

Optimal Pricing Strategy in a Competitive Retailing Setting

By

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Abstract

Abstract: This thesis is interested in the conditions for retailers who request financial assistance from the bank. The bank evaluates the payoff ability of the retailers based on the marketing influence and the leadership status. To examine the impact of these two measurements on the bank's decision, the problem is modeled using three different games: 1) Supplier Stackelberg; 2) Retailer Stackelberg; 3) Nash equilibrium. Based on the optimal solutions, I conduct sensitivity analyses and use empirical evidence to illustrate the impacts on prices, demands, and profits of the retailer and the supplier, as well as on the bank's revenue and the retailer's financing cost. Results show that as more effort the retailer puts on promoting its marketing influence, its profit first increases and then decreases. However, the financing cost keeps increasing. Besides, when the retailer is the supply chain leader, it gains a high profit and a low financing cost.

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Chapter 1 Introduction

Bank loans are the predominant source of external financing for many firms in the modern corporate landscape. The Canadian Bankers Association (CBA; 2016) shows that bank financing represents almost 70% of all lending supplied to the business sector through business loans, short-term promissory notes, and other lending products. It is, therefore, important to determine which factors ultimately influence the credit-risk assessment of firms by banks. In theory, many factors can affect a bank's decision to extend financing to a firm. In reality, banks look at the total package (e.g., business plan, cash flow projections, sales, marketplace analysis, business viability) as well as the company's ability to repay a loan when making lending decisions. Interestingly, most of those factors can be recognized as either financial or operational aspects of the firm and, hence, can be classified as parts of the overall supply chain financing (SCF) pattern of a firm, a rapidly developing area of both finance and operation research. Understanding the financing implications of SCF is particularly important for retail firms; they are heavily supply-chain dependent and in an industry with a very thin profit margin, which makes them more susceptible to financial distress. For instance, Nine West Holdings, Inc. filed for bankruptcy in March 2018 with debt of over \$1.5 billion (Globe & Mail, 2018). As part of the debt restructuring deal with creditors, the company plans to sell assets to generate fire-sale cash flows. The story is similar for other debt-ridden retail firms. In the midst of uncertainty in the retail environment, banks can be a reliable source of financing. This is because banks, as expert monitors and information

powerhouses, can accurately assess the impact of various financial and operational aspects of the firm on its credit risk and going-concern viability. In this thesis, I focus on a retailer's downstream market power, which I denote as marketing influence, and upstream market power, which I label as the leadership status of the retailer within the supply chain, and examine how the interactions within the supply chain of a retailer influence its credit-risk assessment by banks.

I am interested in the conditions for retailers with financial constraints that request financial assistance from the bank. Obviously, the bank will evaluate the payoff ability of the retailers. I focus on factors of the payoff ability of retailers: the retailers' marketing influence and the pricing leadership status. The rationale for considering these two factors is that as competition intensifies, gaining market power to become a leader in the market can be significant in seeking assistance from the bank. Not only does the firm have the ability to set the price, but it can also expand its market share. Naturally, when the bank proposes the interest rate in response to a retailer's loan request, it will evaluate the retailer's payoff ability based on something it can observe or measure, such as the retailer's marketing influence and the leadership status. The bank will also adjust the offer of interest rate based on these factors. In this research, the impacts of a retailer's leadership status and marketing influence on the bank loan it can secure are examined.

The objective of this thesis is to investigate the impact of a retailer's marketing influence and leadership status in a supply chain on the financial assistance that it can

receive from the bank by addressing the following interesting issues:

- 1) to study how the marketing influence can affect both operational and financial performance of a retailer in a supply chain under three different game sequences, and further investigate the impact of marketing influence on the bank loan that the retailer can secure;
- 2) to identify the relationship between bank loan and the retailer's supply chain leadership status by assuming that the bank loan is the only source of external financial for the retailer.

A basic model is developed in which a single-period cash flow model for a supply chain is considered: a supplier supplies a product to a retailer that needs financial assistance to obtain the products from the supplier in order to sell them to the customers. To ensure receipt of the bank loan, the retailer must promote the products and store images to gain more marketing influence. The level of effort the retailer puts into its marketing influence can be observed by customers and will affect their purchasing decisions. The bank will evaluate the payoff ability of the retailer based on two measurements: the retailer's market power and its leadership status in the supply chain. To examine the impact of these two measurements on the bank's decision, as well as prices, customer demands, and profits of each member in the supply chain, the problem is modeled using three different games: 1) the Supplier Stackelberg game, in which the supplier is the leader and the retailer is the follower; 2) the Retailer Stackelberg game, in which the retailer is the leader while the supplier is the follower; 3) the Nash

equilibrium game, in which the supplier and the retailer have the same levels of market power. Based on the optimal solutions under three different supply chain structures, I conduct extensive sensitivity analyses and use numerical examples to illustrate the impacts of marketing influence, leadership status, and other factors on prices, demands, and profits of the retailer and the supplier, as well as on the bank's revenue and the retailer's financing cost.

This study yields several interesting results. First, when the retailer puts more effort on promoting its marketing influence, its profit first increases and then decreases. This implies that it is not always the case that the more investment on promoting the marketing influence, the more benefit the retailer can gain. The retailer should balance the benefit from marketing expansion due to the promotion against the cost. Second, when the retailer invests more in marketing influence, the financing cost will be higher. To highlight the value of supply chain leadership, this study compares the retailer's profit and financing cost under three games that are widely used in the literature. Derived results show that when the retailer is the supply chain leader, it benefits from high profit and low financing cost. The underlying rationale is that the retailer can always benefit from being the first mover by setting the price; however, it gains the least profit when it is as the second mover.

In addition, built upon theoretical results derived from models, I propose several hypotheses. Empirical evidences have also been presented to support theoretical results. To verify the results derived from models I developed, empirical studies are included in

this thesis that use financial information of suppliers and their customers (retailers) over 300 industries, for the period 1950 to 2017. Various measurements have been identified as the independent variables, such as the retailer's initial investment on marketing influence and the level of retailer's marketing influence that customers can observe; measurements for the dependent variables are also identified: the retailer's profit and financing cost. The regression model as a tool is first applied for the deep analysis. The empirical results support the proposed hypotheses on the impact of different factors on retailer's profit and financing cost.

This study contributes not only to the literature, but also the practice:

- 1) In terms of the academic study, this research combines the aspects of both operational and financial research and studies how the nature of supply chain (market power) can affect the profits of the firms in the supply chain, and further affect the ability of the retailer to obtain a loan from the bank. In addition, differing from most of the literature, which focuses on either theoretical models or empirical approaches, this research uses empirical evidence to support the theoretical results;
- 2) From the perspective of practical applications, this thesis takes the real business issues into consideration and proposes that the interest rate offered by the bank to the retailer depends on the performance of the retailer, such as its leadership status in the market and its effort on marketing influence. Again differing from other studies, mine provides additional managerial insights to the executives by investigating the influence of the firm's performance under three different games:

1) the Supplier Stackelberg game; 2) the Retailer Stackelberg game; 3) the Nash equilibrium. In this way, this research identifies the optimal bargaining strategies for retailers under three supply chain structures.

The rest of the thesis is organized as follows. Chapter 2 represents the literature review. Chapters 3 & 4 describe the model and discuss results on the retailer's profit and its financing cost under three different supply chain games, and proposes the hypotheses. Chapter 5 empirically tests these theoretical hypotheses proposed in Chapter 4. Chapter 6 concludes the study in this thesis and proposes the future research.

Chapter 2 Literature review

In this thesis, the focus is to examine the impact of market power on firm's profit and financing cost in a supply chain. The literature review presented in this chapter will focus on studies on two main research streams: the market power and supply chain finance. Table 1 outlines issues corresponding to each of these two main research streams.

Table 1. Issues corresponding to each of two main research streams

Research streams	Issues
Market power relationship	Market power in general
	Market power on firm's financial performance
	Market power on firm's operational performance
Supply chain finance	External bank credit financing (BCF)
	Internal trade credit financing (TCF)
	Comparison between BCF and TCF

2.1 Market power relationships

In this subsection, I will review the relationship on the market power. Studies in the literature can be classified into three issues: market power in general, market power on firm's operational performance, and market power on financial performance.

2.1.1 Market power in general

Market power plays a significant role in both operational and financial areas as it

can affect both the firm's order quantity and profits in a competitive market. Existing literature has defined market power and examined the impact of the market power and its measurements for different types of products in different markets.

Keeley (1990) finds that banks with more market power tend to hold more capital relative assets while they have a lower default risk. Berger (1995) explains the profit-structure relationship in banking and compares the market-power and efficient-structure. Stephen (1993) indicates that the market share itself is not a reliable indicator of market power and more factors need to be considered in different situation. In addition, he shows that the barriers to entry, instead of market shares, are the key to the market power.

More studies in the literature measure the market power under different product market. Pauly (1988) tests the details of monopolistic market power in health insurance markets. He concludes that the role of monopolistic power in the medical service market can increase rents of an insurer with market power. Borenstein (1989) estimates the significance of route and airport dominance in discovering the level of market power in an airline industry. The results reveal that the ability to mark-up price above cost can be significantly influenced by an airline's share of passengers on a route and at the endpoint airports. Besides, Ohno and Gallagher (1992) measure the market power for Japanese soyabean markets. The data proves that there was market power in the Japanese soyabean wholesale market after the US embargoes. The estimates show that Japanese consumers lose \$376 million during this episode, and most of which was transferred to the importers. Sexton and Zhang (2001) test the impact of food industry market power

for U.S. consumers. Results indicate that even the modest market power can enlarge the food marketing to capture more shares of the market surplus. However, efficiency (deadweight) loss is small unless the level of market power is high enough or if it is exercised at multiple stages of the channel. Nevo (2001) empirically examines this finding. He concludes that prices in the industry are consistent with noncollusive pricing behavior. Leading firms have the right to maintain a portfolio of differentiated products and influence the perceived quality of the products by the customers.

Differing from the above studies, I identify the supply chain leaders and followers by measuring the market power for retailers and their suppliers in the empirical studies in this thesis. To be more specific, I measure the market share of each firm as an indicator of the market power.

2.1.2 Market power on firm operational performance

Stackelberg model is commonly used in studies in economics and supply chain management. In this subsection, I will review the literature that uses Stackelberg strategy as a tool to analyze different market conditions.

Leitmann (1978) extends the theory of Stackelberg strategy to a nonunique 'rational' response of the follower. This practice guarantees the leader of Stackelberg strategy a cost value that cannot be exceeded. In that way, he defines a generalized Stackelberg strategy pair. Sherali et al. (1983) study the existence and uniqueness of a Stackelberg-Nash-Cournot equilibrium. Sherali (1984) presents a model with multiple leader Stackelberg that extends the Stackelberg's leader-follower duopoly and discusses the

existence of uniqueness and computation of an equilibrium solution. On the top of that, Basar and Srikant (2002) develop a Stackelberg network game with a great number of followers. They consider a hierarchical network game with a single service provider, and a large number of users with multiple levels. As a result, they show that the game can have a unique equilibrium solution. He et al. (2007) study sequential decision making in the supply chain management and marketing channels by testing the Stackelberg differential game models. Moreover, Huck et al. (2001) find that competition will be less intense for Stackelberg markets when firms remain in pairs.

For the applications of the Stackelberg models, Yu et al. (2009) discuss how the vendor can take an advantage by using a Stackelberg game to increase his own profit in a vendor managed inventory (VMI) system. The results indicate that: (1) the manufacturer (vendor) can benefit from his leadership by enhancing its profit in the VMI system; (2) market and raw material related factors have crucial influence on the net profits of the manufacturer and each retailer. Furthermore, Liu et al. (2012) study the two-stage Stackelberg game models to investigate the impact of competition and consumers' environmental awareness on key supply chain players. Qin et al. (2007) study the coordination of volume discounts and franchise fees in a system that consists of a supplier and a buyer with price-sensitive demand and analyze the problem as a Stackelberg game. Furthermore, Zhang et al. (2013) formulate the problem of optimal decisions between the manufacturer and the retailer in two different games: Stackelberg game and cooperative game. They propose a new method in terms of coordinating the

supply chain that both the manufacturer and the retailer have the power to share each other's advertising costs.

Different from the above studies, I compare three games, the Supplier Stackelberg, the Retailer Stackelberg, and the Nash game, to examine the impact of retailer's leadership status on its loan from the bank in a supply chain framework with a supplier and a retailer. I also develop hypotheses based on optimal solutions to these games and use data to verify the validation of the models. Detailed discussions are presented in Chapter 3.

2.1.3 Market power on firm financial performance

Pricing strategy is proved to be a useful tool in the supply chains and has been widely applied in markets. Pricing strategy is one of common strategies that firms use for gain competitive advantages. This subsection reviews the pricing strategy used in supply chain and how it affects the firm's financial performance.

Yao and Liu (2005) study the price competition between a retail and an e-tail distribution channels under two market game settings: the Bertrand and the Stackelberg price competitions. They show that there exists an optimal wholesale price for each market structure that can be used to encourage the retailer to accommodate to the additional e-tail channel. He et al. (2009) investigate the cooperative advertising and pricing in a dynamic stochastic supply chain. Cai et al. (2009) evaluate the influences of price discount contracts and pricing schemes under the dual-channel supply chain competition. They show that the scenarios with price discount contracts can perform

better than the non-contract scenarios under the Supplier Stackelberg, the Retailer Stackelberg, and the Nash game theoretic perspectives. In addition, they show that consistent pricing scheme can reduce the channel conflict and earn more profit to the retailer. Also, Chen et al. (2012) examine a manufacturer's pricing strategies in a dual-channel supply chain, in which the manufacturer is a Stackelberg leader and the retailer is a follower. They show that both the manufacturer and the retailer prefer a dual-channel supply chain under certain conditions. Besides, Wei and Choi (2010) explore the application of a wholesale pricing and profit sharing scheme (WPPS) for coordinating supply chains under the mean-variance (MV) decision framework. They prove that there exists a unique equilibrium of the Stackelberg game with WPPS in the decentralized supply chain. Dan et al. (2012) use the two-stage optimization technique and Stackelberg game to examine the optimal decisions on the retail services and prices under both centralized and decentralized dual-channel supply chain. The results indicate that retail services affect the manufacturer and the retailer's pricing strategies a lot. On the top of that, Lan et al. (2018) test the manufacturer's optimal pricing strategy in a dual-channel supply chain. The result shows that both the manufacturer and the retailer can be benefited by the dual-channel system benefits if the level of demand uncertainty is greater than a threshold. Fang et al. (2017) propose a one-leader-one-follower Stackelberg (OLOFS) game model with multiple eavesdroppers. They use the optimal power allocation and pricing strategy to maximize the players' utilities. The result indicates that the proposed game model improves network energy efficiency. Besides,

Madani and Rasti-Barzoki (2017) study the pricing policies, greening strategies and governance tariffs under supply chains competition. The results demonstrates that cooperating between members makes more profit for them and produces more eco-friendly products.

In my thesis, I model the retailer's market power as the pricing bargain ability in the supply chain and use Stackelberg model to test how the market power can affect the optimal solution of the retail price as well as wholesale price. Details can be referred to Chapter 3.

2.2 Supply chain financing

The integration of supply chain management and finance has gained more attention recently. There are two general streams that have been extensively discussed: external bank credit financing (BCF) and internal trade credit financing (TCF). This subsection will review the literature related to these two streams and the comparison between them.

2.2.1 External bank credit financing

From a bank's perspective, credit risk management is essential to the long-term success of organization. In general, banks will make decisions on whether or not to lend money to the company after making a credit risk analysis. Banks will not offer their financial assistance if they notice the lending behavior cannot generate any revenue.

