chooses to use it. A study examined this issue at great length, considering the platform's investor interest rate (i_{cr}) as an exogenous factor [9].

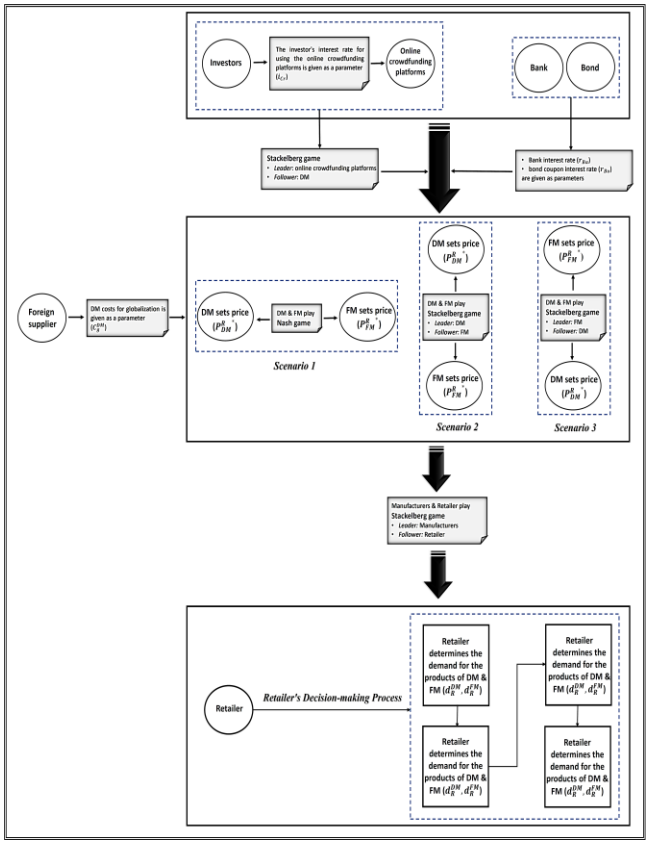


Fig. 2. The competitive pricing and decision-making process

We regard bank interest rates and bonds as exogenous factors (i.e. parameters) since these components are determined by bank officials, companies, and beneficiaries. For instance, in the United States, the Federal Reserve Bank sets the interest rates based on the conditions of the financial markets [45]. Therefore, we do not consider banks and bonds as decision makers due to their fixed and specific rates. However, we consider online crowdfunding as a decision variable [9], [46]. In fact, due to the distinct nature of online crowdfunding compared to banks and bonds, and taking into consideration the financial resources needed by the company and investors, different service rates are considered to maximise profits. Hence, they are regarded as decision makers in our research.

IV. Supply Chain's Optimal Decisions

This section presents the case settings, objectives of the SC participants and optimal solutions to the decision variables. We use the expressions in Exhibit A of the supplemental material

file to simplify the equations proposed in this section. The proposed mathematical models use the notations of Table 1.

TABLE I
NOTATIONS

Parameters	
α_{DM}	Market potential of the domestic manufacturer
α_{FM}	Market potential of the foreign manufacturer
β_{DM}^{R}	Retailer sensitivity to the price of the good of the domestic manufacturer
β_{FM}^{R}	Retailer sensitivity to the price of the good of the foreign manufacturer
β_{C}^{DM}	Market price sensitivity to the domestic manufacturer's product
β_{C}^{FM}	Market price sensitivity to the foreign manufacturer's product
β'	Price substitutability degree between two types of products
B_{DM}	Initial capital of the domestic manufacturer
i_{Cr}	The interest rate of investor for using the online crowdfunding platform
f_D	The domestic manufacturer's fixed cost to produce one product
c_D	The domestic manufacturer's cost to improve quality of product
C_g^{DM}	The domestic manufacturer's costs of globalisation
C_{DT}	The total cost of domestic manufacturer
f_F	The foreign manufacturer's fixed cost to produce one product
c_F	Quality improvement cost of the foreign manufacturer
C_g^{FM}	The costs of globalisation for the foreign manufacturer
φ_F	Customs tariff rate
q_{DM}	The domestic manufacturer's product quality
q_{FM}	The foreign manufacturer's product quality
γ_{DM}^{R}	Retailer sensitivity to the domestic manufacturer's product quality
γ_{FM}^{R}	Retailer sensitivity to the foreign manufacturer's product quality
γ'	Quality substitutability degree between two types of products
T_{Cr}	Tax rates for online crowdfunding method
r_{Ba}	Bank interest rate
N_{Ba}	Due date for bank method
A_{Bo}	The cost of the coupon payments
T_{Bo}	Tax rates for bond method
r_{Bo}	Bond coupon interest rate
N_{Bo}	Maturity for bond method
Decision variables	
d_R^{DM}	The retailer's demand from the domestic manufacturer
d_R^{FM}	The retailer's demand from the foreign manufacturer
d_C^{RD}	The market's demand from the domestic manufacturer
d_C^{RF}	The market's demand from the foreign manufacturer
C_{FT}	The total cost of foreign manufacturer
s_{Cr}	Service rate of the online crowdfunding platform
P_{DM}^{R}	Selling price of the domestic manufacturer
P_{FM}^{R}	Selling price of the foreign manufacturer
P_{RD}^{C}	Retailer's unit retail price of the domestic manufacturer 's product
P_{RF}^{C}	Retailer's unit retail price of the foreign manufacturer 's product

To formulate supply chain models aligning with the problem definition and previously outlined decision variables in the preceding sections, three distinct case settings have undergone analysis. The first two case settings pertain to the demand functions of manufacturers (DM and FM) and retailers. It is important to highlight that all demands in this paper, including those from manufacturers and retailers for manufacturers' goods, are decision variables. A multitude of factors and parameters, including product prices, price sensitivity coefficients, and the degree of price substitutability, influence these demands. The demand could potentially fluctuate in various scenarios. Moreover, the numerical value of these demands is impacted by indirect factors such as the nature of competition among manufacturers, including the Nash and two types of Stackelberg games. The competitive landscape directly shapes the proposed prices of manufacturers, consequently influencing the level of demand for their products. Case settings 1 and 2 clarify that demand is inherently variable and responsive to different conditions. The third case setting also describes the cost structure of each DM and FM product. Detailed elaboration on these case settings will follow.

Case setting (1): This study assumes market demand for both domestic and imported products by considering parameters to bring the model closer to the real world. The retailer decides to buy the products from each manufacturer based on the maximum market potential of the manufacturers (α_{DM}, α_{FM}), the quality of manufactured products (q_{DM}, q_{FM}), the price of the products (P_{DM}^{R}, P_{FM}^{R}), and the sensitivity of the customers to the price ($\beta_{DM}^{R}, \beta_{FM}^{R}$) and quality ($\gamma_{DM}^{R}, \gamma_{FM}^{R}$) of each product. For example, if there is an affinity with the domestic product, α_{DM}increases and α_{FM} declines. If the average salary level of the customers of these products is low, the retailer becomes more sensitive to the price offered by the manufacturers, resulting in an increase in β_{DM}^{R} and β_{FM}^{R}. According to the concept of arbitrage, when there are two similar products and the price of one product increases, consumers move towards a similar product with a lower price. Since, in this study, the competition is between DM and FM, the lower priced product attracts more customers [47]. To make the proposed function more realistic, we consider the degree of substitutability between the two types of products in price (β') and quality (γ') [48]. More specifically, when the product price increases and the product quality of each manufacturer decreases, the retailer's demand for the same product produced by the other manufacturer increases. Equations (1) and (2) present the retailer's demand function for the products.

$$d_R^{DM} = \alpha_{DM}\text{-}(\beta_{DM}^{R} P_{DM}^{R})\text{-}\ \beta'(P_{DM}^{R} - P_{FM}^{R}) + (\gamma_{DM}^{R} q_{DM}) + \gamma'(q_{DM} - q_{FM}) \quad (1)$$

$$d_R^{FM} = \alpha_{FM}\text{-}(\beta_{FM}^{R} P_{FM}^{R})\text{-}\ \beta'(P_{FM}^{R} - P_{DM}^{R}) + (\gamma_{FM}^{R} q_{FM}) + \gamma'(q_{FM} - q_{DM}) \quad (2)$$

Case setting (2): In reality, the retailer buys some of the manufacturer's products based on the forecasted demand [46]. In another decision-making process, it determines the selling price of the products. Since, in practice, the volume of the retailer's sales usually differs from the quantity purchased from the manufacturers, this study distinguishes between the customers' demand from the retailer and the retailer's demand from the manufacturers. In the best scenario, the retailer will sell all products to the customers. However, this may not be the case in reality. In a situation, the retailer may set a price that does not help them to sell all products. Some products remain unsold. This strategy yields a loss in demand but gains more profit [49], [43]. In this study, the amount of the retailer's sales for each manufacturer's products depends on the product price set by the retailer and customers' sensitivity to the prices of the domestic and imported products ($\beta_C^{DM}, \beta_C^{FM}$). The following expression elucidates the market demand functions for the

manufacturers:

$$d_C^{RD} = d_R^{DM} - (\beta_C^{DM} P_{RD}^C) \quad (3)$$

$$d_C^{RF} = d_R^{FM} - (\beta_C^{FM} P_{RF}^C) \quad (4)$$

Case setting (3): In order to make the model realistic, we obtain the cost functions of the DM and FM by equations (5) and (6), respectively.

$$C_{DT} = f_D + (c_D q_{DM}) + C_g^{DM} \quad (5)$$

$$C_{FT} = f_F + (c_F q_{FM}) + (\varphi_F P_{FM}^R) + C_g^{FM} \quad (6)$$

As shown in equation (5), the cost of the domestic product depends on three factors, namely fixed production cost, product quality improvement cost and product globalisation cost. For the DM, the production cost includes the fixed production cost and the product quality improvement cost. In other words, the DMs must invest in order to enhance the quality of their products, and this expenditure varies depending on the nature of the product and the prevailing conditions. Therefore, a parameter is required that, when multiplied by the quality parameter (q_{DM}), indicates the cost required to achieve an improvement in quality. In many instances, it is generally less costly to enhance the quality of a product at a lower level than at a higher level, for example, going from 0.5 to 1 is less expensive than from 1.5 to 2 [42]. In this study, the c_D and c_F factors are utilized to calculate the total cost associated with quality improvement.