Many studies have been on the credit risk and credit scoring for both banks and consumers. Hand and Henley (1997) review statistical classification methods by using consumer credit scoring. Thomas (2000) shows that credit and behavioural scoring are

two most important forecasting techniques that can be used in the retail and consumer finance areas. For credit scoring, Lee et al. (2006) use classification and regression tree (CART) and multivariate adaptive regression splines (MARS) to explore the performance of credit scoring. The results reveal that, CART and MARS are more accurate than traditional discriminant analysis, logistic regression, neural networks, and support vector machine (SVM) approaches.

Some studies discuss the bank loan under certain different environments. Qian and Strathan (2007) suggest that under strong creditor protection, loans tend to have more concentrated ownership, longer maturities, and lower interest rates. Moreover, they find that the impact of creditor rights on loans depends on borrower's characteristics, such as the size and tangibility of assets. In addition, Bharath et al. (2011) conclude that even firms can borrow from multiple outside financial assistance, borrowing from a previous lender will gain better loan terms.

There are also some reported studies on specific cases or evidences on bank lending. Ivashina and Sharfstein (2010) show that new loans borrowed by large firms decreased by 47% during the financial crisis. In particular, authors show that banks will stop lending if they have better access to deposit financing. Lummer and McConnell (1989) find that banks can be transmitters in capital markets, but new bank loans do not communicate information at all. On the top of that, Diamond (1991) finds that borrowers with middle level credit ratings rely on bank loans.

In this thesis, I address a problem in which the retailer has to consider finance

assistance from the bank to make the order from the supplier. In return, the bank will evaluate the payoff ability of retailer based on its market power and supply chain leadership status.

2.2.2 Internal trade credit financing

Trade credit financing (TCF) is another popular topic in recent years. Many studies have been proposed to examine this issue between suppliers and retailers because trade credit is always linked to the solution of financial constraints. Practice shows that trade credit is a crucial tool for financing growth. A properly prepared financial plan can be helpful for retailers to negotiate with suppliers. In this thesis, I focus only on the applications of trade credit and its guarantee contract between a supplier, a budget-constrained retailer, and a bank.

Chen and Cai (2011) extend the model in the supply chain with a supplier, a budget-constrained retailer, a bank, and a 3PL firm. They conclude that the control role model has higher profits both for the 3PL firm and for the entire supply chain and has a better performance for the supply chain as long as the 3PL firm's marginal profit is greater than the supplier's marginal profit. Cai et al. (2014) find that retailer prefers trade credit when the trade credit market is more competitive than the bank credit market. Besides, the study of credit guarantee contract in a capital-constrained supply chain has been presented by Yan et al. (2016) and Kouvelis and Zhao (2016). Yan et al. (2016) show that the partial credit guarantee contract can maximize the profit based on a suitable guarantee coefficient. On the other hand, Kouvelis and Zhao (2016) focus on the

contract design. The finding of their study supports the use of revenue-sharing contracts under decentralized supply chains.

In my model, trade credit condition is not considered for the retailer. Instead, I assume that if the retailer is on a budget constraint and needs a financial support, it can borrow loan from the bank rather than negotiate with the supplier for a late payment.

2.2.3 Comparison between BCF and TCF

BCF and TCF have been compared in the existing studies (for example, Kouvelis & Zhao, 2012; Cai et al., 2014; Jing & Seidmann, 2014). Some studies show that TCF is a better option than BCF under certain scenarios. For instance, Kouvelis & Zhao (2012) and Cai et al. (2014) show that the trade credit performs better than bank loan from the perspective of supplier. Moreover, Jing & Seidmann (2014) study a two-level supply chain coordinating with manufacturers and budget-constrained retailers. They find that TCF is more effective than bank credit when production costs are low while BCF is more effective when production costs are high. On the top of that, Chen (2015) examines a distribution channel with one manufacturer and one capital-constrained retailer. Results show that trade credit benefits both manufacturer and retailer more in a wholesale price contract. Besides that, he shows that trade credit is a better method to coordinate the channels by centralizing the finance distribution from the manufacturer. For credit risk of small firms, Nilsen (2002) finds that trade credit is widely used by the small firms suffering the loan decline.

2.3 Limitation of previous research

In this section, I identify the research gaps and summarize as follows.

- 1) In most cases, the information about financial performance for a budget-constrained retailer is assumed to be common knowledge to the potential creditor (bank). But in practice, the retailer sometimes has more precise knowledge than creditors. For example, it might hide data and records that could negatively affect the bank's decision on loans. Therefore, in this research, I take the common information between bank and retailers into consideration and propose my model for it;
- 2) In certain conditions, the customer's perception of a product may be affected by the retailer's advertising and promotion activities. In other words, customer's purchasing decision is related to the retailer's efforts in promoting its product. However, current research has not addressed this aspect. In my research, I develop the mathematical model in which customer's demand is related to the level of retailer's investment in promoting its market influence and product image;
- 3) Most of the research concerns coordination of supply chain between suppliers and retailers. However, few studies include the role of the bank in the supply chain or investigate how the bank will behave under different supply chain structures. In my research, I combine the operational and financial aspects of the supply chain and study how the bank reacts to the performance of retailers in different scenarios;
- 4) Most of the research tests the theoretical results by applying numerical examples. In this thesis, empirical evidence has been gathered and analyzed to support the hypotheses.

Chapter 3 Model description

3.1 Overview

Consider a simple supply chain, in which a supplier provides a single product to a retailer who will sell the products to the customers. It is assumed that retailer will need to spend more money on relationship-specific assets to promote its marketing influence in order to gain more market power.

The objective of this study is to investigate how the retailer's market power affects the bank's loan rate in a supply chain framework. The retailer has to consider financial assistance from the bank as it cannot afford the order payments to the supplier. However, the bank will evaluate the payoff ability of the retailer based on its market leadership status and its initial investment level on promoting its marketing influence. Hence, the bank's interest rate is assumed to be dependent on both the retailer's initial investment on promoting its marketing influence (for example, the investment on store or product image) and leadership status in the supply chain.

3.2 Model description

In the supply chain, the supplier produces the product with a unit production cost (c). To simplify the model and focus on the analysis of the impact of the retailer's market power on the bank loan's interest rate, I normalize unit production cost (c) to be 0. The robustness checks shows that this assumption does not affect the major results and insights of this study. The supplier should decide the unit wholesale price (w). The retailer should predetermine the level of marketing influence (α) it will invest, where

$0 \leq \alpha \leq 1$. Following studies of Anderson et al. (1997) in marketing, I assume that the retailer's cost of initial investment in marketing influence is $C_I = \frac{1}{2}k(\alpha)^2$, where $0 < k \leq 1$, a constant parameter, representing an accelerating rate in this investment cost. In the supply chain, pricing leadership also reflects the market power in terms of bargain ability. Three supply chain games between the supplier and the retailer are examined: a simultaneous game (Bertrand-Nash game, denoted as B), a game with the retailer as the price leader (Retailer Stackelberg, denoted as R), and a game with the supplier as the price leader (Supplier Stackelberg, denoted as S). I denote the supply chain's price leadership relationship as $l = \{B, R, S\}$. Since the bank loan depends on the retailer's market power and leadership, the interest rate (r) of the bank's loan can be written as:

$$r = r_0 - \theta l - \delta \alpha, \quad (1)$$

where r_0 is the bank's initial interest rate without considering the factors of the retailer's market power or leadership status; θ ($\theta \in (0,1)$) and δ ($\delta \in (0,1)$) are the weights that bank perceives on the retailer's leadership in the supply chain and investment in marketing influence, respectively. Notice that $r_0 > \theta l + \delta \alpha$ to ensure a positive r . Equation (1) indicates that if the retailer plays a Stackelberg leader in the supply chain or/and if the retailer initially invests heavily in the marketing influence, the bank will offer a lower interest rate for the loan. To sell the products to the customers, the retailer should decide the retail price (p). Fig. 1. illustrates the framework of bank debt financing in the supply chain.

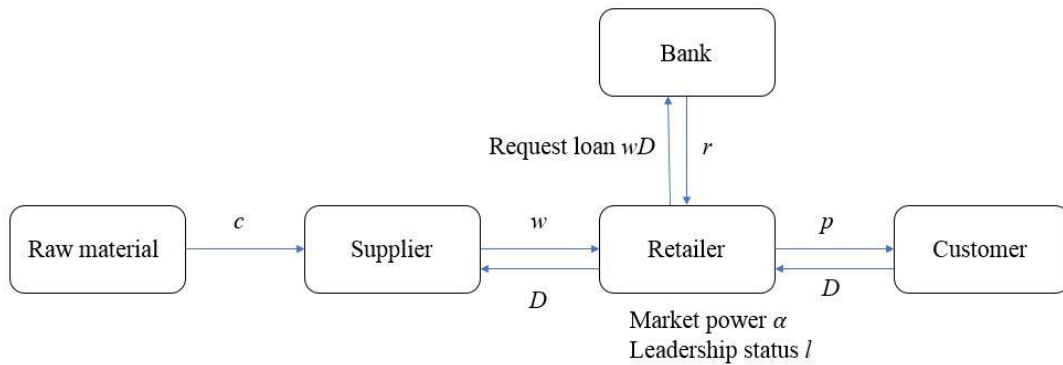


Fig 1. Framework of bank debt financing

To capture the retailer's pricing leadership in the supply chain, I assume that $l = 1$ if the retailer is the Stackelberg leader; $l = 0$ if the retailer plays Bertrand Nash game with the supplier; $l = -1$ if the supplier is the Stackelberg leader.

It is also assumed that the retailer's marketing influence level affects the customer's decision on purchasing the products. The intuition is that when the customer observes the retailer has more marketing influence, he/she is more likely to be a loyal customer of the retailer and more likely to have a high willingness-to-pay (WTP). Let s represents the level of bargaining power for retailer that customers can perceive. Then:

$$s = b\alpha, \quad (2)$$

where $b \in (0,1)$, the degree of importance that the customers perceive the retailer's marketing influence.

Assuming that customers are heterogeneous in product valuation, v , which is uniformly distributed between 0 and 1, as in other studies in the marketing literature (for example, Chiang et al., 2003; Choudhary et al., 2005). Knowing the retail price (p) and observing the retailer's level of bargaining power, the customer's utility function is:

$$U(v) = v - p + s. \quad (3)$$

The customers with valuation v on the product will buy the product if $U(v) \geq 0$; otherwise, the customers will not buy the product. Then, the demand (D) can be derived as:

$$D(p) = 1 - p + s. \quad (4)$$

To be cost efficient, the supplier is assumed to produce exactly the number of products that the retailer needs. That is, production quantity is equal to the retailer's order quantity, in order to meet the customer's demand (D).

The notation used in this research is summarized in Table 2.

Table 2. Table of notation

Index	
l	Retailer's leadership status
S, R, B	Superscript, index of the Supplier Stackelberg, Bertrand-Nash game, and Retailer Stackelberg supply chain, respectively
S, R	Subscript, index of the supplier and the retailer, respectively
Parameters	
v	The customer's valuation on the product, random variable, uniform distribution $[0,1]$
D	Retailer's demand
r	Interest rate of the bank
r_0	Initial interest rate of the bank
s	Customer's perceived value on the retailer's bargaining power
b	Customer's perceived value on the retailer's marketing influence
δ	Linear effect of market power on the bank's interest rate
k	Rate of acceleration in costs for marketing influence
π_S, π_R	The profit of the supplier and the retailer, respectively
C_I	Cost of retailer's initial investment in marketing influence
m	Margin Profit
C_F	Financing cost for the retailer (money borrow from the bank)
R_F	Bank's revenue
α	Level of the retailer's marketing influence
θ	The weight that bank perceives on the retailer's leadership
Decision variables	

p	Unit retail price
w	Unit wholesale price

Chapter 4 Model discussion

In this chapter, I first model the problems of the retailer, the supplier, and the bank, respectively. Then I present the game sequence when the retailer has the different leadership status ($l = \{S, R, B\}$).

4.1 Model

4.1.1 The retailer's problem

With demand function in (4), predetermined level of the marketing influence (α), the bank's interest rate (r) in (3), the retailer will maximize its profit by setting optimal retail price (p^*):

$$\pi_R = pD(p) - C_F - C_I. \quad (5)$$

Notice that $C_F = wD(p)(1 + r)$. On the right-hand side of (5), the first term is the retailer's revenue from selling the product to the customers; the second term is the costs of loan borrowed from the bank to pay the purchasing cost to the supplier and to pay the interest to the bank; the last term is the retailer's investment cost in marketing influence.

4.1.2 The supplier's problem

With demand function in (4), the supplier will maximize its profit by setting the optimal wholesale price (w^*):

$$\pi_s = wD(p). \quad (6)$$

On the right-hand side of (6) is the revenue of the supplier from supplying products to the retailer. Since the unit production cost (c) is normalized to 0, the profit of the

supplier will equal to its revenue.

4.1.3 The bank's problem

As discussed above, the bank will evaluate the payoff ability of the retailer based on its market leadership status and its initial investment level. Therefore, after observing the retailer's performance, leadership status (l) and marketing influence (α), the bank will announce its interest rate (r) in (1) to the retailer, which is common information for both the retailer and the bank. Then the bank's revenue is:

$$R_F = wD(p)r. \quad (7)$$

According to (7), since the financing cost from the bank (C_F) is what the retailer needs to borrow from the bank to purchase the products from the supplier, the bank's revenue comes from the interest of the loan accordingly.

The game sequence depends the retailer's leadership status (l). If the retailer is the Stackelberg leader in the supply chain ($l = R$), the retailer first chooses its margin profit (m). As the follower, after observing the retailer's margin profit (m), the supplier announces the wholesale price (w). When the supplier is the Stackelberg leader in the supply chain ($l = S$), the supplier announces the wholesale price first (w). After knowing the supplier's wholesale price, the retailer decides the retail price (p). When the retailer plays the Nash game with the supplier, the supplier announces the wholesale price and the retailer announces retail price simultaneously.

Next, the equilibrium solutions are derived from the retailer's three different leadership status ($l = \{S, R, N\}$). The problem for each game is solved backwardly.

4.2 Equilibrium solutions

4.2.1 Supplier Stackelberg ($l = S$)

4.2.1.1 General impact

Given a wholesale price (w^S) and with (5), the second-order condition of (5) w.r.t. p is negative, then there exists a unique optimal $p^S(w)^*$ by setting the first-order condition of the retailer's profit in (5) w.r.t. p to be 0, which gives:

$$p^S(w)^* = \frac{1+\alpha b+w(1+\theta+r_0-\delta\alpha)}{2}. \quad (8)$$

It is intuitive that $p^S(w)^*$ increases with the wholesale price (w) so that equation (8) also shows that the retailer compensates for the investment cost. In addition, for a given w , (8) shows that $p^S(w)^*$ increases with the retailer's initial investment level (α) if the supplier's wholesale price is sufficiently low ($w < b/\delta$); otherwise, $p^S(w)^*$ decreases with α . This suggests that if the retailer's unit purchasing price (w) is sufficiently low, as it invests more in marketing influence, it should raise the retail price to compensate for the investment cost. However, if the retailer's unit purchasing price (w) is sufficiently high ($w > b/\delta$), as it invests more in marketing influence, it should cut the retail price to attract more demand from customers. Furthermore, $p^S(w)^*$ decreases with δ , implying that if the bank puts greater weight on the retailer's initial investment in marketing influence, the retailer will set a lower price to expand demand; if customers' perceived value on the retailer's effort in promoting the marketing influence (b) is higher, the retailer will set a higher price.

With (8) and the supplier's profit function in (6), the second-order condition of (8)

and (6) w.r.t. w is negative. I have the following results:

Proposition 1: *There exists unique optimal prices (p^{S*}, w^{S*}) for the retailer and the supplier, which are given:*

$$p^{S*} = \frac{3(1+\alpha b)}{4}. \quad (9)$$

$$w^{S*} = \frac{1+\alpha b}{2(1+r_0+\theta-\delta\alpha)}. \quad (10)$$

Proposition 1 shows the interesting results. The optimal retail price (p^{S*}) only relates to the retailer's investment in promoting marketing influence. Specifically, that retailer sets a higher price if it invests more in the marketing influence (α) in the early stage to compensate for the investment cost. Besides, if customers' perceived value on the retailer's effort in promoting the marketing influence (b) is higher, the retailer will set a higher price because a good product/store image attracts more demand.

In addition, w^{S*} increases with customers' perceived values on the retailer's effort in promoting the marketing influence (b). It implies that the higher customers' perceived values, the more customers will buy the products. With more demand, the supplier can charge a high wholesale price as the retailer will order more. Furthermore, w^{S*} increases with δ , implying that if the bank puts greater weight on the retailer's initial investment in the marketing influence, the retailer will have a lower financing cost and thus the supplier can set a higher wholesale price to increase its margin profit. Equation (9) also shows that w^{S*} decreases with θ , suggesting that when the bank gives greater weight to the retailer's leadership status, in a Supplier Stackelberg supply chain, the supplier should reduce the wholesale price because the retailer's financing

cost from the bank is high.

With Equations (4)–(7), the retailer's demand, profits of the retailer and the supplier, the bank's revenue, and the retailer's financing cost are:

$$D^{S*} = \frac{1+\alpha b}{4}, \quad (11)$$

$$\pi_R^{S*} = \frac{(1+\alpha b)^2}{16} - \frac{k\alpha^2}{2}, \quad (12)$$

$$\pi_S^{S*} = \frac{(1+\alpha b)^2}{8(1+r_0+\theta-\delta\alpha)}, \quad (13)$$

$$R_F^{S*} = \frac{(1+\alpha b)^2(r_0+\theta-\delta\alpha)}{8(1+r_0+\theta-\delta\alpha)}, \text{ and} \quad (14)$$

$$C_F^{S*} = \frac{(1+\alpha b)^2}{8}. \quad (15)$$

As discussed above, the retail price (p^*) is related to both the retailer's initial investment level (α) and the effort that the retailer puts into promoting the marketing influence (b). Equation (11) suggests that if the retailer invests more through promotion activities to maintain and improve its product/store image, customers tend to purchase more products. The optimal result shows a positive relationship between the customer's demand (D^{S*}) and retailer's initial investment level (α) for more marketing influence. It is obvious that the supplier benefits from the retailer's investment because it can charge a higher wholesale price and the retailer orders more product due to the increase in demand. However, the retailer's profit can be increased only when this effect on the retail price and demand exceeds its cost of investment ($k\alpha^2/2$). Equation (12) demonstrates that when k is sufficiently low ($k < b^2/8$), the retailer enhances its profit if it increases the initial investment level (α). This represents that when the accelerating rate (k) in this investment cost is low, even if the retailer sets a higher investment level

in marketing influence, the total investment cost is still relatively low, which can be offset by the expansion in the demand and the increase in the retail price. As a result, the retailer benefits from this investment. When the accelerating rate (k) in this investment cost is sufficiently high ($k > b^2/8$), however, the retailer's profit will decrease due to high investment cost. This suggests that when the retailer is aware that k is sufficiently low ($k < b^2/8$), investing in promoting store/product image may be a good option. Also, if customers perceive that the retailer's effort in promoting the marketing influences (b) more, more customers will buy products. Moreover, since retailer price (p^{S*}) increases with the customer's perceived value on retailer's effort in promoting its product (b), apparently, both the profits of the retailer and the supplier increase with b . Since the retailer's financing cost increases with b , the bank's revenue increases as well. On the other hand, the wholesale price (w^{S*}) will increase with the level that the bank weights the retailer's initial investment in the marketing influence (δ), as well as decreases with the level that the bank weights the retailer's leadership status (θ). The supplier's profit (π_s^{S*}) increases with δ and decreases with θ . The bank's revenue (R_F^{S*}) decreases with δ and increases with θ because it gives the retailer a low interest rate if δ is high and a high interest rate if retailer is a follower in the supply chain.

4.2.1.2 The impact of retailer's initial investment level (α)

In this section, the impact of retailer's initial investment level on marketing influence (α) on prices, demand, profits of the retailer and the manufacturer, and the

revenue of the bank is illustrated by a numerical example and shown in Fig. 2, for the Supplier Stackelberg game. Here, I set $b = 0.4$, $r_0 = 0.12$, $\theta = 0.15$, $\delta = 0.2$, and $k = 0.66$.

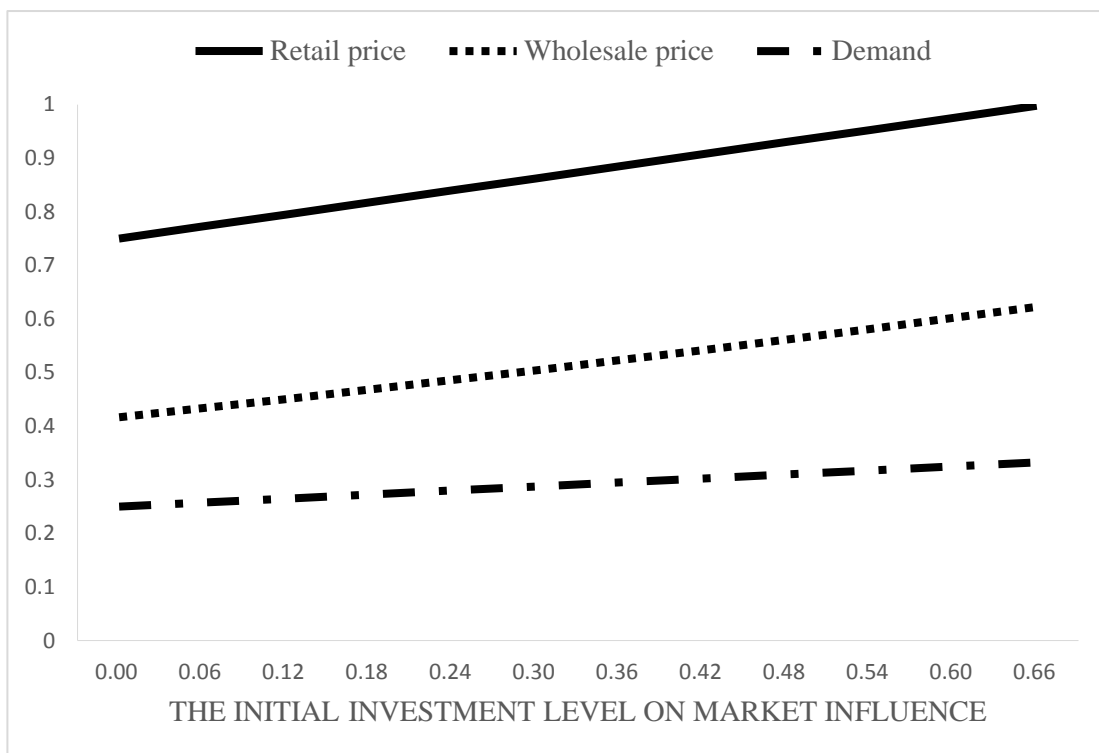


Fig 2. (a) The impact of α on p^{S*} , w^{S*} , and D^{S*} under the Supplier Stackelberg supply chain

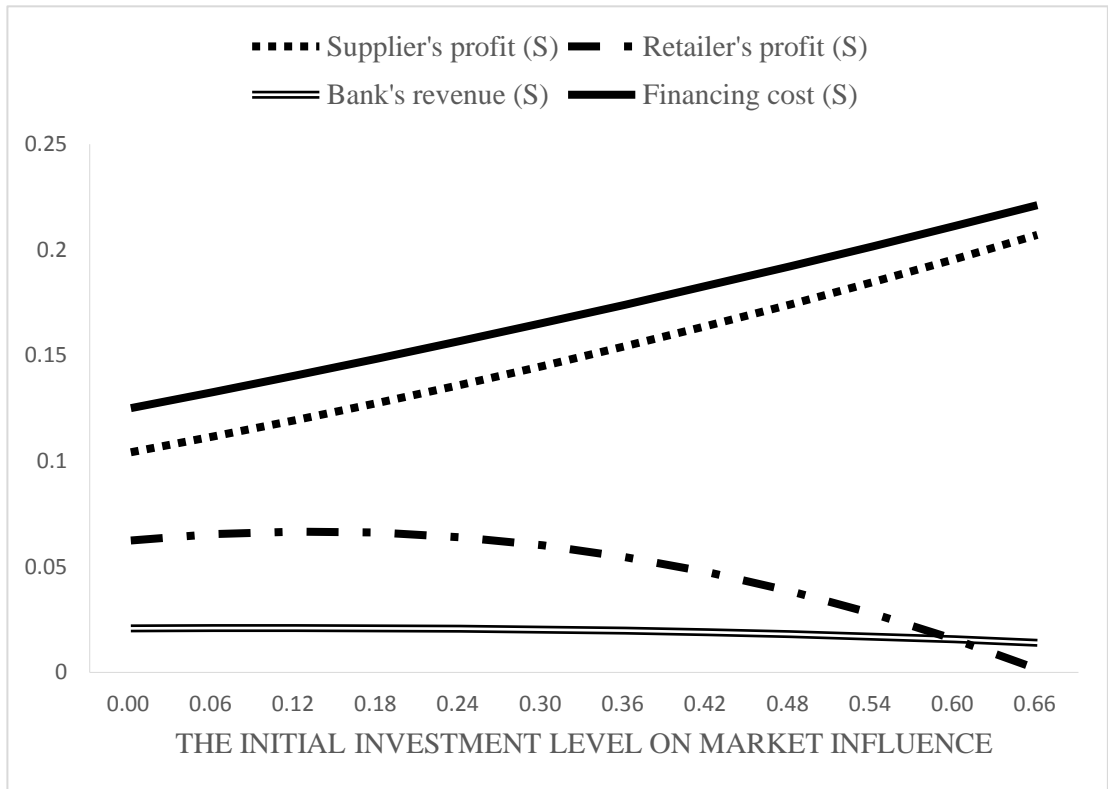


Fig 2. (b) The impact of α on π_S^{S*} , π_R^{S*} , R_F^{S*} , and C_F^{S*} under the Supplier Stackelberg supply chain

As discussed above, the retailer sets a higher retailer price (p^{S*}) if it invests more in the marketing influence (α) in the early stage, to compensate the investment cost as more customers will purchase products. Therefore, there is a positive relationship between the customer's demand (D^{S*}) and the retailer's initial investment level (α) for more marketing influence. It is obvious that the supplier benefits the retailer's investment as it can charge a high wholesale price (w^{S*}) and the retailer orders more product due to the increase in demand. It is straight forward that the supplier's profit increases with α in Fig. 2. However, in terms of retailer's profit, Fig. 2 shows that it keeps increasing till it reaches the maximum value point ($\frac{\alpha b^2 + b - 8\alpha k}{8}$) then starting decreasing. After the point when $\alpha = 0.66$, the retailer's profit becomes zero, the retailer will stop investing as it is not profitable. Thus, Fig. 2 only illustrates the results

between α equals 0 and 0.66. When the wholesale price increases as retailer invests more, financing cost of the retailer will increase as well even the bank will offer a low interest rate. For the bank's revenue, it first increases when $\delta < b[(\theta + r_0 - \delta\alpha)^2 - \delta\alpha] - 1$ while starts decreasing when $\delta > b[(\theta + r_0 - \delta\alpha)^2 - \delta\alpha] - 1$ which indicates when the bank weighs the retailer's initial investment in the marketing influence (δ) is sufficiently low ($\delta < b[(\theta + r_0 - \delta\alpha)^2 - \delta\alpha] - 1$), the bank's revenue will increase due to high wholesale price and demand. This suggests that when (δ) is sufficiently high ($\delta > b[(\theta + r_0 - \delta\alpha)^2 - \delta\alpha] - 1$), the bank offers a low interest may be a good option for the bank.

4.2.2 Retailer Stackelberg ($l = R$)

4.2.2.1 General impact

Given a margin profit ($m^R = p^R - w^R$), with (6), the second-order condition of (6) w.r.t. w is negative, then there is a unique optimal $w^R(m)^*$ by setting the first-order condition to be 0, which gives:

$$w^R(m)^* = \frac{1+\alpha b-m}{2}. \quad (16)$$

It is intuitive that $w^R(m)^*$ decreases with the margin profit (m^R). As the retailer reserves more profit margin, the supplier has to reduce the wholesale price. In addition, (16) shows that the wholesale price, $w^R(m)^*$, increases with the retailer's initial investment level (α). This suggests that because the retailer invests more in marketing influence, the supplier's margin profit increases as it can charge a higher wholesale price. Furthermore, $w^R(m)^*$ increases if customers' perceived value on the retailer's effort in

promoting the marketing influence (b) is high.

With (16) and the retailer's profit function in (5), the second-order condition of (5) w.r.t. m is negative, then there exists a unique optimal profit margin (m^{R*}), which is given by setting the first-order condition to be 0. I obtain the following results:

Proposition 2: *There exists unique optimal margin profit and wholesale price (m^{R*}, w^{R*}) for the retailer and the supplier, which are given:*

$$m^{R*} = \frac{(1+\alpha b)(1+r_0-\theta-\delta\alpha)}{(2+r_0-\theta-\delta\alpha)}. \quad (17)$$

$$w^{R*} = \frac{1+b\alpha}{2(2+r_0-\delta\alpha-\theta)}. \quad (18)$$

Proposition 2 illustrates some interesting findings. The optimal profit margin m^{R*} increases with customers' perceived values on the retailer's effort in promoting the marketing influence (b). It implies that the higher customers' perceived values, the more customers will buy the products. With more demand, the retailer can earn a higher profit margin to compensate for the investment cost. One might expect that the retailer's margin increases with the level that the bank weights the retailer's initial investment in the marketing influence (δ). However, (17) also shows that the retailer's profit margin decreases with the level that the bank weights the retailer's initial investment in the marketing influence (δ), as well as decreases with the level that the bank weights the retailer's leadership status (θ). This means that when the bank gives more weight to both the retailer's initial investment in the marketing influence and the retailer's leader status, the retailer's financing cost will be low under the Retailer Stackelberg supply chain, and its profit margin will be low, which is counterintuitive.

Moreover, w^{R*} increases with customers' perceived value of the retailer's effort in promoting the marketing influence (b). It implies that the higher customers' perceived value, the more customers will buy the products. A higher demand allows the supplier to charge a higher wholesale price as the retailer will order more. Furthermore, w^{R*} increases with δ , implying that if the bank weights the retailer's initial investment in the marketing influence more, the retailer will have a lower financing cost and thus the supplier can set a higher wholesale price to increase its profit. Equation (18) also shows that w^{R*} increases with θ , suggesting that when the bank weights the retailer's leadership status more, in a Retailer Stackelberg supply chain, the supplier, as a follower, should increase the wholesale price because the retailer's financing cost from the bank is low. Moreover, the supplier's wholesale price has a positive association with the retailer's initial investment level (α), suggesting that the supplier benefits from the retailer's investment because it can charge a higher wholesale price because of higher demand from customers.