Case setting (3) emphasizes the significance of product quality in influencing the performance and competitiveness of the supply chain. The quality not only impacts demand but also influences manufacturers' pricing decisions. Consequently, it affects the overall profitability of supply chain members and is crucial in selecting the optimal financing method. From the retailer's point of view, as outlined in case setting (1), when it wants to determine its demand function for domestic and foreign products, various factors affect this decision, such as the trade-off between quality differences, prices, and their interactions, as well as the retailer's sensitivity coefficients to price and quality (all these factors are considered in equations 1 and 2). Therefore, these sensitivity coefficients reflect the retailer's perception of its customers' preferences and willingness to pay. Then, in equations 3 and 4, d_R^{DM} and d_R^{FM} represent the market potential for domestic and foreign products for the customers. Therefore, product quality directly impacts product pricing, demand, and overall profitability. It is assumed that the DM buys raw materials from foreign suppliers, which is a realistic case setting. For instance, Audi obtains the leather for its cars from foreign suppliers, such as Elmo Leather in Sweden and Valcona and Milano Leathers from northern Italy [50]. So, the globalisation cost for the DM includes the transportation cost of raw materials purchased from the foreign suppliers and duties, taxes and insurance. However, as shown in equation (6), four types of costs are associated with the total cost of the foreign manufacturer's product, including the production (i.e. the first and second terms of the equation) and globalisation costs of exporting the product (i.e. the third and fourth terms of the equation). In reality, the tariff cost for the FM is the coefficient of the imported product price (P_{FM}^R) [51], which we consider in the third term ($\varphi_F P_{FM}^R$) of equation (6). For example, if the foreign manufacturer's product price (decision variable) increases, the cost of foreign production (C_{FT}) will increase, and vice versa. The fourth term of equation (6) (C_g^{FM}) includes costs for transporting products from the country of origin to the country of destination, such as shipping costs, clearance fees and insurance costs.

A. Optimal decision of the retailer

We consider the retailer as one of the key participants in the SC because the retailer directly impacts the manufacturers' profitability. In the Stackelberg game, the manufacturers are the leaders, while the retailer is the follower. The retailer purchases the products from the manufacturers at a suitable product price to obtain maximum profit based on the price sensitivity of the customers for domestic and imported products. Equation (7) displays the retailer's objective function, which is expressed by the symbol $\Pi(P_{RD}^C, P_{RF}^C)$.

$$\Pi(P_{RD}^C, P_{RF}^C) = [(d_C^{RD} P_{RD}^C) - (d_R^{DM} P_{DM}^R)] + [(d_C^{RF} P_{RF}^C) - (d_R^{FM} P_{FM}^R)] \quad (7)$$

As illustrated in equation (7), the retailer's objective function consists of two parts, namely the retailer's profit from the sale of the domestic products and the profit from the sale of the imported products. The retailer calculates the total profit based on the bid price (P_{RD}^C, P_{RF}^C) and the sales of products purchased from each manufacturer. To solve the problem based on the case settings and the competition type between the retailer and the manufacturers, first, the retailer's optimal selling price to the customers is obtained from the price suggested by the manufacturers and the retailer's demand function (as stated in Proposition 1).

Lemma 1. The objective function of the retailer, in equation (7), is concave. Therefore, it has optimal coordinates to maximise the profit (proof is available in Exhibit B of the supplemental material file).

Proposition 1. According to the above case settings, the optimal prices for domestic and imported products reflect the influence of price and quality competition between manufacturers as shown in equations (8) and (9), respectively (proof is available in Exhibit B of the supplemental material file):

$$P_{RD}^{C\,*} = \frac{\alpha_{DM} - (\beta_{DM}^R P_{DM}^R) + \beta'(P_{FM}^R - P_{DM}^R) + (\gamma_{DM}^R q_{DM}) - \gamma'(q_{FM} - q_{DM})}{2\beta_C^{DM}} \quad (8)$$

$$P_{RF}^{C\,*} = \frac{\alpha_{FM} - (\beta_{FM}^R P_{FM}^R) - \beta'(P_{FM}^R - P_{DM}^R) + (\gamma_{FM}^R q_{FM}) + \gamma'(q_{FM} - q_{DM})}{2\beta_C^{FM}} \quad (9)$$

Proposition 1 demonstrates that the amounts of β_C^{DM} and β_C^{FM} have an inverse effect on the sales price of both manufacturers, $P_{RD}^{C\,*}$ and $P_{RF}^{C\,*}$, respectively. As depicted in Equations 8 and 9, the term $(P_{FM}^R - P_{DM}^R)$ significantly influences the optimal price of the manufacturers, positively impacting $P_{RD}^{C\,*}$ and negatively influencing $P_{RF}^{C\,*}$. This finding is in line with intuition since, as the gap between foreign and domestic prices increases, the demand for domestic products grows, allowing DM to set higher prices. Another factor affecting manufacturers' optimal price is the term $(q_{FM} - q_{DM})$. If this difference is considerable, it indicates that the foreign product quality is higher than the domestic product, necessitating that DM sets lower prices for its products to compete with foreign companies and attract

customers. The opposite of these conditions is true for FM.

B. Manufacturers' optimal decisions

We assume that two manufacturers compete for maximum profit and retail market share in three different ways, namely the Nash game between two manufacturers, the Stackelberg game with the DM as the leader, and (another round of) the Stackelberg game, where the FM is the leader. This competition is about finding the right pricing strategy for the products, aimed at fully utilising market capacity and maximising profits. Based on the case setting (1), each manufacturer wants to discourage its customers from using a competing firm's products and convince its customers to use its products by setting a reasonable product price. We derive the objective function of the FM ($\Pi(P_{FM}^R)$) in equation (10). The DM has access to three financial resources. Equations (11) to (13) express DM's profits when employing various financing methods. Here, $\Pi^{Cr}(P_{DM}^R)$ represents DM's profit from online crowdfunding, while $\Pi^{Ba}(P_{DM}^R)$ and $\Pi^{Bo}(P_{DM}^R)$ represent DM's profits from using banks and bonds, respectively.

$$\Pi(P_{FM}^R) = [(d_R^{FM} P_{FM}^R) - (d_R^{FM} C_{FT})] \quad (10)$$

$$\Pi^{Cr}(P_{DM}^R) = [(d_R^{DM} P_{DM}^R) - (d_R^{DM} C_{DT})] - [((d_R^{DM} C_{DT}) - B_{DM})(i_{Cr} + s_{Cr} + 1)] \quad (11)$$

$$\Pi^{Ba}(P_{DM}^R) = \left\{ [(d_R^{DM} P_{DM}^R) - (d_R^{DM} C_{DT})] - \left[\left((d_R^{DM} C_{DT}) - B_{DM} \right) \left({(r_{Ba}(1+r_{Ba})^{N_{Ba}})} \Big/ {((1+r_{Ba})^{N_{Ba}} - 1)} \right) \right] * N_{Ba} \right\} \quad (12)$$

$$\Pi^{Bo}(P_{DM}^R) = \left\{ [(d_R^{DM} P_{DM}^R) - (d_R^{DM} C_{DT})] - \left[\left((d_R^{DM} C_{DT}) - B_{DM} \right) + \left[\left[A_{Bo} + \left[((d_R^{DM} C_{DT}) - B_{DM}) r_{Bo} \right] \right] * (1 - T_{Bo}) \right] * N_{Bo} \right] \right\} \quad (13)$$

As shown in equation (10) and following case setting (3), the profit of the FM is equal to the sales of its products to the retailer minus the product cost. The domestic manufacturer's objective functions in equations (11) to (13) demonstrate two main parts. The first part relates to the manufacturer's revenue from product sales to the retailers, which is similar to the foreign manufacturer's revenue. In the second part, the domestic manufacturer pays a portion of the profit to the financing platform it relies on for financial support. This payment includes the interest rate and the principal. Equation (11) illustrates that the interest rate of the online crowdfunding platform includes the service rate of the platform and the expected interest rate of the investors ($i_{Cr} + s_{Cr}$).

The second term in equation (12) provides the formula for determining the loan payment to the bank. This formula assumes that the loan will be repaid in equal instalments over the loan term, which is a usual way of repaying loans, also called the equal payment or blended payment method [11]. The formula for the loan payment to the bank is $\frac{\left((d_R^{DM} C_{DT}) - B_{DM}\right) * r_{Ba}}{1 - \frac{1}{(1+r_{Ba})^{N_{Ba}}}}$ that simplifies the equation to $\left((d_R^{DM} C_{DT}) - B_{DM}\right) \left({(r_{Ba}(1+r_{Ba})^{N_{Ba}})} \Big/ {((1+r_{Ba})^{N_{Ba}} - 1)} \right)$. The term ${(r_{Ba}(1+r_{Ba})^{N_{Ba}})} \Big/ {((1+r_{Ba})^{N_{Ba}} - 1)}$ represents the reciprocal of the present value annuity factor, which depends on the interest rate and the number of payments. This term reflects the ratio of the interest rate to the difference between the compound interest factor and one. The compound interest factor $(1 + r_{Ba})^{N_{Ba}}$ is the amount that the loan will grow to after N_{Ba} periods, if compounded at the interest rate r_{Ba}. The difference between the compound interest factor and one represents the total interest to be paid over the loan term. The ratio of the interest rate to the total interest indicates the fraction of the loan amount that must be paid each period to fully repay the loan in N_{Ba} years [52].