With Proposition 2, the optimal unit retailer price p^{R*} is:

$$p^{R*} = \frac{(1+b\alpha)(3+2r_0-2\theta-2\delta\alpha)}{2(2+r_0-\theta-\delta\alpha)}. \quad (19)$$

Interestingly, the optimal retail price relates to the retailer's effort in promoting marketing influence. If customers' perceived value of the retailer's effort in promoting the marketing influence (b) is higher, customers tend to require more products, the retailer will set a higher retail price because a good product/store image helps to increase its margin profit. Besides, the retail price decreases with the level that the bank weights

the retailer's initial investment in the marketing influence (δ), as well as decreases with the level that the bank weights the retailer's leadership status (θ). In other words, when the bank offers a low interest rate, the retailer's financing cost is low, hence the retailer can set a low retail price to attract more demand.

With (4)–(7), the retailer's demand, profits of the retailer and the supplier, the bank's revenue, and the retailer's financing cost are:

$$D^{R*} = \frac{1+b\alpha}{2(2+r_0-\theta-\delta\alpha)}, \quad (20)$$

$$\pi_R^{R*} = \frac{(1+b\alpha)^2}{4(2+r_0-\theta-\delta\alpha)} - \frac{k\alpha^2}{2}, \quad (21)$$

$$\pi_S^{R*} = \frac{(1+b\alpha)^2}{4(2+r_0-\theta-\delta\alpha)^2}, \quad (22)$$

$$R_F^{R*} = \frac{(1+b\alpha)^2(r_0-\theta\pm\delta\alpha)}{4(2+r_0-\theta-\delta\alpha)^2}, \text{ and} \quad (23)$$

$$C_F^{R*} = \frac{-(1+b\alpha)^2(1+r_0-\theta-\delta\alpha)}{4(2+r_0-\theta-\delta\alpha)^2}. \quad (24)$$

As discussed above, the retail price (p^{R*}) is related to the effort that the retailer puts into promoting the marketing influence. Equation (20) suggests that if the retailer puts more effort into promotion activities to maintain and improve its product/store image, more customers will purchase the products. The optimal result shows a positive relation between the customer's demand (D^{R*}) and the retailer's initial investment level (α) for more marketing influence. It is obvious that the supplier benefits from the retailer's investment because it can charge a high wholesale price and the retailer orders more product due to increase in demand. Moreover, since retail price (p^{R*}) increases with customer's perceived value on the retailer's effort in promoting its product (b), apparently, the profits of both retailer and supplier increase with b . Since the retailer's

financing cost increases with b , the bank's revenue increases as well. As the wholesale price (w^{R^*}) increases with the level that the bank weights the retailer's initial investment in the marketing influence (δ), as well as increases with level that the bank weights the retailer's leadership status (θ), the supplier's profit ($\pi_S^{R^*}$) increases with both δ and θ . The bank's revenue ($R_F^{R^*}$) decreases with both δ and θ as it gives the retailer a low interest rate if either δ is high or if the retailer is a leader in the supply chain.

4.2.2.2 The impact of retailer's initial investment level (α)

In this section, I use a numerical example to illustrate the impact of retailer's initial investment level on prices, demand, profits of the retailer and the supplier and the revenue of the bank in Fig. 3, for the Retailer Stackelberg supply chain. For comparison purpose, I set the same parameters as in 4.2.1.2.

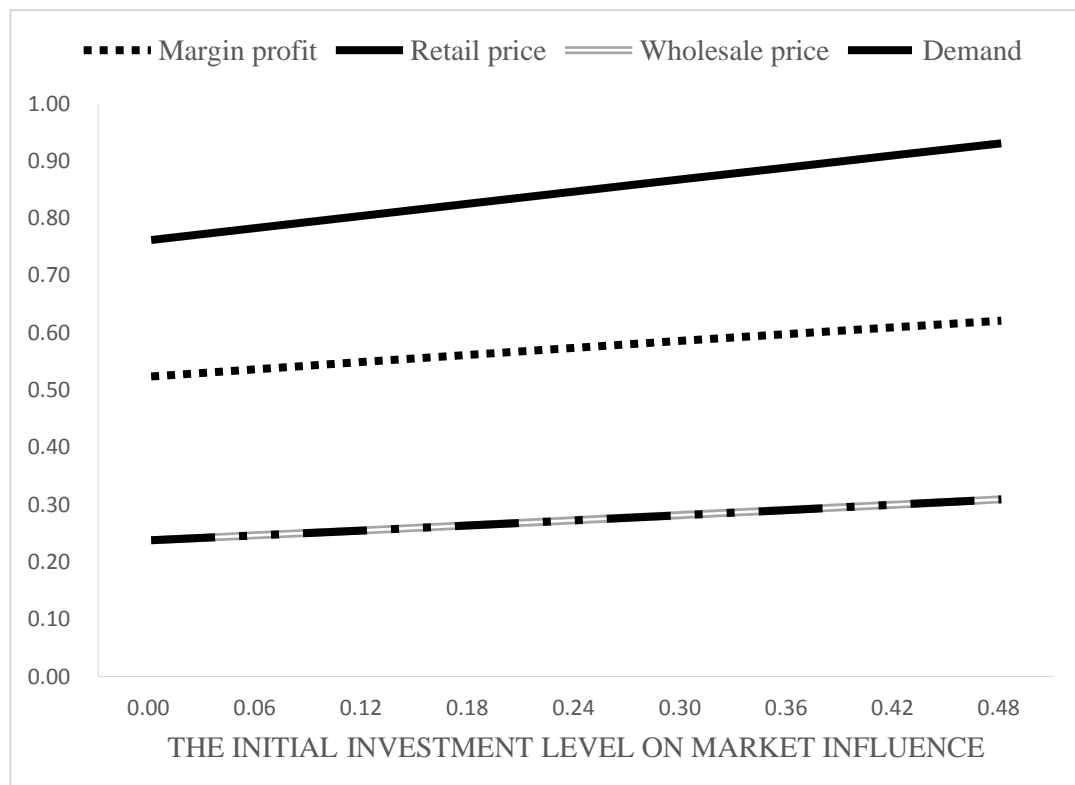


Fig 3. (a) The impact of α on p^{R*} , w^{R*} , m^{R*} , and D^{R*} under the Retailer Stackelberg supply chain

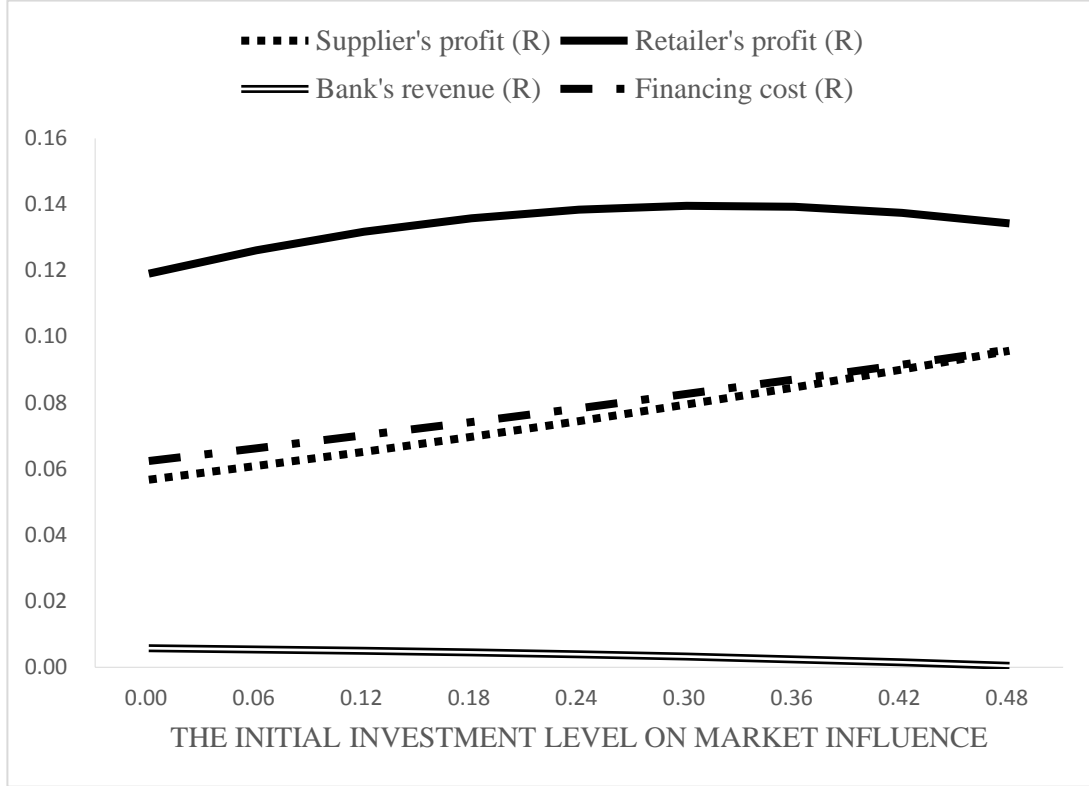


Fig 3. (b) The impact of α on π_S^{R*} , π_R^{R*} , R_F^{R*} , and C_F^{R*} under the Retailer Stackelberg supply chain

As discussed above, the wholesale price, w^{R*} , increases with the retailer's initial investment level (α). This suggests that as the retailer invests more in marketing influence, the supplier's wholesale price increases due to higher demand (D^{R*}). That is, both the wholesale price and customer demand increase with α . Therefore, supplier benefits from the retailer's investment in profit. As showed in Fig. 3, the retailer's financing cost increases with the higher wholesale price and demand. However, for the bank's revenue, it increases first when $\frac{2(2+r_0-\theta-\delta\alpha)}{\delta(1+b\alpha)} < 1$ and decreases when $\frac{2(2+r_0-\theta-\delta\alpha)}{\delta(1+b\alpha)} > 1$. After the point when $\alpha = 0.48$, bank's revenue decreases to zero and bank stops lending money to the retailer. Therefore, Fig. 3 illustrates the results within

the range from 0 to 0.48. From Fig. 3, it is obvious that both the retail price and its margin profit increases as the retailer invests more. This represents that the retailer can set a high retailer price to enhance its margin profit as more customers tend to purchase products from the retailer. However, in terms of the retailer's profit, the Fig. 3 shows that it increases with α first till reaches a maximum point and starts decreasing. This represents that with an increasing α , the retailer's profit increases due to higher demand from the customers. As α continue increases, however, the revenue from increasing sales cannot offset the increasing financing cost and investment cost, therefore the retailer's profit starts decreasing.

4.2.3 Bertrand-Nash Equilibrium ($l = B$)

4.2.3.1 General impact

With the margin profit ($m^B = p^B - w^B$), and (4)-(7), It can be proved that there exists a unique wholesale price (w^{B*}) and margin profit (m^{B*}) of the retailer. I find the following results:

Proposition 3: *There exists unique optimal margin profit and wholesale price (m^{B*}, w^{B*}) for the retailer and the supplier, which are given:*

$$w^{B*} = \frac{1+b\alpha}{3+r_0-\delta\alpha} \text{ and } m^{B*} = \frac{(1+b\alpha)(1+r_0-\delta\alpha)}{3+r_0-\delta\alpha}. \quad (25)$$

It is intuitive that both w^{B*} and m^{B*} increase with the customer's perceived value on retailer's effort in promoting its product (b). Since more customers purchase the products due to higher perceived value on retailer's effort (b), the retailer can gain a higher profit margin, which allows the supplier to charge a higher wholesale price.

Furthermore, w^{B*} increases with the level that the bank weights the retailer's initial investment in the marketing influence (δ) while m^{B*} decreases with δ , implying that if the bank weights the retailer's initial investment in marketing influence more, the retailer will have a lower financing cost and thus the supplier can set a higher wholesale price to enhance its revenue; therefore the margin profit (m^{B*}) of the retailer will decrease. Equation (25) shows that supplier's wholesale price increases with the retailer's initial investment level (α) as customers' demand is high due to retailer's promotion activities; therefore, the supplier can set a high wholesale price to increase profit margin. Also, retailer's profit margin will increase with α due to more demand from the customers.

With Proposition 3, the optimal retail price p^{B*} is:

$$p^{B*} = \frac{(1+b\alpha)(2+r_0-\delta\alpha)}{3+r_0-\delta\alpha}. \quad (26)$$

As shown in (25), m^{B*} increases with b , implying that if the customers' perceived value on retailer's effort (b) is higher, the retailer can gain a higher margin profit. Therefore, the retail price (p^{B*}) will increase. However, since m^{B*} decreases with the level that bank weighs the retailer's initial investment in the marketing influence (δ), retail price decreases with δ . That is, when bank offers a low interest rate and the retailer's financing cost is low, the retailer can set a low retail price to attract more demand.

With (4)–(7), the retailer's demand, profits of the retailer and the supplier, the bank's revenue, and the retailer's financing cost are:

$$D^{B*} = \frac{1+b\alpha}{3+r_0-\delta\alpha}, \quad (27)$$

$$\pi_R^{B*} = \frac{(1+b\alpha)^2}{(3+r_0-\delta\alpha)^2} - \frac{k\alpha^2}{2}, \quad (28)$$

$$\pi_S^{B*} = \frac{(1+b\alpha)^2}{(3+r_0-\delta\alpha)^2}, \quad (29)$$

$$R_F^{B*} = \frac{(1+b\alpha)^2(r_0-\delta\alpha)}{3+r_0-\delta\alpha}, \text{ and} \quad (30)$$

$$C_F^{B*} = \frac{(1+b\alpha)^2(1+r_0-\delta\alpha)}{(3+r_0-\delta\alpha)^3}. \quad (31)$$

As discussed above, the retail price (p^{B*}) is related to the effort that the retailer spends in promoting the marketing influence (b). Equation (27) suggests that if the retailer invests more through promotion activities to maintain and improve its product/store image, more customers will purchase the products. Moreover, since retailer price (p^{B*}) increases with customer's perceived value on retailer's effort in promoting its product (b), apparently, both the profits of the retailer and the supplier increase with b . Since the retailer's financing cost increases with b , the bank's revenue increases. The optimal result also shows a positive relation between the customer's demand (D^{B*}) and the retailer's initial investment level (α) for more marketing influence, which indicates that as the retailer invests more, more customers tend to buy. Equation (27) also shows that customers demand increases with the level that the bank weights the retailer's initial investment in the marketing influence (δ) as the retailer will set a low retail price due to low interest rate to attract more customers' demand. It is obvious that the supplier benefits from the retailer's investment because it can charge a higher wholesale price and the retailer orders more product due to the increase in demand. Since wholesale price (w^{B*}) will increase with the level that the bank weights

the retailer's initial investment in the marketing influence (δ), the supplier's profit (π_s^{B*}) increases with δ as well. The bank's revenue (R_F^{B*}) decreases with δ because it gives the retailer a low interest rate if δ is high.

4.2.3.2 The impact of retailer's initial investment level (α)

In this subsection, numerical examples are used to illustrate the impact of retailer's initial investment level on prices, demand, and profits of the retailer and the manufacturer, and the revenue of the bank in Fig. 4, when the supplier and the retailer play Bertrand Nash game. To comparison purpose, the same parameters are set as in 4.2.1.2.

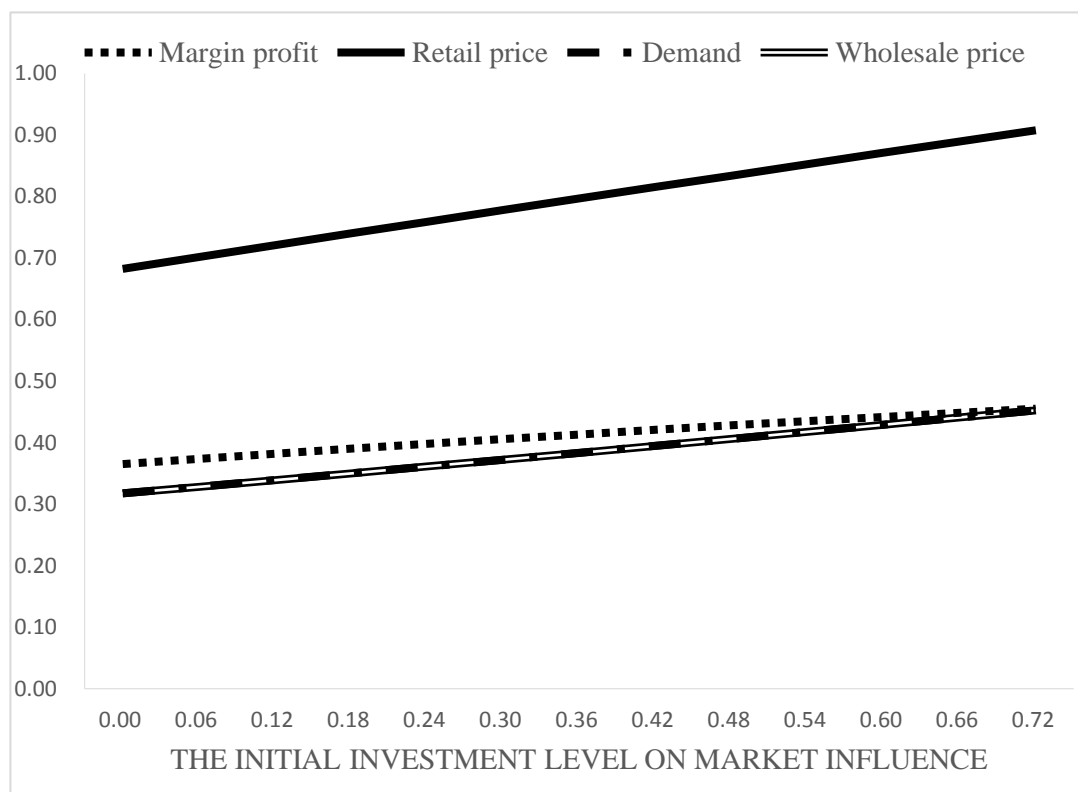


Fig 4. (a) The impact of α on p^{B*} , w^{B*} , m^{B*} , and D^{B*} under the Bertrand-Nash game supply chain

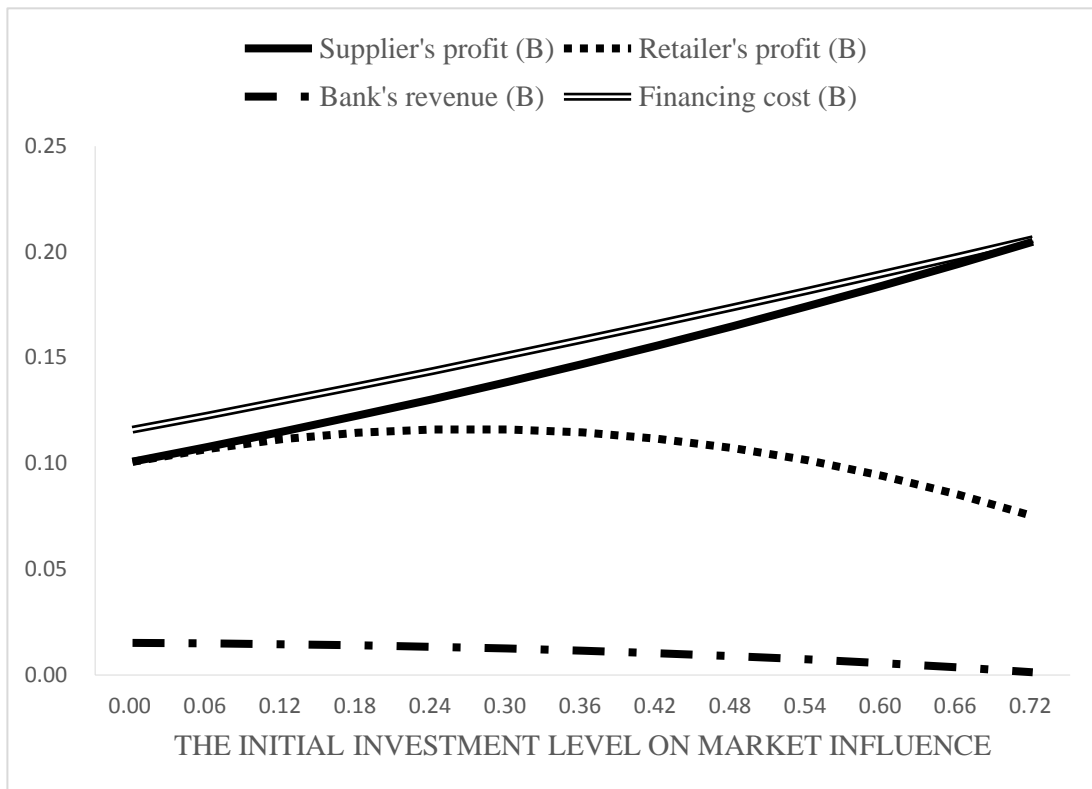


Fig 4. (b) The impact of α on π_S^{B*} , π_R^{B*} , R_F^{B*} , and C_F^{B*} under the Bertrand-Nash Game supply chain

As discussed above, both the wholesale price (w^{B*}) and the demand (D^{B*}) have a positive association with the level of the retailer's initial investment. Therefore, both the supplier's profit and the financing cost increases with α due to the higher wholesale price and customers demand. However, it is clear that the bank's revenue (R_F^{B*}) decreases as the retailer invests more. This represents that the effect of α on both the wholesale price and the demand cannot offset that effect on the interest rate from the bank, since the interest rate is relatively low under the Bertrand-Nash game supply chain. After the point when $\alpha = 0.72$, bank's revenue becomes zero. In other words, bank stops lending money to the retailer. Hence, Fig. 4 only includes the results between $\alpha = 0$ and $\alpha = 0.72$. Moreover, Fig. 4 shows that the retail price (p^{B*}) increases as the retailer invests more, implying that the retailer can set a high retail price due to the

increase in customers demand. In terms of the retailer's margin profit (m^{B*}), it increases with α . This represents the impact of level of retailer's initial investment level on the retail price is greater than that of on the wholesale price. Besides, Fig. 4 also indicates the retailer's profit (π_R^{B*}) increases first, after that the retailer's profit decreases. This represents that with an increasing α , the retailer's profit increases due to higher demand from the customers. However, as α further increases, the increasing sales revenue cannot offset the increasing financing cost and investment cost, therefore the retailer's profit starts decreasing.

4.3 Comparison for three retailer's leadership

In this subsection, I conduct numerical studies to illustrate how the retailer's leadership status affects its loan from the bank.

4.3.1 The impact of retailer's initial investment level (α)

In this subsection, I use numerical examples to illustrate the impact of the retailer's initial investment level on the retailer's profit (illustrated in Fig. 5), the supplier's profit (illustrated in Fig. 6), the revenue of the bank (illustrated in Fig. 7), and the financing cost (illustrated in Fig. 8). For easy comparison and illustration, parameters are set $b = 0.50$, $r_0 = 0.15$, $\theta = 0.05$, $\delta = 0.20$, and $k = 0.50$.

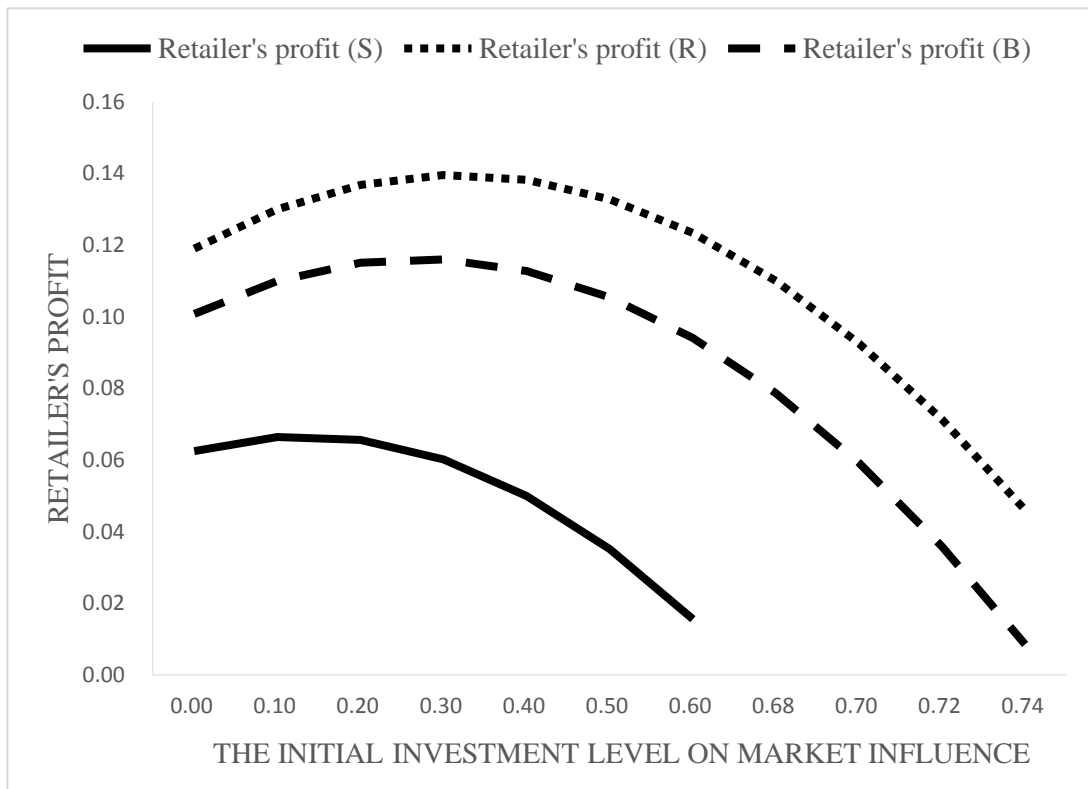


Fig 5. The impact of α on π_R under three supply chain structures

Interestingly, the retailer's profits under various supply chain structures have a similar pattern. The results are summarized as follows.

Observation 1:

- 1) *The retailer's profit increases first and then decreases with α no matter who is the leader in the supply chain;*
- 2) *When the retailer is the leader in the supply chain, it always benefits from being the first mover and gains the least profit from being the second mover;*
- 3) *The retailer's profit reaches the highest point when α is 0.32, 0.28, and 0.14 under games of the Retailer Stackelberg, the Nash Equilibrium, and under the Supplier Stackelberg, respectively. Let α_S , α_B , and α_R be these values. This numerical example shows $\alpha_S < \alpha_B < \alpha_R$;*

- 4) *When the supplier is the leader, the retailer will not invest on the marketing influence when α is 0.66.*

Based on the discussion, Observation 1 can be explained as: 1) the impact of marketing influence on the retailer's revenue is greater than the impact on both investment cost and financing cost when the retailer begins investing in its marketing influence. However, as the retailer invests more, the impact of α on the retailer's revenue is less than the impact on its costs. Hence the retailer's profit increases first and then decreases. This implies that it is not always the case that the more investment in promoting the marketing influence, the more benefit the retailer can gain. The retailer should balance the benefit from marketing expansion due to the promotion versus the cost; 2) when the retailer has more supply chain power, it receives a lower interest rate from the bank, therefore the retailer's profit can be enhanced; 3) when the retailer is the price leader in the supply chain, in addition to gaining higher profit, it has the highest profit when the retailer invests more on marketing influence; when the retailer is the price follower, however, it earns the highest profit when the retailer invests less on the marketing influence. This finding suggests the retailer should invest more to achieve the highest profit when it has more supply chain power, and invest less when it is the second mover in the supply chain; 4) the retailer will stop investing in marketing influence because it will not be profitable due to high investment cost.

The impact of retailer's initial investment level (α) on the supplier's profit (π_S) is illustrated by Fig. 6.

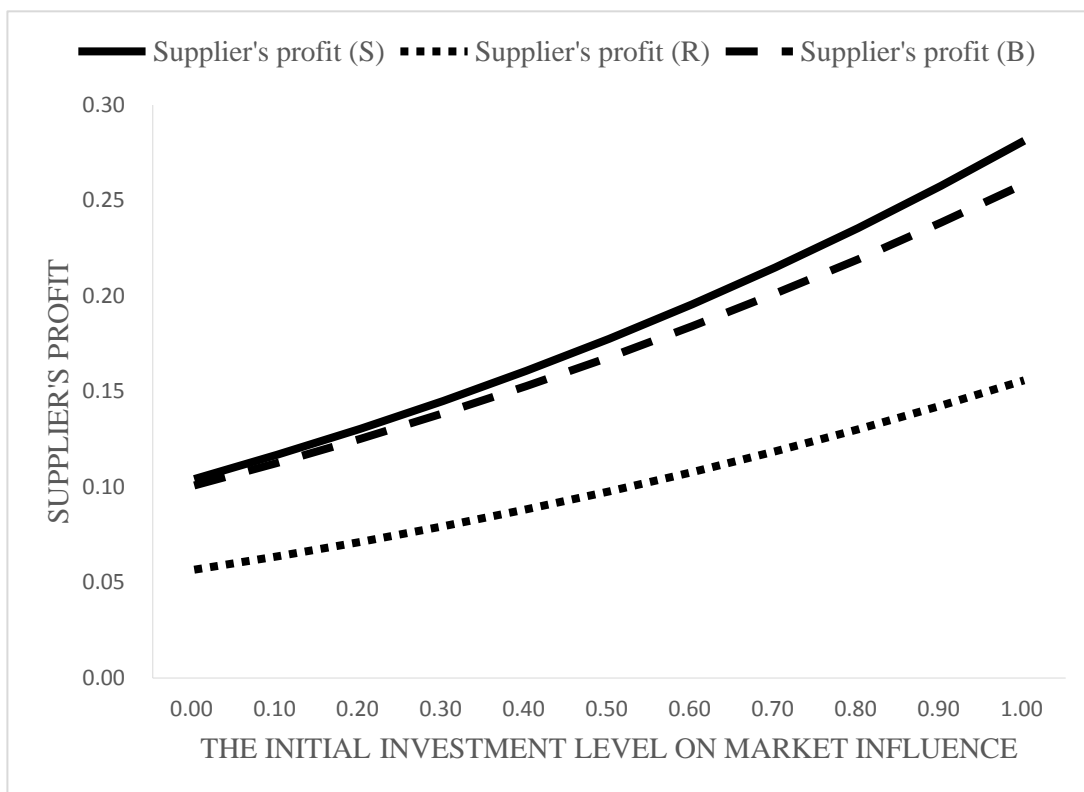


Fig 6. The impact of α on π_s under three supply chain structures

It is obviously that the supplier benefits more when the retailer invests more in improving its marketing influence. The interesting results are summarized in the following observation.

Observation 2:

- 1) *Under three conditions, the supplier's profit keeps increasing with α ;*
- 2) *When the supplier is the leader in the supply chain, as the retailer invests more on marketing influence, the supplier gains the highest profit, followed by in the Nash Equilibrium game and the Retailer Stackelberg game.*

These interesting results from Observation 2 can be explained as: 1) since both demand D and wholesale price w increase as the retailer invests more, the profit will increase as well no matter who is the leader in the supply chain; 2) the supplier benefits

a lot from being a first mover as it can set a higher wholesale price due to higher demand from both the retailer and customers.