Finally, the second term of equation (13) is a component of the formula for computing the total cost of the bond financing. This formula assumes that the bond financing is done by issuing a coupon bond, which is a kind of bond that pays a fixed amount of interest until the maturity date, when the principal amount is paid back, where A_{Bo} is the cost of the coupon payments, and N_{Bo} is the maturity for the bond method. This term is the multiplication of the cost of the bond financing and the maturity for the bond method. The cost of the bond financing is the addition of the coupon payment and the interest payment on the principal amount. Generally, the meaning of this term is that it shows the total amount of money that the domestic manufacturer has to pay to the bondholders during the bond term in order to finance the purchase of the product. The total cost of bond financing is the addition of the discounted values of each coupon and interest payment, using the bond coupon interest rate as the discount rate [53]. It is worth to mention that in the case of bank financing and bonds, the borrower must make payments at specific interest rates on specific due dates. In addition, the borrower must repay the principal of the bonds on the final maturity date. Therefore, bonds usually have a lower interest rate than bank loans ($r_{Bo} < r_{Ba}$) because banks face more uncertainty when they lend money to borrowers than investors who buy bonds from issuers. They have to consider the chance of default, late payments, or changes in the borrowers' creditworthiness, which can hurt their profitability and liquidity. Therefore, banks charge higher interest rates to attract deposits from savers and offset potential uncertainties. In contrast, bond issuers typically offer lower interest rates, especially when backed by the government or a high credit rating, due to their greater reliability. Bond investors also have more legal protection and recourse if the issuer defaults, as they can claim the issuer's assets [54].

Based on the above arguments and the manufacturers' objective function, Propositions 2 to 4 express the optimal values of the decision variables of these two SC participants under three scenarios, including a Nash game between two manufacturers and two rounds of the Stackelberg game, where one of the manufacturers (domestic or foreign) plays once as the leader and once as the follower.

Lemma 2. The foreign manufacturer's objective function in equation (10) is concave. Therefore, it has an optimal point to maximise the profit.

Lemma 3. The domestic manufacturer's objective functions are concave in equations (11) to (13). Therefore, these equations have optimal maximum points.

Proposition 2. The optimal prices set by the manufacturers for the retailers, considering their objective functions, the Nash game between them, and the best response function of the retailers, reflect the interactions and competition in different

financing scenarios. The optimal prices are expressed separately in equations (14) and (15) for crowdfunding, equations (16) and (17) for bank financing, and equations (18) and (19) for bond financing (proof is available in Exhibit B of the supplemental material file).

$$P_{DM}^{R}{}^{*} = \frac{-\begin{Bmatrix} (-\mu_3 + s_{Cr}C_{DT}(1-\varphi_F))(2\beta_{DM}^{R}(\beta_{FM}^{R}+\beta')) + \\ \beta_{FM}^{R}(2(\alpha_{DM}+s_{Cr}\beta'(1-\varphi_F)) + \mu_2 - 4\mu_3) \\ +\beta'((2\alpha_{DM}+\alpha_{FM})(1-\varphi_F)+\mu_4) + (\mu_9 - 2\mu_5 - 2\mu_8) \end{Bmatrix}}{(\varphi_F - 1)\mu_6} \quad (14)$$

$$P_{FM}^{R}{}^{*} = \frac{\begin{Bmatrix} (2\beta_{FM}^{R}(\beta_{DM}^{R}+\beta'))\begin{pmatrix} c_g^{FM}+f_F \\ +c_F q_{FM} \end{pmatrix} + \beta'\begin{pmatrix} (\alpha_{DM}+2\alpha_{FM})(1-\varphi_F) \\ +\mu_4 \end{pmatrix} \\ +\beta_{DM}^{R}\beta'(-\mu_3 + 2(c_g^{FM}+f_F)) + (\mu_9 - \mu_5 - \mu_8) \end{Bmatrix}}{(\varphi_F - 1)\mu_6} \quad (15)$$

$$P_{DM}^{R}{}^{*} = \frac{\begin{Bmatrix} \mu_{10}(2\beta_{DM}^{R}(\beta_{FM}^{R}+\beta')) + \beta_{FM}^{R}\begin{pmatrix} \mu_{11}(2\alpha_{DM}+2q_{FM}\gamma') \\ +\beta'(2\mu_{10}+\mu_{12}) + q_{DM}\mu_{13} \end{pmatrix} \\ +\beta'\left((2\alpha_{DM}+\alpha_{FM})(1-\varphi_F(1+(1+r_{Ba})^{N_{Ba}})) + q_{DM}\mu_{14} + q_{FM}\mu_{15}\right) \\ +(\mu_9 + 2\mu_{16} + \mu_{17}) \end{Bmatrix}}{(\varphi_F - 1)((1+r_{Ba})^{N_{Ba}} - 1)\mu_6} \quad (16)$$

$$P_{FM}^{R}{}^{*} = \frac{\begin{Bmatrix} 2\beta_{DM}^{R}\beta_{FM}^{R}(C_{DT}(1-(1+r_{Ba})^{N_{Ba}})) \\ +\beta'\left((\alpha_{DM}+2\alpha_{FM})(1-\varphi_F(1+(1+r_{Ba})^{N_{Ba}})) + q_{DM}\mu_{18} + q_{FM}\mu_{19}\right) \\ +\beta_{DM}^{R}\beta'(2\mu_{12}+\mu_{10}) \\ +\beta_{FM}^{R}\beta'(2\mu_{12}) + \beta_{DM}^{R}\begin{pmatrix} \mu_{11}(2\alpha_{FM}+2q_{DM}\gamma') \\ +q_{FM}\mu_{13} \end{pmatrix} + 2(\mu_9+\mu_{17}) + \mu_{16} \end{Bmatrix}}{(\varphi_F - 1)((1+r_{Ba})^{N_{Ba}} - 1)\mu_6} \quad (17)$$

$$P_{DM}^{R}{}^{*} = \frac{-\begin{Bmatrix} \mu_{20}(2\beta_{DM}^{R}(\beta_{FM}^{R}+\beta')) + 2\beta_{FM}^{R}(\mu_{20} + (1-\varphi_F)(\alpha_{DM}+\mu_{21})) \\ +\beta'((2\alpha_{DM}+\alpha_{FM})(1-\varphi_F)+\mu_4) + (\mu_9 + 2\mu_{22}) \end{Bmatrix}}{(\varphi_F - 1)\mu_6} \quad (18)$$

$$P_{FM}^{R}{}^{*} = \frac{-\begin{Bmatrix} \beta_{DM}^{R}\begin{pmatrix} \beta'\mu_{20} \\ +(1-\varphi_F)(2\alpha_{FM}+\mu_{23}) \end{pmatrix} + (2\beta_{FM}^{R}(\beta_{DM}^{R}+\beta'))\begin{pmatrix} c_g^{FM}+f_F \\ +c_F q_{FM} \end{pmatrix} \\ +\beta'(2\beta_{FM}^{R}(c_g^{FM}+f_F) + (\alpha_{DM}+2\alpha_{FM})(1-\varphi_F) + \mu_{24}) + (2\mu_9+\mu_{22}) \end{Bmatrix}}{(\varphi_F - 1)\mu_6} \quad (19)$$

Proposition 3. The optimal prices offered by the manufacturers to the retailers, based on their objective functions, the Stackelberg game between them (where the DM is the leader), and the retailers' best response function, reflect pricing decisions influenced by financing methods and competition type. The optimal prices are expressed separately in equations (20) and (21) for crowdfunding, equations (22) and (23) for bank financing, and equations (24) and (25) for bond financing (proof is available in Exhibit B of the supplemental material file).

$$P_{DM}^{R}{}^{*} = \frac{\begin{Bmatrix} \alpha_{DM} + \gamma_{DM}^{R}q_{DM} + \gamma'(q_{DM} - q_{FM}) + \mu_{25}C_{DT}(s_{Cr} + i_{Cr} + 2) \\ +\beta'\begin{pmatrix} \frac{(\varphi_F - 1)(\alpha_{FM} + \gamma_{FM}^{R}q_{FM} - \gamma'(q_{DM} - q_{FM}))}{-\left((\beta_{FM}^{R}+\beta')(c_g^{FM}+f_F+c_F q_{FM})\right)} \\ 2(\beta_{FM}^{R}+\beta')(\varphi_F - 1) \end{pmatrix} \end{Bmatrix}}{2\mu_{25}} \quad (20)$$

$$P_{FM}^{R}{}^{*} = \frac{\begin{Bmatrix} (\varphi_F - 1)(\alpha_{FM} + \beta' P_{DM}^{R} + \gamma_{FM}^{R}q_{FM} - \gamma'(q_{DM} - q_{FM})) \\ -\left((\beta_{FM}^{R}+\beta')(c_g^{FM}+f_F+c_F q_{FM})\right) \end{Bmatrix}}{2(\beta_{FM}^{R}+\beta')(\varphi_F - 1)} \quad (21)$$

$$P_{DM}^{R}{}^{*} = \frac{\begin{Bmatrix} \alpha_{DM} + \gamma_{DM}^{R}q_{DM} + \gamma'(q_{DM} - q_{FM}) + \mu_{25}C_{DT} \\ +\frac{N_{Ba}r_{Ba}\mu_{25}C_{DT}(1+r_{Ba})^{N_{Ba}}}{((1+r_{Ba})^{N_{Ba}} - 1)} \\ +\beta'\left((\varphi_F - 1)\begin{pmatrix} \alpha_{FM} + \gamma_{FM}^{R}q_{FM} \\ -\gamma'(q_{DM} - q_{FM}) \end{pmatrix} - \left((\beta_{FM}^{R}+\beta')(c_g^{FM}+f_F+c_F q_{FM})\right)\right) \\ \hline 2(\beta_{FM}^{R}+\beta')(\varphi_F - 1) \end{Bmatrix}}{2\mu_{25}} \quad (22)$$

$$P_{DM}^{R}{}^{*} = \frac{\begin{Bmatrix} \alpha_{DM} + \gamma_{DM}^{R}q_{DM} + \gamma'(q_{DM} - q_{FM}) + \mu_{25}C_{DT} \\ +\frac{N_{Ba}r_{Ba}\mu_{25}C_{DT}(1+r_{Ba})^{N_{Ba}}}{((1+r_{Ba})^{N_{Ba}} - 1)} \\ +\beta'\begin{pmatrix} \frac{(\varphi_F - 1)(\alpha_{FM} + \gamma_{FM}^{R}q_{FM} - \gamma'(q_{DM} - q_{FM}))}{-\left((\beta_{FM}^{R}+\beta')(c_g^{FM}+f_F+c_F q_{FM})\right)} \\ 2(\beta_{FM}^{R}+\beta')(\varphi_F - 1) \end{pmatrix} \end{Bmatrix}}{2\mu_{25}} \quad (23)$$

$$P_{DM}^{R}{}^{*} = \frac{\begin{Bmatrix} \alpha_{DM} + \gamma_{DM}^{R}q_{DM} + \gamma'(q_{DM} - q_{FM}) + 2\mu_{25}C_{DT} \\ -N_{B0}r_{B0}\mu_{25}C_{DT}(T_{B0} - 1) \\ +\beta'\begin{pmatrix} (\varphi_F - 1)(\alpha_{FM} + \gamma_{FM}^{R}q_{FM} - \gamma'(q_{DM} - q_{FM})) \\ -\left((\beta_{FM}^{R}+\beta')(c_g^{FM}+f_F+c_F q_{FM})\right) \\ \hline 2(\beta_{FM}^{R}+\beta')(\varphi_F - 1) \end{pmatrix} \end{Bmatrix}}{2\mu_{25}} \quad (24)$$

$$P_{FM}^{R}{}^{*} = \frac{\begin{Bmatrix} (\varphi_F - 1)(\alpha_{FM} + \beta' P_{DM}^{R} + \gamma_{FM}^{R}q_{FM} - \gamma'(q_{DM} - q_{FM})) \\ -\left((\beta_{FM}^{R}+\beta')(c_g^{FM}+f_F+c_F q_{FM})\right) \end{Bmatrix}}{2(\beta_{FM}^{R}+\beta')(\varphi_F - 1)} \quad (25)$$

Proposition 4. The manufacturers' optimal prices offered to the retailers are based on their objective functions, the Stackelberg game between them (where the FM is the leader), and the retailers' best response function. The optimal prices are expressed separately in equations (26) and (27) for crowdfunding, equations (28) and (29) for bank financing, and equations (30) and (31) for bond financing (proof is available in Exhibit B of the supplemental material file).

$$P_{DM}^{R}{}^{*} = \frac{\begin{Bmatrix} (\alpha_{DM} + \beta' P_{FM}^{R} + \gamma_{DM}^{R}q_{DM} + \gamma'(q_{DM} - q_{FM})) \\ +(\beta_{DM}^{R}+\beta')C_{DT}(s_{Cr} + i_{Cr} + 2) \end{Bmatrix}}{2(\beta_{DM}^{R}+\beta')} \quad (26)$$

$$P_{FM}^{R}{}^{*} = \frac{-\begin{Bmatrix} \mu_{26}(c_g^{FM}+f_F+c_F q_{FM}) - (\varphi_F - 1)\begin{pmatrix} \alpha_{FM} + \gamma_{FM}^{R}q_{FM} \\ -\gamma'(q_{DM} - q_{FM}) \end{pmatrix} + \\ \beta'\begin{pmatrix} (\varphi_F - 1)(\alpha_{DM} + \gamma_{DM}^{R}q_{DM} + \gamma'(q_{DM} - q_{FM})) \\ +(\beta_{DM}^{R}+\beta')C_{DT}(s_{Cr} + i_{Cr} + 2) \\ \hline 2(\beta_{DM}^{R}+\beta') \end{pmatrix} \end{Bmatrix}}{2(\varphi_F - 1)\mu_{25}} \quad (27)$$

$$P_{DM}^{R}{}^{*} = \frac{\begin{Bmatrix} (\alpha_{DM} + \beta' P_{FM}^{R} + \gamma_{DM}^{R}q_{DM} + \gamma'(q_{DM} - q_{FM})) + (\beta_{DM}^{R}+\beta')C_{DT} \\ +\frac{N_{Ba}r_{Ba}(\beta_{DM}^{R}+\beta')C_{DT}(1+r_{Ba})^{N_{Ba}}}{((1+r_{Ba})^{N_{Ba}} - 1)} \end{Bmatrix}}{2(\beta_{DM}^{R}+\beta')} \quad (28)$$

$$P_{FM}^{R}{}^{*} = \frac{\begin{Bmatrix} (\varphi_F - 1)(\alpha_{FM} + \gamma_{FM}^{R}q_{FM} - \gamma'(q_{DM} - q_{FM})) + \\ \beta'\begin{pmatrix} (\alpha_{DM} + \gamma_{DM}^{R}q_{DM} + \gamma'(q_{DM} - q_{FM})) + (\beta_{DM}^{R}+\beta')C_{DT} \\ +\frac{N_{Ba}r_{Ba}(\beta_{DM}^{R}+\beta')C_{DT}(1+r_{Ba})^{N_{Ba}}}{((1+r_{Ba})^{N_{Ba}} - 1)} \\ \hline 2(\beta_{DM}^{R}+\beta')\mu_{26}(c_g^{FM}+f_F+c_F q_{FM}) \end{pmatrix} \end{Bmatrix}}{2(\varphi_F - 1)\mu_{25}} \quad (29)$$

$$P_{DM}^{R}{}^{*} = \frac{\begin{Bmatrix} (\alpha_{DM} + \beta' P_{FM}^{R} + \gamma_{DM}^{R}q_{DM} + \gamma'(q_{DM} - q_{FM})) \\ +2(\beta_{DM}^{R}+\beta')C_{DT} - N_{B0}r_{Bo}(\beta_{DM}^{R}+\beta')C_{DT}(T_{B0} - 1) \end{Bmatrix}}{2(\beta_{DM}^{R}+\beta')} \quad (30)$$

$$P_{FM}^{R}{}^{*} = \frac{\begin{Bmatrix} (\alpha_{DM} + \beta' P_{FM}^{R} + \gamma_{DM}^{R}q_{DM} + \gamma'(q_{DM} - q_{FM})) + \\ \beta'\begin{pmatrix} (\alpha_{DM} + \gamma_{DM}^{R}q_{DM} + \gamma'(q_{DM} - q_{FM})) \\ +(\beta_{DM}^{R}+\beta')C_{DT} - -N_{B0}r_{Bo}(\beta_{DM}^{R}+\beta')C_{DT}(T_{B0} - 1) \\ \hline 2(\beta_{DM}^{R}+\beta')\mu_{26}(c_g^{FM}+f_F+c_F q_{FM}) \end{pmatrix} \end{Bmatrix}}{2(\varphi_F - 1)\mu_{25}} \quad (31)$$

C. Online crowdfunding platform's optimal decisions

The online crowdfunding platform seeks to maximise revenue by setting a service rate. More specifically, this platform determines an optimal service rate so that it can convince the DM to rely on the platform for their fiscal deficit and earn a reasonable profit relative to the interest rate granted to the borrowers and the taxes it pays to the government (T_{Cr}). Therefore, in the competition between the platform and the DM in a Stackelberg game, i_{Cr} and s_{Cr} are significant components. The investors determine i_{Cr} and the investment platform determines s_{Cr}. So, they play a substantial role in the success rate of the DM in competing with FMs to capture the retail market. Equation (32) expresses the objective function of this platform, indicating by $\Pi(s_{Cr})$.

$$\Pi(s_{Cr}) = \left((d_R^{DM}C_{DT}) - B_{DM}\right) * (s_{Cr} - T_{Cr}) \quad (32)$$

Proposition 5. Based on the type of competition between manufacturers, the optimal service rate of crowdfunding platforms is influenced by the interactions between players and the amount of financing required. Equations (33) to (35)

correspond to the Nash game, the Stackelberg game with the DM as the leader, and the Stackelberg game with the FM as the leader, respectively. Proofs are available in Exhibit B of the supplemental material file.

$$s_{Cr}{}^{*} = -\frac{\left\{\begin{array}{c}((\beta_{DM}^{R}+\beta')C_{DT})\left(\begin{array}{c}2\beta_{DM}^{R}\beta'\mu_1+\beta_{FM}^{R}\mu_2+2\beta_{DM}^{R}\beta_{FM}^{R}\mu_3\\+\beta'((2\alpha_{DM}+\alpha_{FM})(1-\varphi_F)+\mu_4)\\+(\mu_9+\mu_5)\end{array}\right)\\ \mu_6 B_{DM}+\dfrac{+(T_{Cr}(\beta_{DM}^{R}+\beta')\mu_7(\varphi_F-1))}{(\varphi_F-1)}\end{array}\right\}}{2(\beta_{DM}^{R}+\beta')\mu_7} \quad (33)$$

$$s_{Cr}{}^{*} = -2(\beta_{DM}^{R}+\beta_{FM}^{R})\frac{\left\{B_{DM}+\left[\dfrac{C_{DT}\left(\begin{array}{c}2\beta_{DM}^{R}\beta'\mu_1+\beta_{FM}^{R}\mu_2+2\beta_{DM}^{R}\beta_{FM}^{R}\mu_3+\\ \beta'((2\alpha_{DM}+\alpha_{FM})(1-\varphi_F)+\mu_4)\\+(\mu_9+\mu_5)\end{array}\right)}{4(\beta_{FM}^{R}+\beta')(\varphi_F-1)}\right]\right\}}{\mu_7} \quad (34)$$

$$s_{Cr}{}^{*} = -2(\beta_{DM}^{R}+\beta_{FM}^{R})\frac{\left\{B_{DM}+\left[\dfrac{C_{DT}\left(\begin{array}{c}2\beta_{DM}^{R}\beta'\mu_1+\beta_{FM}^{R}\mu_2+2\beta_{DM}^{R}\beta_{FM}^{R}\mu_3+\\ \beta'((2\alpha_{DM}+\alpha_{FM})(1-\varphi_F)+\mu_4)\\+(\mu_9+\mu_5)\end{array}\right)}{4(\beta_{FM}^{R}+\beta')(\varphi_F-1)}\right]\right\}}{\mu_7} \quad (35)$$

V. Results and Analysis

In this section, we investigate how SC participants behave within the proposed models and in section 6, we provide further discussion and managerial insights. Applying these models is crucial in the competitive landscape between DMs and FMs, especially when DMs suffer from lack of budget. Choosing the right financing methods and product pricing is essential for DMs to maintain their market presence and increase their market share. Equipped with accurate market information, FMs can strategically challenge DMs. One of the critical factors influencing the selection of an appropriate financing method is the prevailing interest rate associated with each financing option. Proposition 6 demonstrates, through theoretical analysis, the conditions under which the interest rate of a particular financing method should be compared to the rates of alternative methods to determine its suitability for DM.