The impact of the retailer's initial investment level (α) on bank's revenue (R_F) is illustrated by Fig. 7.

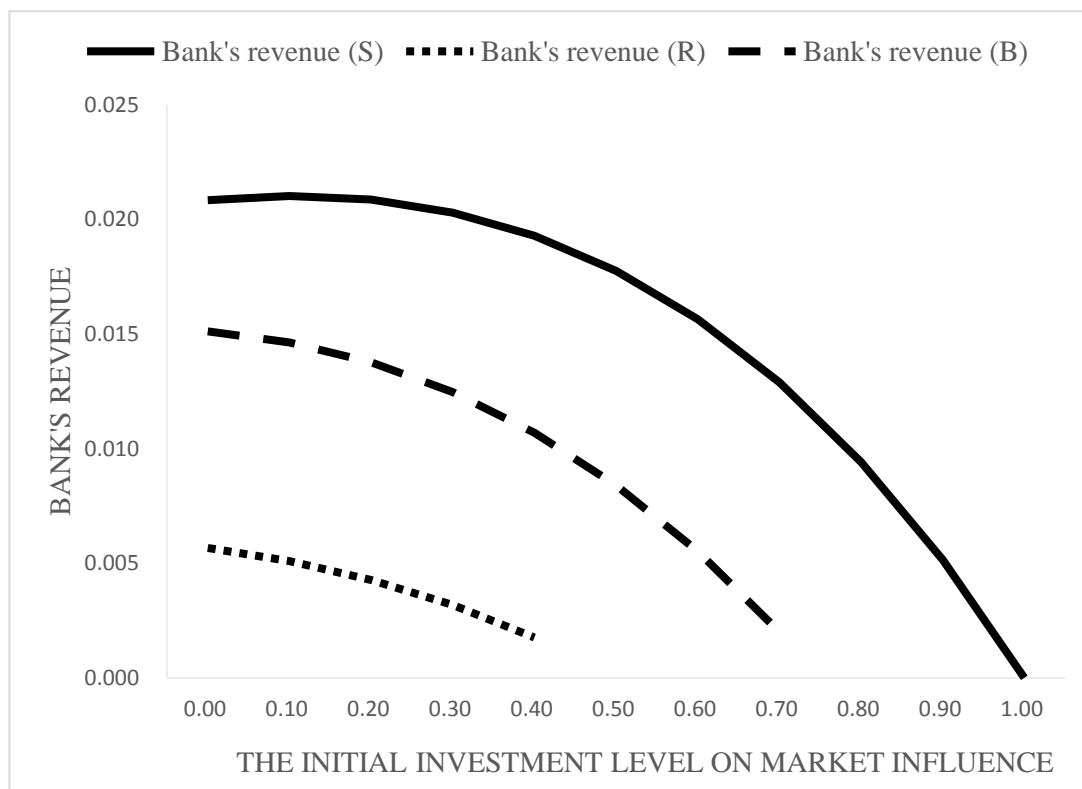


Fig 7. The impact of α on R_F under three supply chain structures

For the bank's revenue under three different games, the interesting results are summarized in the following Observation 3.

Observation 3:

- 1) *Bank's revenue under the Supplier Stackelberg increases first till reaches the maximum point (α is 0.28) and then decreases while bank's revenue keeps decreasing under the Retailer Stackelberg and the Nash Equilibrium;*
- 2) *When the retailer is the leader, bank will no longer lend money to the retailer when*

α is 0.48 while bank stops lending money to the retailer when α is 0.72 under the Nash Equilibrium;

- 3) Bank will earn the highest revenue when the retailer is the follower in the supply chain while it can have the lowest revenue when the retailer is the first mover.

These interesting results can be explained as: 1) when the retailer is the price follower and α is relatively low, bank observes the retailer's leadership status and initial marketing influence level, then offers a high interest rate; as the retailer invests more, bank offers a lower interest rate. Therefore, the bank's revenue increases first then decreases under the Supplier Stackelberg. On the other hand, when the retailer is the price leader and α is low, bank will offer a much lower interest rate due to the retailer's leadership status. Thus, the bank's revenue keeps decreasing under the Retailer Stackelberg. As the retailer invests more, bank will not lend money to the retailer as it is not profitable; 2) when the retailer is the leader, after bank observes its leadership status, bank offers an interest rate that is lower than the condition when it's the Supplier Stackelberg or the Nash Equilibrium. Therefore, bank will earn less revenue under the Retailer Stackelberg and eventually stop lending money to the retailer. 3) Bank prefers the retailer can be the follower in the supply chain because bank offers a high interest rate and receives high revenue.

The impact of the retailer's initial investment level (α) on its financing cost (C_F) is illustrated by Fig. 8.

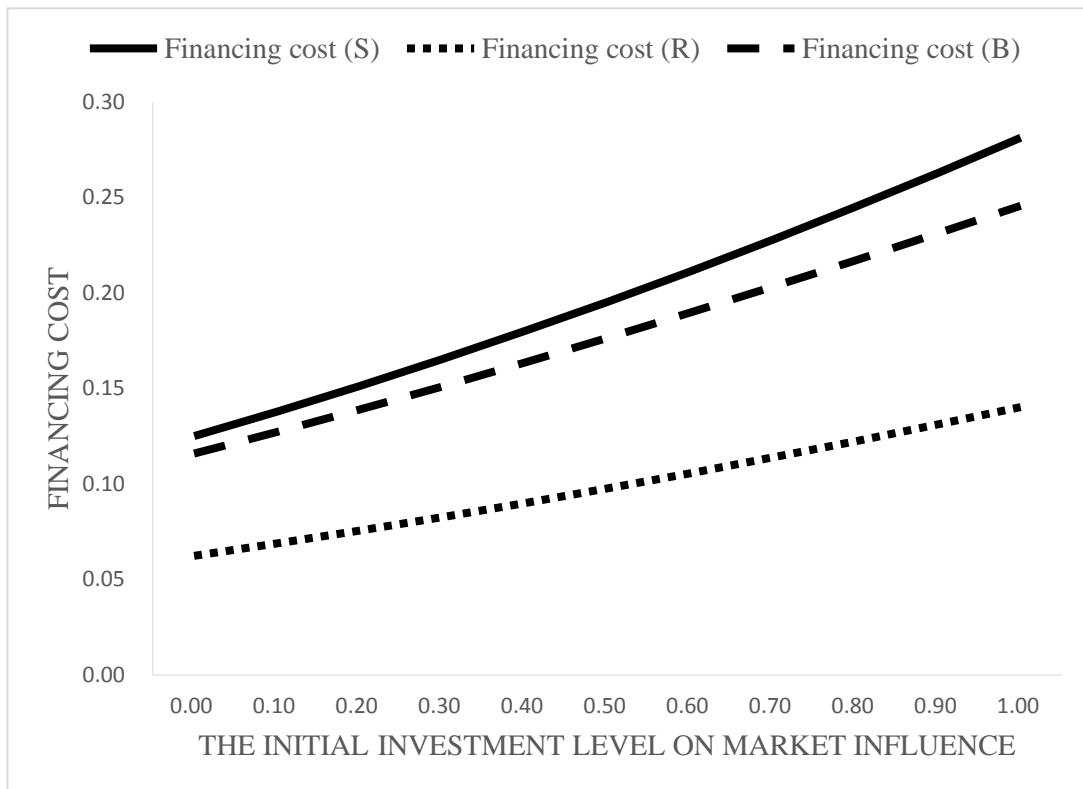


Fig 8. The impact of α on C_F under three supply chain structures

For the retailer's financing cost, the interesting results are summarized as follows.

Observation 4:

- 1) *Financing cost increases with α under three games;*
- 2) *The retailer incurs the highest financing cost under the Supplier Stackelberg games while experiencing the lowest financing cost when the retailer is the leader in the supply chain.*

Based on the discussion, I can explain the Observation 4 as: 1) when the retailer invests more on marketing influence, the financing cost is higher because the impact of α on both wholesale price and demand is greater than the impact of α on the bank's interest rate. Even if the bank offers a lower interest rate, with an increasing α , the financing cost still increases; 2) when the retailer has more power in the supply chain,

the bank observes the leadership status of the retailer and offers a lower interest rate.

Hence, the financing cost will be lower under the Retailer Stackelberg supply chain.

4.3.2 Hypotheses

This thesis focus on the impact of different factors on both the retailer's profit and financing cost. Hence, in this section, I develop my theoretical hypotheses based on the figures and observations above.

4.3.2.1 Retailer's profit

Hypotheses 1:

- 1) *All else equal, when α increases, the retailer's profit is non-linear with respect to retailer's initial investment level on marketing influence;*
- 2) *When the retailer is the leader in the supply chain, the retailer's profit is higher as compared to the retailer's profit if it is a follower.*

4.3.2.2 Financing cost

Hypotheses 2:

- 1) *The retailer has the lowest financing cost if it is the leader in the supply chain;*
- 2) *However, financing cost increases linearly with an increasing α .*

4.3.3 The impact of the importance of the retailer's marketing influence (b)

The impact of the importance of the retailer's marketing influence (b) that customers can observe is illustrated by numerical examples. The impact on the retailer's profit (illustrated in Fig. 9), the supplier's profit (illustrated in Fig. 10), the revenue of the bank (illustrated in Fig. 11), and the retailer's financing cost (illustrated in Fig. 12)

are also summarized. For easy comparison and illustration, I set $\alpha = 0.30$, $r_0 = 0.15$, $\theta = 0.05$, $\delta = 0.20$, and $k = 0.50$.

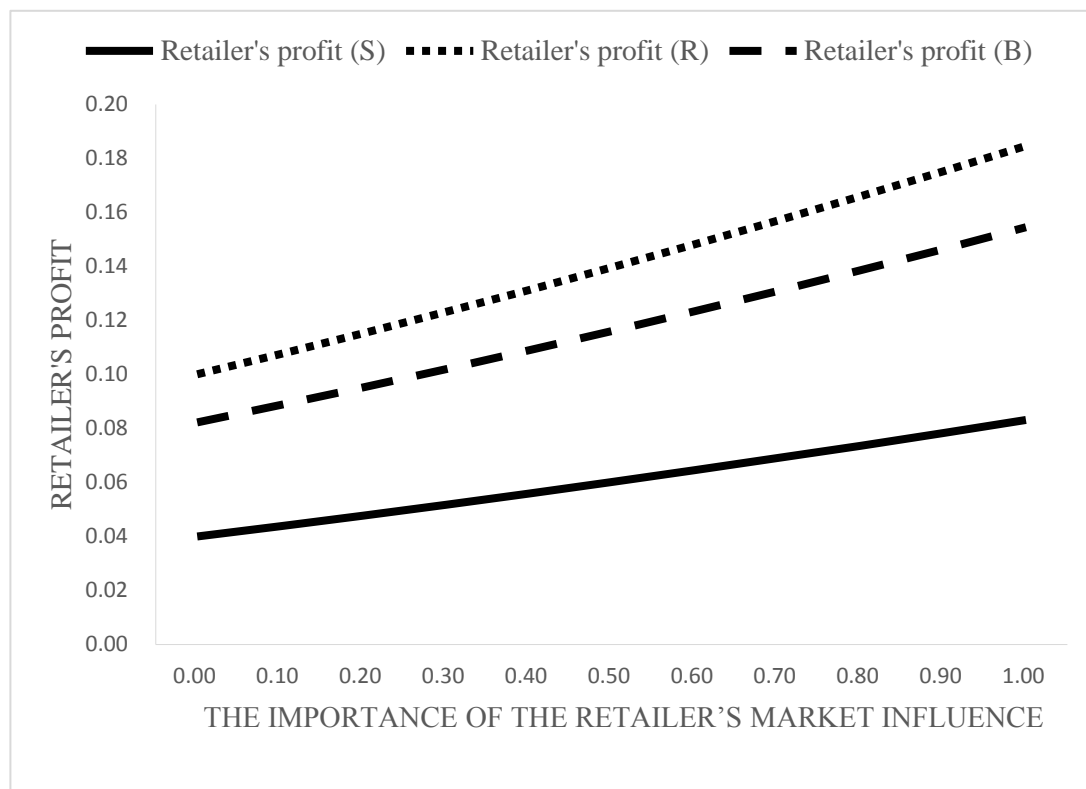


Fig 9. The impact of b on π_R under three supply chain structures

Interestingly, the retailer's profits under supply chain structures perform similarly.

The results can be summarized in Observation 5.

Observation 5:

- 1) *The retailer's profit increases with b under three games;*
- 2) *When the retailer is the leader in the supply chain, it always benefits from being the first mover and gains the least profit when it is the second mover.*

Observation 5 indicates that: 1) the retailer will gain more profit as consumers perceive that it puts more effort into promoting its marketing influence because customers' purchasing decisions are affected by the retailer's marketing influence; 2)

when the retailer has more power in the supply chain, the bank will offer a lower interest rate. Therefore, the profit will be higher under the Retailer Stackelberg supply chain.

The impact of the importance of the retailer's initial investment level (b) on the supplier's profit (π_S) is illustrated by Fig. 10.

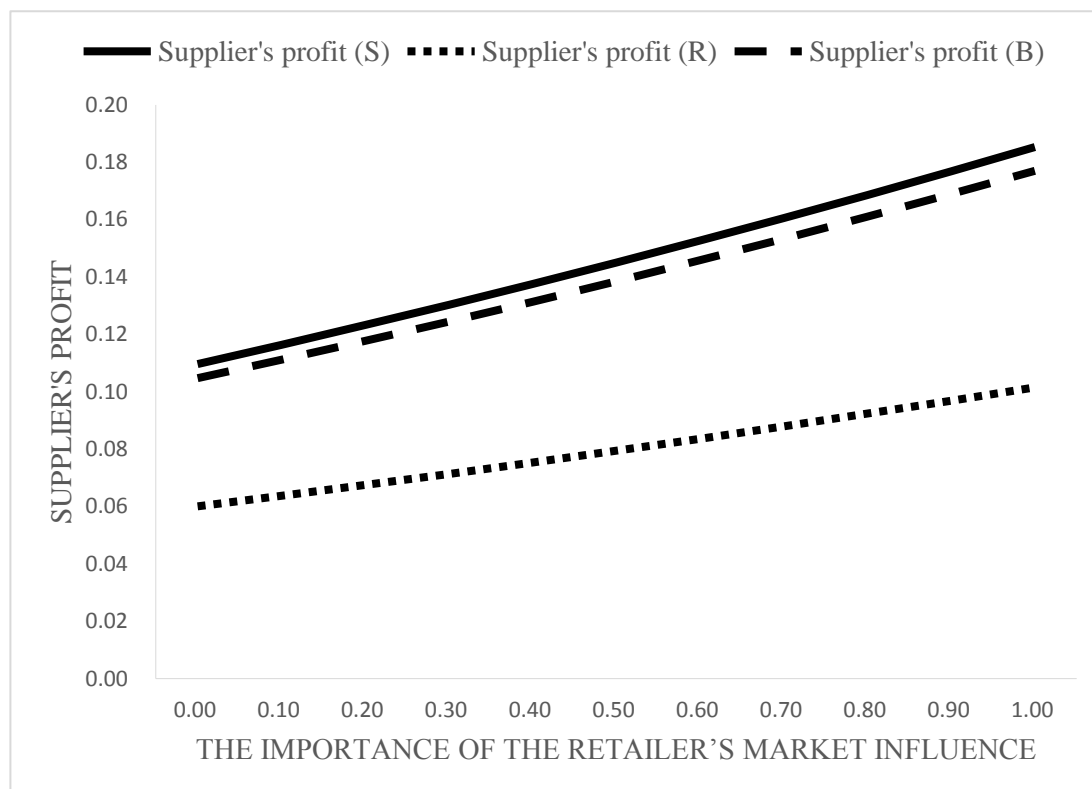


Fig 10. The impact of b on π_S under three supply chain structures

It is obviously that the supplier benefits more when the retailer puts more effort on its marketing influence. The interesting results are summarized in the following Observation 6.