Proposition 6. Based on the DM's objective functions across various financing methods, a financing option is considered suitable for DM if the interest rate associated with that method satisfies the following conditions (proof is available in Exhibit C of the supplemental material file).

i) Online crowdfunding will be the best option if meets the two below conditions.

$$\begin{cases} 1)\ \Pi^{Cr} \geq \Pi^{Ba} & if\ s_{Cr} \leq \left[\left(\frac{(r_{Ba}(1+r_{Ba})^{N_{Ba}})*N_{Ba}}{((1+r_{Ba})^{N_{Ba}}-1)}\right)-(i_{Cr}+1)\right] \\ 2)\ \Pi^{Cr} \geq \Pi^{Bo} & if\ s_{Cr} \leq \left[\left(\left(\frac{A_{Bo}}{((d_R^{DM}C_{DT})-B_{DM})}+r_{Bo}\right)*(1-T_{Bo})*N_{Bo}\right)-i_{Cr}\right] \end{cases} \quad (36)$$

ii) Bank will be the best option if meets the two below conditions.

$$\begin{cases} 1)\ \Pi^{Ba} \geq \Pi^{Cr} & if\ \left(\frac{(r_{Ba}(1+r_{Ba})^{N_{Ba}})}{((1+r_{Ba})^{N_{Ba}}-1)}\right) \leq \left(\frac{i_{Cr}+s_{Cr}+1}{N_{Ba}}\right) \\ 2)\ \Pi^{Ba} \geq \Pi^{Bo} & if\ \left(\frac{(r_{Ba}(1+r_{Ba})^{N_{Ba}})}{((1+r_{Ba})^{N_{Ba}}-1)}\right) \leq \left[\frac{1}{N_{Ba}}+\left(\left(\left(\frac{A_{Bo}}{((d_R^{DM}C_{DT})-B_{DM})}+r_{Bo}\right)*(1-T_{Bo})\right)*\frac{N_{Bo}}{N_{Ba}}\right)\right] \end{cases} \quad (37)$$

iii) Bond will be the best option if meets the two below conditions.

$$\begin{cases} 1)\ \Pi^{Bo} \geq \Pi^{Cr} & if\ r_{Bo} \leq \left[\left(\frac{(i_{Cr}+s_{Cr})}{(1-T_{Bo})*N_{Bo}}\right)-\left(\frac{A_{Bo}}{((d_R^{DM}C_{DT})-B_{DM})}\right)\right] \\ 2)\ \Pi^{Bo} \geq \Pi^{Ba} & if\ r_{Bo} \leq \left[\left(\frac{((1+r_{Ba})^{N_{Ba}}(N_{Ba}*r_{Ba}-1))+1}{((1+r_{Ba})^{N_{Ba}}-1)*(1-T_{Bo})*N_{Bo}}\right)-\left(\frac{A_{Bo}}{((d_R^{DM}C_{DT})-B_{DM})}\right)\right] \end{cases} \quad (38)$$

Equations 36 to 38 clarify the fact that for the financing methods to be attractive, attention must be paid to several factors before making decisions about interest rates. Factors include comparing interest rates with other financing methods and assessing the manufacturer's budget requirements. Additionally, decisions regarding bank interest rates and bond yields can significantly affect the profitability of crowdfunding methods, illustrating the intricate interplay among various financing approaches.

We also conduct sensitivity analyses on cost-related parameters, the initial capital of domestic manufacturers (B_{DM}), price sensitivity, and quality. We consider a wide range of data and real-life scenarios to capture the various situations that manufacturers or policymakers may encounter in practice. As a result, our study extends beyond specific cases to provide an extensive analysis and a comprehensive framework supporting different competitive scenarios that arise among supply chain members. Sample data is utilised from a study in 2018, with a focus on parameters pertaining to online crowdfunding [9]. Parameters concerning banks and bonds (r_{Ba} and r_{Bo}) follow Iranian regulations, with values of 0.18 and 0.12, respectively.

A. Sensitivity analysis of costs

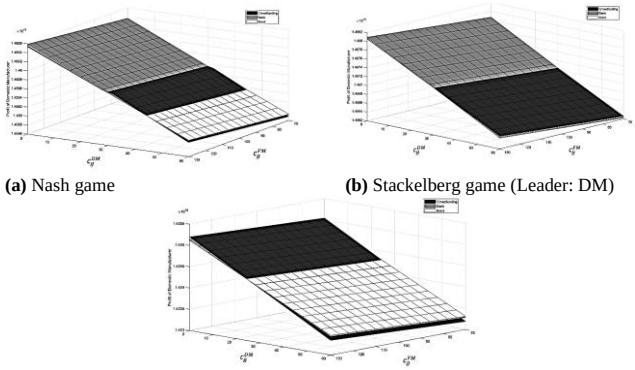
Given the third case setting, in addition to the fixed production costs and the production costs related to increasing the product quality, the DM must also pay the expenses associated with the globalisation of the product. In addition to the above costs, the FM must also pay the customs tariff costs. Therefore, these costs affect the final price of the product. Thus, in the following sections, we analyse the sensitivity of the cost parameters c_g^{DM}, c_g^{FM} and φ_F, which are globalisation costs for DM and FM and customs tariff rates, respectively. We examine the impact of their changes on the profitability of the SC participants.

1) The impact of globalisation costs

We analyse the impact of two factors, c_g^{DM} and c_g^{FM}, on manufacturers' production costs. These factors play significant roles in the cost functions of the DM and FM, respectively in equations (5) and (6). By keeping other parameters constant, we observe how changes in c_g^{DM} and c_g^{FM} affect the objective functions of the SC members. Figures 3 to 5 illustrate the profit functions of the competing SC members as c_g^{DM} and c_g^{FM} vary, considering different types of competition and financing methods chosen by the DM.

In general, increasing c_g^{DM} and c_g^{FM} leads to higher production costs and lower profits for the DM (Figure 3). This implies that the DM should try to reduce its costs of globalisation by improving its efficiency and quality, or by outsourcing some of its activities to low-cost regions. In the Nash game, where both players act simultaneously, the DM achieves the highest profit when the bank covers the financial gap (Figure 3(a)). However, this advantage diminishes as c_g^{DM} increases, making crowdfunding a more attractive option. This suggests that the DM should consider the trade-off between the bank interest rate (r_{Ba}) and service rate of the online crowdfunding platform (s_{Cr}) when choosing between bank financing and crowdfunding. In

the Stackelberg game, where one player acts as the leader and the other as the follower, the DM's profit varies depending on the leadership role and the financing method. When the DM is the leader, bank financing yields the maximum profit (Figure 3(b)). However, as c_g^{DM} increases, the DM should switch to crowdfunding platforms to reduce its financing costs. This indicates that the DM should leverage its leadership position and exploit its first-mover advantage by choosing the optimal financing method and setting a competitive price. The FM should also monitor its costs of globalisation and adjust its pricing strategy accordingly. The FM should also be aware of the DM's financing options and anticipate its pricing decisions. Then respond to the DM's actions by choosing the best possible price. When the FM is the leader, the DM's profit is maximised when it uses online crowdfunding platforms (Figure 3(c)). However, if c_g^{DM} increases, the DM should opt for bond financing instead. This implies that the DM should be flexible and adaptable to the changing market conditions and the FM's leadership. The FM should use its leadership role to influence the DM's financing and pricing decisions by setting a strategic price.