Observation 6:

- 1) Under all three games, the supplier's profit increases with b ;
- 2) When the supplier is the leader in the supply chain, it always benefits from being the first mover to gain the highest profit and gains the least profit as the second

mover.

Based on the discussion, Observation 6 can be explained as: 1) since both demand D and wholesale price w increase as the retailer puts more effort on promoting its marketing influence, the supplier's profit increases no matter who is the leader in the supply chain; 2) when the supplier has more supply chain power, it has the right to set a higher wholesale price because of higher demand. Hence, the supplier's profit is higher under the Supplier Stackelberg supply chain.

The impact of the importance of the retailer's initial investment level (b) on the bank's revenue (R_F) is illustrated by Fig. 11.

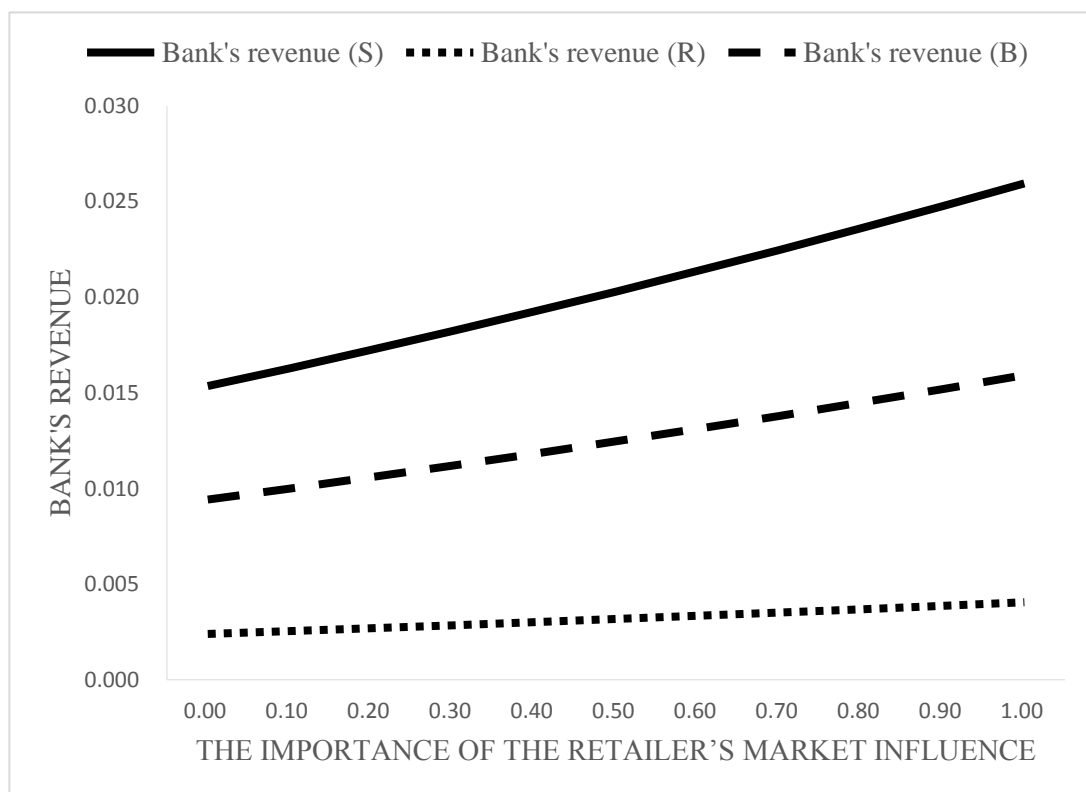


Fig 11. The impact of b on R_F under three supply chain structures

For the bank's revenue, the interesting results are summarized in Observation 7 as follows.

Observation 7:

- 1) *Under three conditions, the bank's revenue increases with b ;*
- 2) *When the retailer is the follower in the supply chain, the bank's revenue can gain the highest revenue while gaining the least revenue when the retailer is the leader.*

These interesting results can be explained as: 1) both demand D and wholesale price w increase as the customers perceive that retailer puts more effort on promoting its marketing influence. Hence, bank's revenue increases with b as well; 2) when the retailer has low supply chain power, bank will offer a high interest rate. However, when bank observes the retailer has more supply chain power, it offers a lower interest. Therefore, bank prefers the retailer can be the follower in the supply chain because bank can receive a high revenue by offering a high interest rate.

The impact of the importance of the retailer's initial investment level (b) on the financing cost (C_F) is illustrated by Fig. 12.

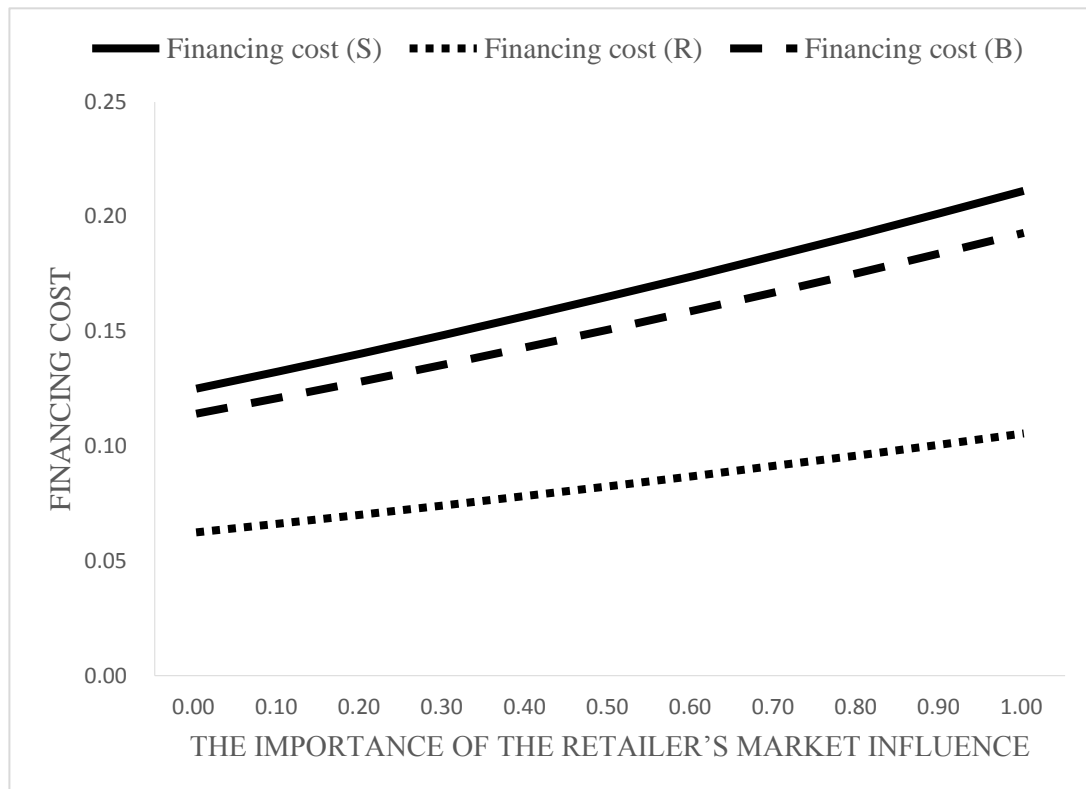


Fig 12. The impact of b on C_F under three supply chain structures

For the retailer's financing cost, the interesting results are summarized in the following Observation 8.

Observation 8:

- 1) *Financing cost increases with b under three conditions;*
- 2) *The retailer experiences the highest financing cost under the Supplier Stackelberg games while experiencing the lowest financing cost when it is the price leader in the supply chain.*

Observation 8 can be explained as: 1) both wholesale price and demand increase with b , thus, the financing cost of the retailer increases when customers observe that the retailer puts more effort on promoting its marketing influence; 2) when the retailer is the Stackelberg leader in the supply chain, the bank needs to offer a lower interest rate.

In this way, the retailer's financing cost is lower under the Retailer Stackelberg supply chain.

4.3.4 Hypotheses

This thesis investigates the impact of different factors on both the retailer's profit and financing cost. Hence, in this section, I develop theoretical hypotheses based on the discussions and observations above.

4.3.4.1 Retailer's profit

Hypothesis 3:

- 1) *All else equal, when b increases, the retailer's profit is positively linear with respect to retailer's effort on promoting marketing influence;*
- 2) *When the retailer is the leader in the supply chain, the retailer's profit is always higher as compared to the retailer's profit if it is a follower.*

4.3.4.2 Financing cost

Hypothesis 4:

- 1) *The retailer has the lowest financing cost if it is the leader in the supply chain;*
- 2) *Financing cost increases linearly with an increasing b .*

4.3.5 The impact of the level that the bank weighs the retailer's initial investment in the marketing influence (δ)

In this section, I use a numerical example to illustrate the impact of the level that the bank weighs the retailer's initial investment in the marketing influence on the retailer's profit (illustrated in Fig. 13), supplier's profit (illustrated in Fig. 14), the

revenue of the bank (illustrated in Fig. 15), and the financing cost (illustrated in Fig. 16). For easy comparison and illustration, I set $\alpha = 0.30$, $r_0 = 0.15$, $b = 0.50$, $\theta = 0.05$, and $k = 0.50$.

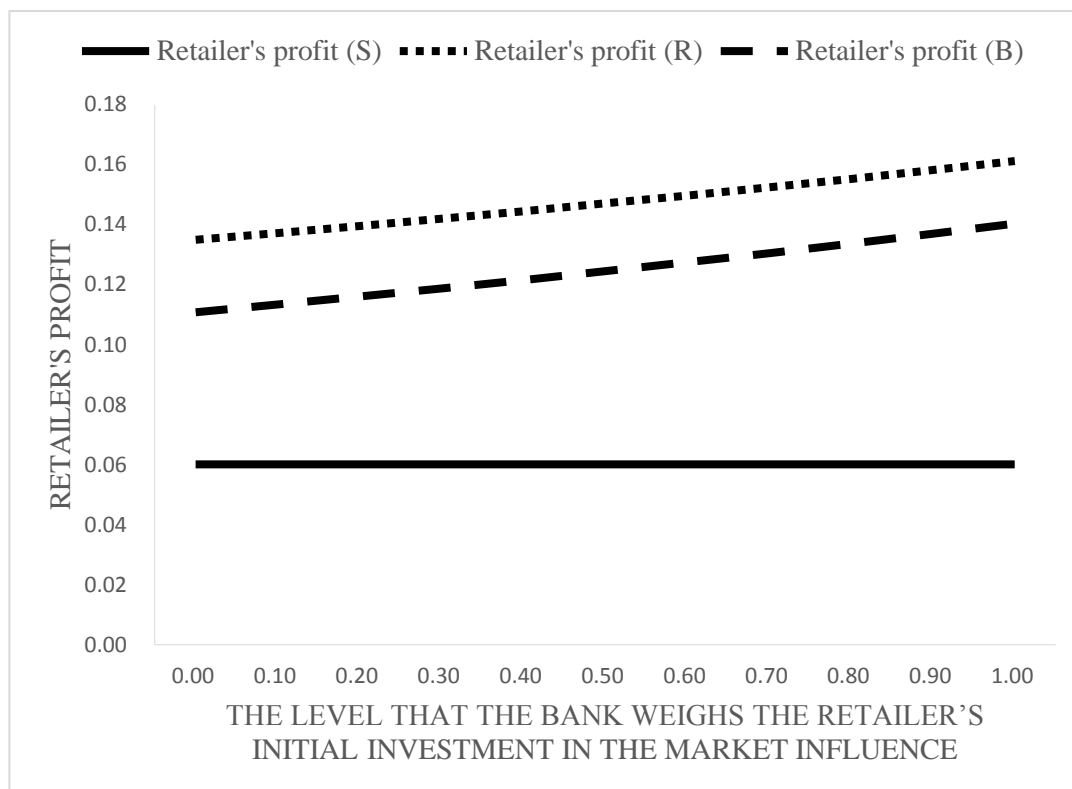


Fig 13. The impact of δ on π_R under three supply chain structures

Interestingly, the retailer's profits under supply chain structures do not have the similar performance. The results are summarized in Observation 9 as follows.

Observation 9:

- 1) *The retailer's profits increase with δ under the Retailer Stackelberg and the Nash Equilibrium while the retailer's profit does not change with δ when supplier is the price leader in the supply chain;*
- 2) *When the retailer is the leader in the supply chain, it always benefits from the first mover and gains the least profit from the second mover.*

Based on the discussion, Observation 9 can be explained as: 1) when the retailer is the Stackelberg leader, bank perceives its leadership status and offers a lower interest rate. Hence, the retailer's profit is increasing. Under the Supplier Stackelberg, the impact of the increasing wholesale price with δ offsets the impact of the decreasing interest rate with δ . Therefore, the retailer's profit does not change. This represents that even if the bank observes the retailer's initial investment on the marketing influence, if the retailer is the second mover in the supply chain, the profit will not change; 2) when the retailer has more power in the supply chain, bank offers a lower interest rate. Thus, the profit will be higher under the Retailer Stackelberg supply chain.

The impact of the level that bank weighs the retailer's initial investment level (δ) on the supplier's profit (π_S) is illustrated by Fig. 14.

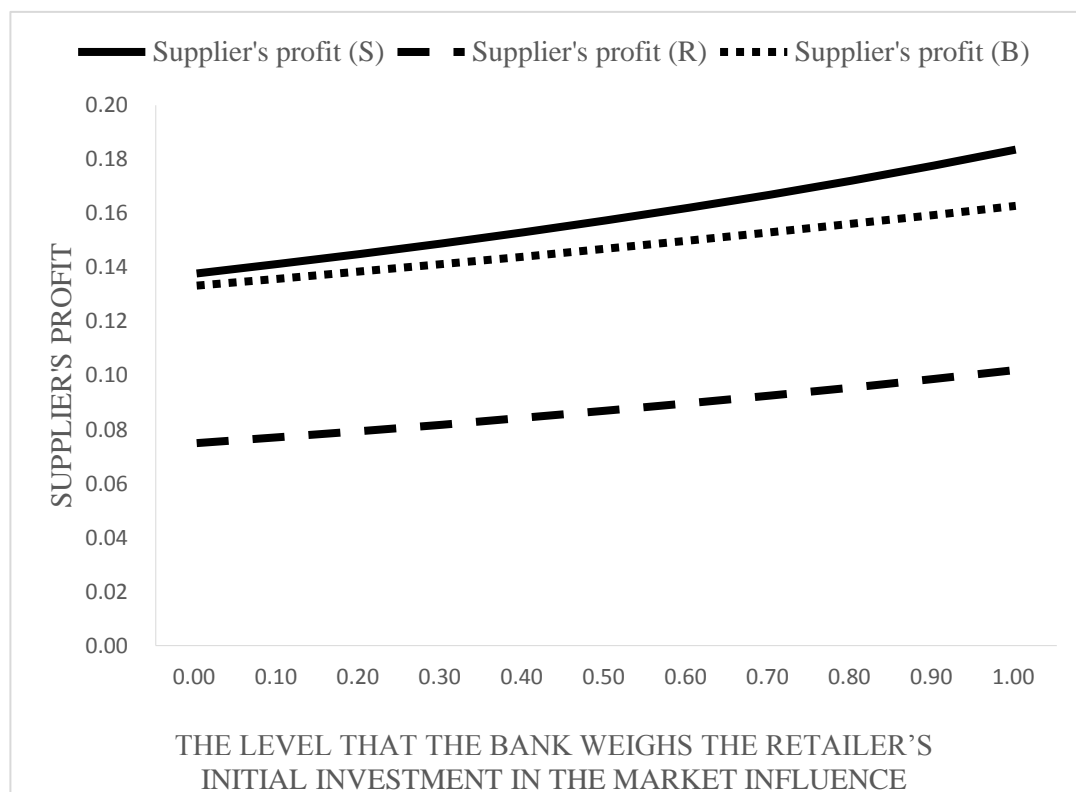


Fig 14. The impact of δ on π_S under three supply chain structures

It is obviously that supplier benefits a lot when bank weighs the level of the retailer's initial investment in the marketing influence more. The interesting results can be summarized in Observation 10 as follows.