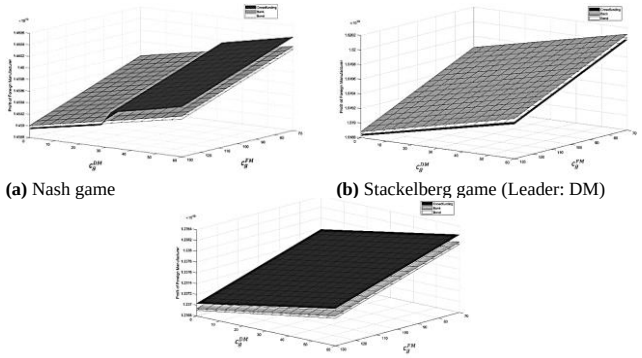


(a) Nash game **(b)** Stackelberg game (Leader: DM)

(c) Stackelberg game (Leader: FM)

Fig. 3. Profit of the DM

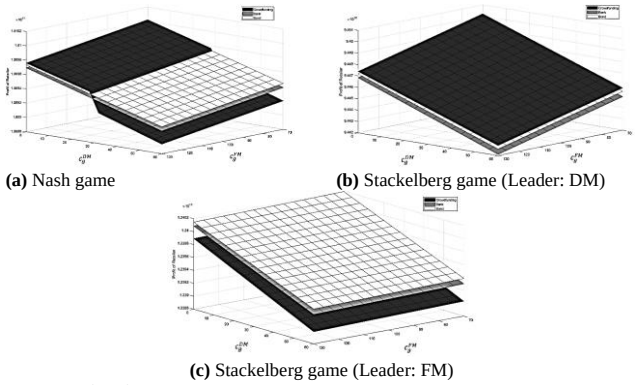
In terms of the FM's profit, Figure 4 shows that the FM's profit depends on the DM's costs of globalisation and financing method. In the Nash competition, the FM maximises profit when the DM chooses crowdfunding (Figure 4(a)). However, as the DM's costs of globalisation decrease, the FM's profit decreases as well. This suggests that the FM faces more intense competition from the DM and should seek to lower its own costs of globalisation or differentiate its product. In the DM-led Stackelberg game, the FM obtains the highest profit when the DM uses bank financing (Figure 4(b)). However, if the DM switches to crowdfunding, the DM's profit will decrease significantly, and the DM will do this action when the cost increases (Figure 3 (b)). This implies that the FM should be prepared for the DM's possible change of financing method and adjust its pricing strategy accordingly. In the FM-led Stackelberg game, the FM achieves the highest profit when the DM uses crowdfunding platforms for financing (Figure 4(c)). This suggests that the FM can use its power to influence the DM's financing and pricing decisions, so the FM should monitor the market conditions and the DM's reactions and revise its price if necessary.



(a) Nash game **(b)** Stackelberg game (Leader: DM)

(c) Stackelberg game (Leader: FM)

Fig. 4. Profit of the FM



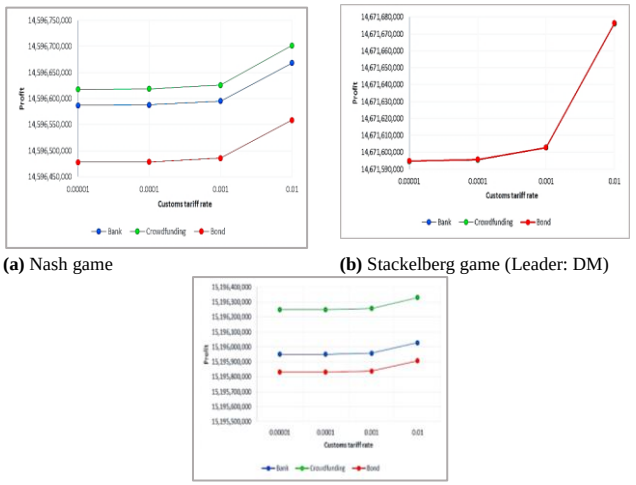
(a) Nash game **(b)** Stackelberg game (Leader: DM)

(c) Stackelberg game (Leader: FM)

Fig. 5. Profit of the retailer

2) The impact of customs tariff rate

Equation (6) highlights the significant impact of the customs tariff rate (φ_F) on the FM's cost, subsequently influencing the cost of imported products. Table B1 (shown in the supplemental material file) presents the profits of SC members under different φ_F values and financing methods. As φ_F increases, the FM's competitive advantage over the DM diminishes, as higher tariffs make imported products relatively expensive. Consequently, regardless of how much it reduces its profit margin, there is a compulsion to increase the price of products from foreign manufacturers. This increase in price diminishes the customers' desire to purchase these products, which in turn, contributes to a decrease in the foreign manufacturers' profit. Figure 6 depicts the DM's profit with varying φ_F in both Nash and Stackelberg games. In the Nash game, all financing methods yield increasing profits for the DM as φ_F rises, with crowdfunding displaying optimal profitability (Figure 6(a)). In the Stackelberg game with the DM as the leader, profits using all three financing methods are similar (Figure 6(b)). However, when the FM is the leader, crowdfunding provides the highest profits for the DM, followed by banks and bonds (Table D1, Exhibit D, supplemental material file).



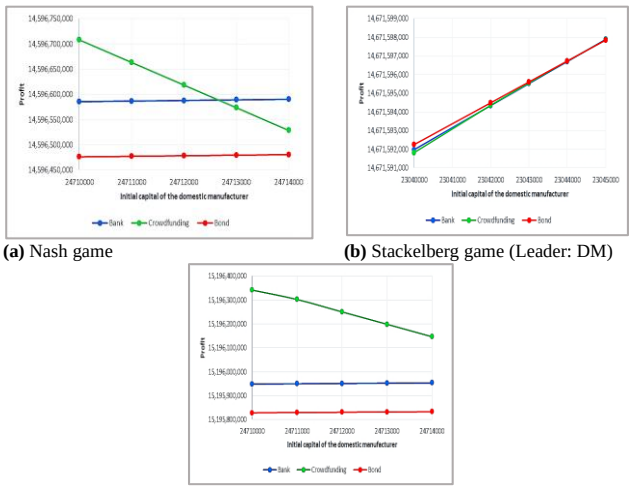
(a) Nash game **(b)** Stackelberg game (Leader: DM)

(c) Stackelberg game (Leader: FM)

Fig. 6. Profit of the DM based on φ_F

B. *The impact of budget*

We introduce a budget constraint for the DM to enhance the model's realism. The parameter B_{DM}, representing the DM's initial capital, influences its profit in objective functions (11), (12), and (13). Table B2 (Exhibit D, of the supplemental material file) presents the profits of manufacturers and retailers in various scenarios, including Nash and Stackelberg games, using different financing methods. In most cases, increasing B_{DM} results in higher DM profits, although unexpected lower profits can also occur. Section 6 discusses the reason behind this in more detail. Also, domestic manufacturer usually moves to the bank financing method to gain more profit by increasing the budget (Figure 7).



(a) Nash game **(b)** Stackelberg game (Leader: DM)

(c) Stackelberg game (Leader: FM)

Fig. 7. Profit of the DM based on B_{DM}

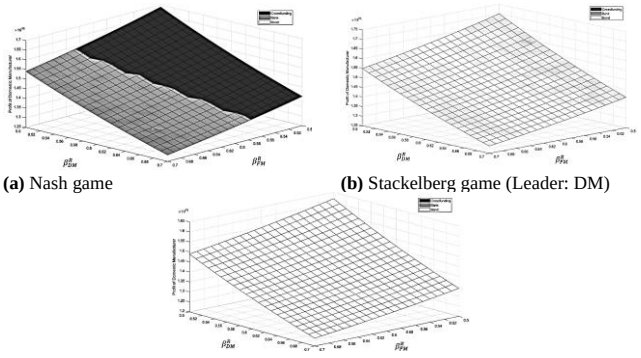
Figure 7(a) illustrates that initially, crowdfunding brings the highest profit for the DM, but its profitability declines as B_{DM} increases. Eventually, bank financing becomes the preferred method. In Figure 7(b), when the DM is the leader, all three methods yield comparable profits, with a slight preference for bank eventually (supplementary material Exhibit D, Table D2). However, when the FM is the leader, the online crowdfunding platform remains the most profitable. As a follower, the DM requires additional funding to enhance its competitive advantage, leading to a marginal preference for bank financing over crowdfunding. Bank financing proves more profitable for the DM compared to bonds. Indeed, as the budget increases, the gap between the bank financing method and online crowdfunding appears to diminish. As depicted in Figure 7(c), it eventually leads to a point where the bank financing method becomes a more favourable option for the DM.

C. *The impact of price sensitivity*

In this section, to examine various scenarios that could affect manufacturers' profits and the demand value, an extensive range of variations is considered that show customers' willingness to pay relative to the proposed price. It explores a wide range of possibilities that might arise in demand and consequently in manufacturers' profits and domestic manufacturers' selection of the optimal financial method. In more detail, we examine the influence of the parameters β_{DM}^R and β_{FM}^R on the SC entities, representing the retailer's sensitivity to the domestic and foreign manufacturer's product prices. These parameters are introduced in equations (1) and (2) for the retailer's product demand function (case setting (1)). The retailer also determines product prices based on β_{DM}^R and β_{FM}^R in equations (8) and (9). β_{DM}^R and β_{FM}^R are crucial parameters that impact the objective function of the retailer, DM and FM. Figures 8 to 10 demonstrate that increasing β_{DM}^R and β_{FM}^R significantly decreases the profits of manufacturers and retailer. Increased sensitivity to the price of goods compels manufacturers to lower their profit margins to offer more competitive prices. Consequently, these decisions will naturally lead to a decrease in profits. Also, with the increase in this sensitivity, we can infer a decrease in the desire to purchase goods. As a result, we can observe that bank and bond methods become more favourable options for DM, depending on the type of competition among manufacturers (Figure 8). Figures 8(a) and 8(b) indicate a shift from online crowdfunding platforms to bank loans and bonds as the more profitable options. Figure 8(c) highlights that bonds offer the highest profitability for the DM when the FM assumes the leadership role. Section 6 provides a more detailed explanation of the reasons for this.

Figure 9 displays the FM's profit under different competitions considering β_{DM}^R and β_{FM}^R parameters. In Figure 9(a), the FM achieves maximum profit when the DM initially opts for crowdfunding and later transitions to bank financing with increased β_{DM}^R and β_{FM}^R. When the DM acts as the leader and chooses bank financing, the FM obtains the highest profit (Figure 9(b)). However, in Figure 9(c), with the FM as the leader, the DM's use of crowdfunding leads to the most profit. Indeed, the results reveal that decreasing β_{DM}^R and β_{FM}^R values or increasing the competitive advantages of FM (like the FM is the leader of the Stackelberg game) make online crowdfunding more profitable for FM.

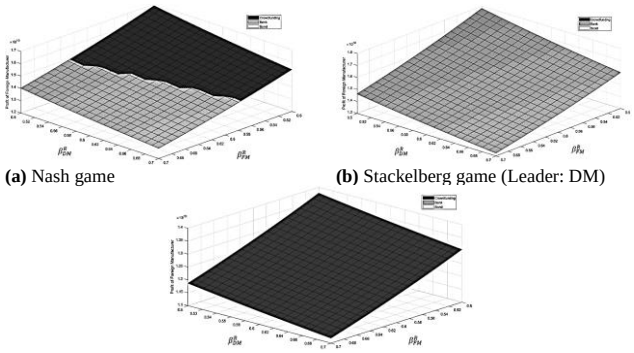
Regarding the retailer, as illustrated in Figure 10, the situation differs from that of the manufacturers. While the banking method was a suitable option for manufacturers when price sensitivities increased, it appears that the online crowdfunding method usually became more profitable for the retailer. The rationale behind this is explained in Section 6.



(a) Nash game **(b)** Stackelberg game (Leader: DM)

(c) Stackelberg game (Leader: FM)

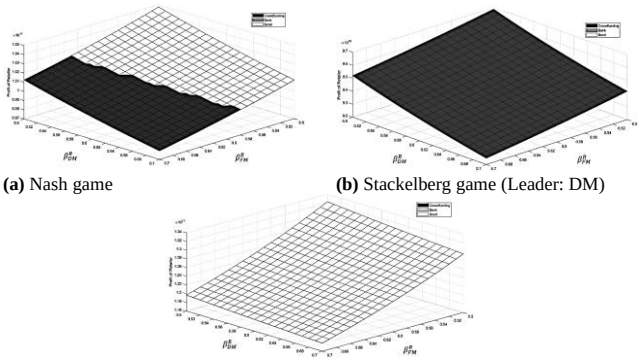
Fig. 8. Profit of the DM



(a) Nash game **(b)** Stackelberg game (Leader: DM)

(c) Stackelberg game (Leader: FM)

Fig. 9. Profit of the FM



(a) Nash game **(b)** Stackelberg game (Leader: DM)

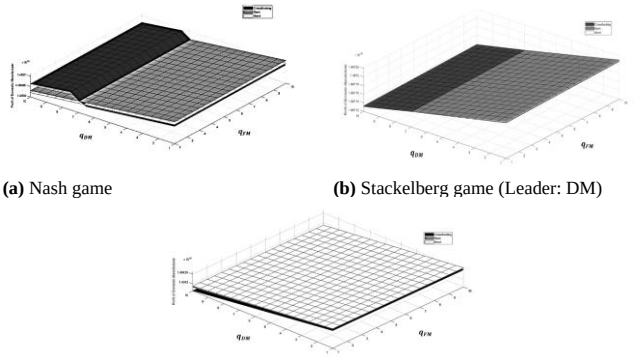
(c) Stackelberg game (Leader: FM)

Fig. 10. Profit of the retailer

D. The impact of quality

In this section, while holding other factors constant, we examine the impact of product quality factors (q_{DM} and q_{FM}) on the profitability of the SC members and the selection of appropriate financing methods (Figures 11 to 13). As shown in case settings (1) and (3), these factors influence customer demand and the production costs for manufacturers. Therefore, a wide range of quality levels is considered for a detailed study.

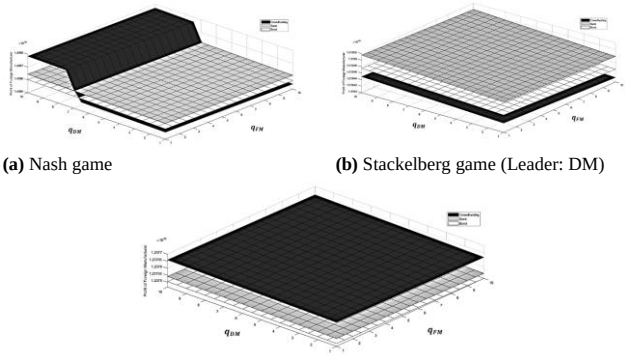
Overall, Figure 11 demonstrates that increasing the product quality of the two manufacturers decreases the DM's profit. This is because the DM, constrained by budget limitations, requires additional financing to enhance quality, thereby reducing its competitiveness compared to the FM and consequently decreasing its profit. Conversely, the profit of the FM increases (Figure 12). Also, Figure 13 indicates that the retailer's profit decreases with the increase in q_{DM} and q_{FM}. This occurs because higher quality increases the two manufacturers' production costs, reducing their ability to offer competitive prices. This could affect the retailer's profit margin through lower sales to customers.



(a) Nash game **(b)** Stackelberg game (Leader: DM)

(c) Stackelberg game (Leader: FM)

Fig. 11. Profit of the DM



(a) Nash game **(b)** Stackelberg game (Leader: DM)

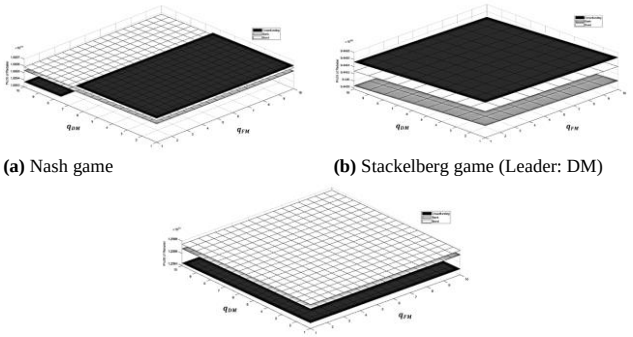
(c) Stackelberg game (Leader: FM)

Fig. 12. Profit of the FM

An interesting observation from Figures 11 and 12 is that when the quality of the DM remains constant and the quality of the FM's products increases, both manufacturers' profits rise. This is because the FM incurs higher production costs compared to the DM. Thus, this allows the DM to implement more competitive pricing, enhancing its profit. Simultaneously, the FM by increasing its product quality can attract a broader range of customers (as per equation (2)), thus boosting its profit. This customer attraction and competitive pricing lead to increased retailer's profit as well (Figure 13). For the DM, as shown in Figure 11 and consistent with previous analyses, when the DM faces increased production costs (higher q_{DM}), it initially turns to online crowdfunding methods (Figures 11(a) and (b)). As the competition intensifies, it shifts towards bond financing methods (Figure 11(c)).

Figure 12 illustrates the FM's profit across various competitive scenarios, considering q_{DM} and q_{FM} parameters. In Figure 12(a), the FM reaches peak profit when the DM first selects bank financing and then switches to crowdfunding as q_{DM} and q_{FM} increase. When the DM acts as the leader and opts for bank financing, the FM secures the highest profit, as shown in Figure 12(b). Conversely, in Figure 12(c), with the FM as the leader, the DM's adoption of crowdfunding results in maximum profit. The findings indicate that higher q_{DM} and q_{FM} values, or

enhancing FM's competitive edge (such as FM leading in the Stackelberg game), make online crowdfunding a better option for FM. Similar to the earlier sections as depicted in Figure 13, the retailer benefits more when the DM employs financing methods with lower interest rates, such as bonds, or uses online crowdfunding.



(a) Nash game **(b)** Stackelberg game (Leader: DM)

(c) Stackelberg game (Leader: FM)

Fig. 13. Profit of the retailer

VI. Discussion and Managerial Implications

This study has various practical implications. For example, Bosch faced a sharp decline in sales during the Coronavirus pandemic [55]. To cope with the crisis, they changed their pricing strategies. Bosch made significant efforts to increase its competitiveness and reduce its costs to gain market share from its foreign rivals, such as LG, who offered lower prices. According to equation 5, they could reduce C_{DT} and sell their products at the new optimal price ($P_{DM}^{R}{}^{*}$) to maintain their market position. Also, by cutting their costs and capital expenditures, the managers generated some free cash flow and ensured that the company had enough financial resources during the crisis. Therefore, a suitable financing method could be beneficial for them. Another example is the automotive parts industry in some countries. DMs failed to compete with FMs in this industry due to a lack of financial resources and pricing strategies [56]. As the total cost of foreign products was lower than domestic products, customers preferred foreign products at a lower price, and foreign competitors captured most of the market share. Therefore, the managers could use price control policies for imported products. In this case, the pricing parameters, such as C_g^{FM} and φ_F, mentioned in case setting (3), could be used to make DMs more competitive. Also, the manufacturers could use appropriate financing methods. By considering both suitable financing methods and pricing strategies for imported products, DMs can compete with FMs for more market share and preserve their market position. The findings of this research can help in such cases. An illustrative case of this financial constraint can be seen in South Africa, where domestic car manufacturers struggle to compete with foreign counterparts due to a lack of initial capital. This financial challenge has hampered their ability to invest in new technologies, innovation, and quality enhancement, ultimately impacting their profitability and competitiveness. Consequently, many consumers have shifted their preference towards imported cars, which offer lower prices and higher quality. It is reported that the market share of domestic cars in South Africa has declined from 70% in 2005 to 38% in 2019, while the market share of imported cars has increased from 30% to 62% over the same period [57].

In the rest of this section, based on the results obtained from Section 5, we discuss how managers and stakeholders can benefit from the outcomes of this study.

A. Managerial decisions considering cost-based parameters

From Section 5.1, decision-makers and stakeholders can conclude that when the cost of globalisation for a domestic manufacturer increases relative to a foreign manufacturer, or when its competitiveness decreases depending on the type of game (for instance, when the foreign manufacturer is the leader), financing methods involving flexible interest rates or lower interest rates are generally deemed more suitable. This is because, in these scenarios, the domestic manufacturer faces greater competition to secure a larger market share. Consequently, it should prefer a financing method that facilitates easier loan repayment. For instance, as depicted in Figure 3, the manufacturer transitions from bank financing to online crowdfunding, a method offering flexible interest rates. Subsequently, it shifts to bonds, which typically offer lower interest rates than other methods. Also, it's crucial to pay close attention to the competitive conditions in the market, as the nature of competition and the magnitude of costs significantly influence the selection of an appropriate financing method. Stakeholders should be aware of the cost of products for domestic manufacturers relative to foreign manufacturers, as an increase in these costs or a decrease in competitiveness might necessitate a shift in financing methods. Lastly, stakeholders should develop strategic plans based on the type of competition (e.g., games where the foreign manufacturer is the leader), which can guide the selection of the most appropriate financing method. These recommendations are general, and the specific circumstances of each stakeholder may require different strategies.

Following our discussion on the impact of financing methods on the profits of two manufacturers, it is clear that the foreign manufacturer needs to not only keep their costs low for increased profit but also reduce these costs for another significant reason. This is because it's generally observed that when competition between two manufacturers decreases, the domestic manufacturer primarily shifts towards bank financing, which in turn increases the profit of the foreign manufacturer. Therefore, if the foreign manufacturer reduces its production costs, it eases the competitive pressure on the domestic manufacturer, enabling both to reach better profits (refer to Figures 3(b) and 4(b) for comparison). This intriguing outcome serves as a valuable insight for both manufacturers and decision-makers or policymakers. It suggests that if policies are implemented to increase the costs of foreign manufacturers, it could potentially lead to a decrease in the profits of domestic manufacturers when competition intensifies. Hence, it's crucial to adopt a policy that improves competition between domestic and foreign manufacturers while minimising pressure on them. From the retailer's perspective, it is observed that their profits increase when the domestic manufacturer shifts to online crowdfunding and bond financing methods. This is attributed to the fact that the DM employs these methods in scenarios when it faces increased competition between manufacturers. The intensification in competition prompts manufacturers to

maintain their market share by lowering their product prices for the retailer. Consequently, the retailer buys products at more competitive and reduced prices, leading to an increase in its profits. This outcome demonstrates that in the scenario of increasing competition between manufacturers, the beneficiary is not the manufacturers, but the retail industry.

Figure 6 provides managers with insights into how the DM's profit changes with increasing φ_F in different financing methods. Managers can identify the optimal financing method that yields maximum profit for the DM. The study's findings suggest to policymakers that local governments can enhance DM competitiveness by implementing contractionary policies towards FMs, such as imposing higher tariffs and taxes to elevate their final product prices when entering the local market. However, excessive implementation of these policies may lead to market monopolies and restrict customer choices. When FM costs rise, the retailer faces market loss in foreign products, resulting in reduced profitability profit (supplementary material Exhibit D, Table D1). While contractionary policies benefit DM profitability, they can negatively impact the retailer. Table B1 highlights that even when the DM assumes a leadership role, bond financing remains more profitable, regardless of the type of competition (Nash or Stackelberg games) where the FM leads.

B. Managerial decisions considering budget parameter

Figure 7 provides managers with insights into finding the optimal state by increasing the DM's initial capital (B_{DM}). By observing the impact of B_{DM} changes on profitability, managers can grasp that high initial capital doesn't always guarantee higher profitability and can impose additional costs. Indeed, the absorption of capital depends on competition and market size, leading to maximum profitability. Also, in most cases, FM profitability decreases (supplementary material Exhibit D, Table D2). Managers understand that greater pricing power for the DM reduces the FM's ability to sell imported products and lowers the FM's profit. Additionally, it's observable that as the budget of the domestic manufacturer increases, the bank financing method becomes the preferred choice across all competitive scenarios. This is attributed to the fact that an increased budget enhances the manufacturer's competitive ability, making the bank financing method, which yields the highest profitability when competition intensity decreases, a viable option. As previously mentioned, this financing method not only boosts the profit of the domestic manufacturer but also benefits the foreign manufacturer. Hence, it's crucial to acknowledge that the budget size significantly influences the choice of appropriate financing for the domestic manufacturer and its subsequent profit. It's an important consideration for DM when strategizing their financial decisions.

C. Managerial decisions considering price parameters

The findings from Section 5.3 reveal that to enhance the profit of the DM, policymakers should aim to decrease price sensitivity. This can be achieved by raising the average income level of consumers. An intriguing aspect of the research is that this reduction in sensitivity should apply not only to domestic products but also to foreign ones. This is because an increase in the sensitivity coefficient for foreign goods compels the FM to offer more competitive prices. Consequently, the domestic manufacturer is also obliged to reduce its profit margin and offer its products at lower prices (as depicted in Figure 8 (a)). This is due to the fact that in a competitive market, product demand is interdependent and not distinct.

Another significant point for decision-makers is that with an increase in sensitivity, the online crowdfunding platform method ceases to be a suitable option for financing. This is because with a decrease in the desire to purchase domestically produced goods, investors, who were seeking profit in the market through online crowdfunding, lose their interest in investing. Alternatively, they may seek to compensate for the reduced demand by requiring higher interest rates from the crowdfunding platform. Consequently, the domestic manufacturer turns to the bank method and bond, which offer more stable interest rates. However, it can be observed that the choice of this online financing method and in some cases, bond for the retailer is associated with the highest profit. This essentially demonstrates that the optimal financial decisions for the DM and the retailer are in conflict in some situations. As we mentioned earlier, the reason for this is that these methods are typically chosen when there is an increase in competition among manufacturers. As a result, the retailer can purchase goods at a better price and consequently achieve higher profits.

D. Managerial decisions considering quality parameter

The results of examining product quality highlight an important point for decision-makers. Increasing quality does not always lead to profitability for manufacturers, especially when facing budget constraints. Therefore, decision-makers must carefully monitor market conditions to select the appropriate strategy for entering their target market. Moreover, product quality has a direct impact on the production costs for manufacturers. These costs, in turn, affect the financial resources available to domestic manufacturers. Additionally, foreign manufacturers adjust their pricing strategies to cover production costs and maximise profits based on product quality. Incorporating quality factors into the demand function and understanding their interaction with other demand components makes the competition more comprehensive. This understanding allows manufacturers and decision-makers to make informed choices by considering how quality interacts with other demand components. They should evaluate not only their own product quality and improvement challenges but also the quality of their competitors' products.

The models developed in this study can guide decision-makers in formulating optimal pricing policies and selecting suitable financing methods. Although quality changes within an organisation involve decisions at strategic or tactical levels, we believe that any company can use its actual data to simulate a range of scenarios caused by quality changes as input to the model. Thus, by understanding their limitations regarding product quality (facilities), companies can enter the market with appropriate pricing and financial strategies.

VII. CONCLUSIONS

This study provides a framework for a competitive SC environment where participants compete based on financial and operational decisions. We offer models for an SC where DM

and FM engage in price competition to offer their products to retailers. This competition can be a Nash game or a Stackelberg game led by either the DM or the FM. On the other hand, the retailer competes with these manufacturers in a Stackelberg game by setting prices on the purchased products to meet the customers' needs. In addition, a DM encountering financial constraints can utilise banks, bonds, and online crowdfunding platforms to overcome its limitations. Our investigation introduces the most effective pricing approaches that manufacturers can adopt to enhance their profits in the retail sector. Additionally, we present a comprehensive evaluation of how the DM's choice of financing methods influences the financial outcomes of all participants in the SC. We conduct sensitivity analysis for the cost parameters, the domestic manufacturer's budget, the price sensitivity, and quality parameters to investigate the behaviour of the SC participants. Finally, through analyses of the results, we answer all research questions and elucidate the trade-off among the governing parameters of the decision-making process based on their competition types and financial resources.

Our analysis reveals that the financial resources used by the DM to compete with the FM remarkably affect the profitability of all involved in an SC. Many manufacturers operate without knowing the capital constraints of their competitors and their methods of meeting these financial needs. We understand that manufacturers and retailers should consider financial issues for optimal decision-making before entering the market to maximise profitability. The domestic manufacturer's choice of the right financing method significantly improves its competitiveness with the FM and the company's profitability. The price sensitivity parameters of the DMs and FMs are some factors impacting the profitability of the SC participants. The DMs and FMs should also take into account the consumers' desire for foreign and domestic products while setting the product price under competition. Therefore, we believe that the findings of this research hold significant implications for all active participants in the SC and for policymakers. Our study offers effective operational solutions for both domestic and foreign manufacturers and retailers, guiding them toward optimal pricing decisions. Furthermore, the DM is able to find the optimal financing method decision to compensate for its lack of budget.

Stakeholders should carefully assess different financing methods, especially when the domestic manufacturer seeks to secure a larger market share. The nature of competition and the magnitude of costs significantly influence the selection of an appropriate profit financing method. Stakeholders should be aware of the cost of products for domestic manufacturers relative to foreign manufacturers, as an increase in these costs or a decrease in competitiveness might necessitate a shift in financing methods. Our discussion on the impact of financing methods on the profits of two manufacturers reveals that when competition between two manufacturers decreases, the domestic manufacturer primarily shifts towards bank financing, which in turn increases the profit of the foreign manufacturer. Therefore, if the foreign manufacturer reduces its production costs, it eases the competitive pressure on the domestic manufacturer, enabling both to reach better profits. From a policymaker's point of view, our results indicate that the implementation of tariff policies and their impact on production costs profoundly affect not just the profits of foreign manufacturers, but the profits of all chain members. The right decision can bring benefits to all active players in the chain, while incorrect policies can negatively impact not only foreign goods but also the profits of domestic manufacturers.

Our study provides a foundation for future research in this area. While we focused on the financial resources of DM, extending the scope to consider financial constraints faced by both retailers and manufacturers would enhance the realism of the study. Additionally, incorporating international trade barriers and their impact on demand functions could provide valuable insights. Future research could also explore how probabilistic distributions affect demand, as well as the influence of bankruptcy risks on financial decisions and pricing strategies. Examining the competitive landscape of crowdfunding platforms in the context of global competition among investment companies could yield interesting insights. Lastly, while our study treats DM and lending platforms as separate entities, exploring potential cooperation contracts between them could be a fruitful area for future research.

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