Observation 10:

- 1) *Under three games, the supplier's profit keeps increasing with δ ;*
- 2) *When the supplier is the leader in the supply chain, it always benefits from the first mover to earn the highest profit and gains the least profit from the second mover.*

Observation 10 can be explained as: 1) since both demand D and wholesale price w increase as bank weighs more on the level of the retailer's initial investment in the marketing influence, the supplier's profit increases as well; 2) when the supplier is the supply chain leader, it always earns more profit through setting a high wholesale price due to higher demand.

The impact of the level that bank weighs the retailer's initial investment level (δ) on the bank's revenue (R_F) is illustrated by Fig. 15.

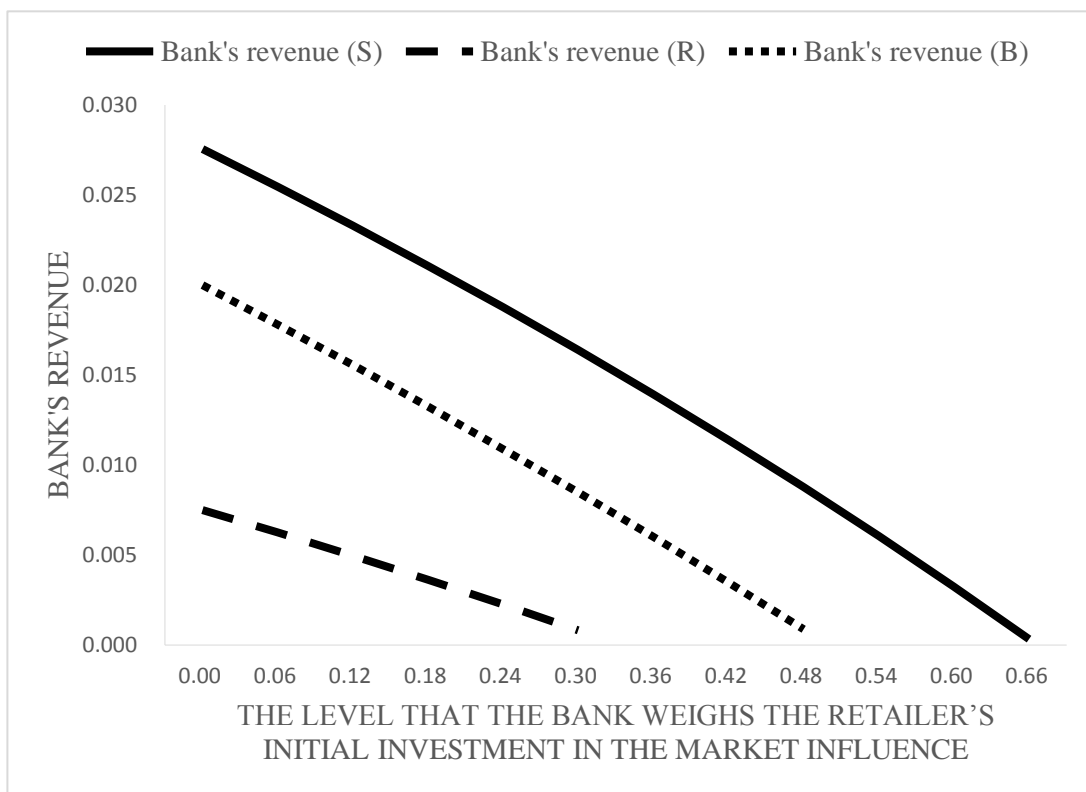


Fig 15. The impact of δ on R_F under three supply chain structures

In terms of bank's revenue, it shows similar performance under three different supply chain games, and the results can be summarized as follows.

Observation 11:

- 1) *Bank's revenue keeps decreasing under three conditions;*
- 2) *Bank's revenue has the highest value when the retailer is the second mover while has the lowest value when the retailer is the first mover in the supply chain;*
- 3) *Bank will not offer loan to the retailer when $\delta = 0.66$ under the Supplier Stackelberg, followed by $\delta = 0.50$ under the Nash Equilibrium and $\delta = 0.32$ under the Retailer Stackelberg.*

Based on Observation 11, the interesting results can be explained as: 1) as the bank observes that the retailer invests a lot in the marketing influence, the bank will offer a

lower interest rate, therefore the bank's revenue decreases no matter who is the Stackelberg leader; 2) this indicates that the bank prefers the retailer be the follower in the supply chain as it can receive a high revenue through offering a high interest rate; 3) the bank will not offer loan to the retailer when it is not profitable to do that.

The impact of the level that bank weighs the retailer's initial investment level (δ) on the financing cost (C_F) is illustrated by Fig. 16.

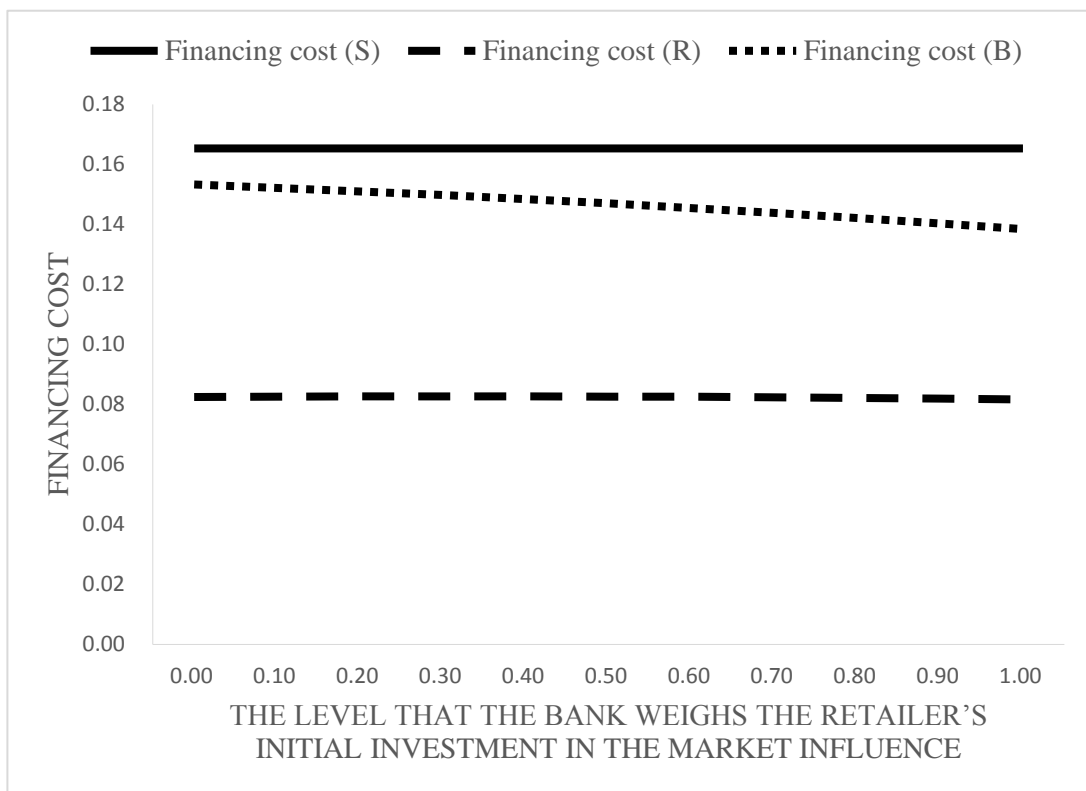


Fig 16. The impact of δ on C_F under three supply chain structures

For the retailer's financing cost, the interesting results can be concluded in the following Observation 12:

Observation 12:

- 1) *The retailer's financing cost increases with δ first till reaches its highest point (δ is 0.34) and then decreases under the Retailer Stackelberg while financing cost*

decreases with δ under the Nash Equilibrium. When the supplier is the leader, financing cost does not change with the level that bank weighs the retailer's investment in the marketing influence;

- 2) *The retailer's financing cost is the highest under the Supplier Stackelberg while it is the lowest when the retailer is the price leader in the supply chain.*

Observation 12 can be explained as: 1) even if the bank observes the retailer's investment level in the marketing influence, as a second mover, the retailer receives a relatively lower interest rate from the bank. With an increasing δ , the impact on a lower interest rate can offset the impact on a higher wholesale price and demand. Hence, the financing cost will not change under the Supplier Stackelberg. Also, under the Retailer Stackelberg, the bank observes the retailer's initial investment level and retailer's leadership status, it offers a low interest rate to the retailer. Besides, the impact of δ on both the wholesale price and the demand is larger than the impact of δ on bank's interest rate first, which makes the financing cost increases with δ . After the point when $\delta = 0.34$, the impact on the wholesale price and the demand is less than the impact of δ on the bank's interest rate, the retailer's financing cost decreases. When the supplier is in the Nash game with the retailer, the bank will offer a relatively low interest rate. Hence, the impact of δ on the wholesale price and the demand is less than the impact on the interest rate, which causes the retailer's financing cost decreases; 2) when the retailer has more power in the supply chain, its financing cost will be lower due to a lower interest rate from the bank.

4.3.6 Hypotheses

This research focus on the impact of different factors on both the retailer's profit and financing cost. Hence, in this section, I develop my theoretical hypotheses based on discussions and observations above.

4.3.6.1 Retailer's profit

Hypothesis 5:

- 1) *All else equal, the retailer's profit is positively linear with respect to the level that bank weighs the retailer's initial investment level on marketing influence under the Retailer Stackelberg and the Nash Equilibrium. However, the level that bank weighs the retailer's initial investment level on marketing influence does not affect the retailer's profit under the Supplier Stackelberg;*
- 2) *The retailer's profit is always higher when the retailer is the leader in the supply chain as compared to the retailer's profit if it is a follower.*

4.3.6.2 Financing cost

Hypothesis 6:

- 1) *The retailer's financing cost decreases linearly with δ under the Nash Equilibrium. However, its financing cost is non-linear with respect to the level that bank weighs the retailer's initial investment level on marketing influence under the Retailer Stackelberg. Under the Supplier Stackelberg, the increasing δ does not affect the financing cost;*
- 2) *The retailer always has the lowest financing cost if it is the leader in the supply*

chain.

4.3.7 The impact of the level that bank weighs on the retailer's leadership (θ)

In this section, I use a numerical example to illustrate the impact of the level that bank weighs on the retailer's leadership on the retailer's profit (illustrated in Fig. 17), the supplier's profit (illustrated in Fig. 18), the revenue of the bank (illustrated in Fig. 19), and the financing cost (illustrated in Fig. 20). For easy comparison and illustration, I set $\alpha = 0.30$, $r_0 = 0.15$, $b = 0.50$, $\delta = 0.20$, and $k = 0.50$.

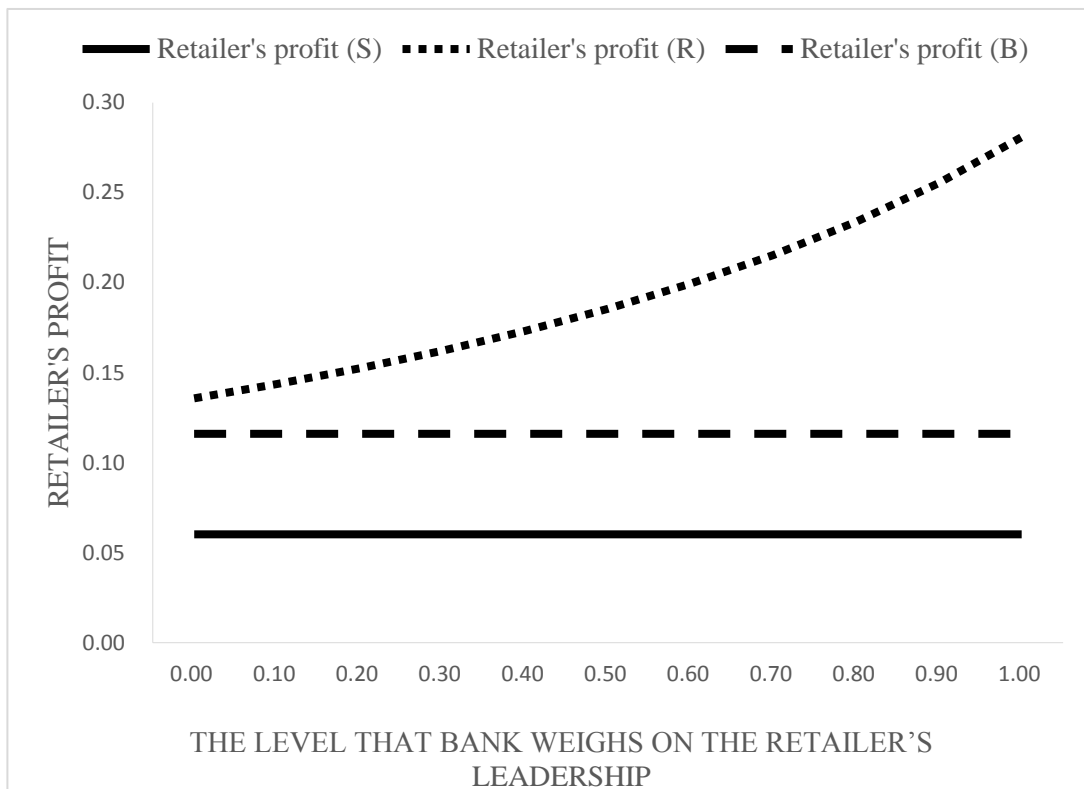


Fig 17. The impact of θ on π_R under three supply chain structures

Interestingly, the retailer's profits vary with different supply chain structures. The results can be summarized in Observation 13 as follows.

Observation 13:

- 1) *The retailer's profit increases with the level that bank weighs on the retailer's*

leadership status when the retailer is the leader. However, when the retailer is the follower or has the equal power with the supplier in the supply chain, the retailer's profit is unchanged with the level that bank weighs on the retailer's leadership status;

- 2) *When the retailer is the leader in the supply chain, it always benefits from the first mover and gains the least profit from the second mover.*

Based on the discussion, Observation 13 can be explained as: 1) the level that bank weighs on the retailer's leadership does not affect retailer's profit under the Supplier Stackelberg and the Nash Equilibrium. When the retailer is the Stackelberg leader, bank offers a lower interest rate. Therefore, the retailer's profit increases when bank perceives the leadership status of retailer more. 2) when the retailer is the Stackelberg leader in the supply chain, it can gain more profit for a lower interest rate.

The impact of the level that bank weighs the retailer's leadership status (θ) on the supplier's profit (π_S) is illustrated by Fig. 18.

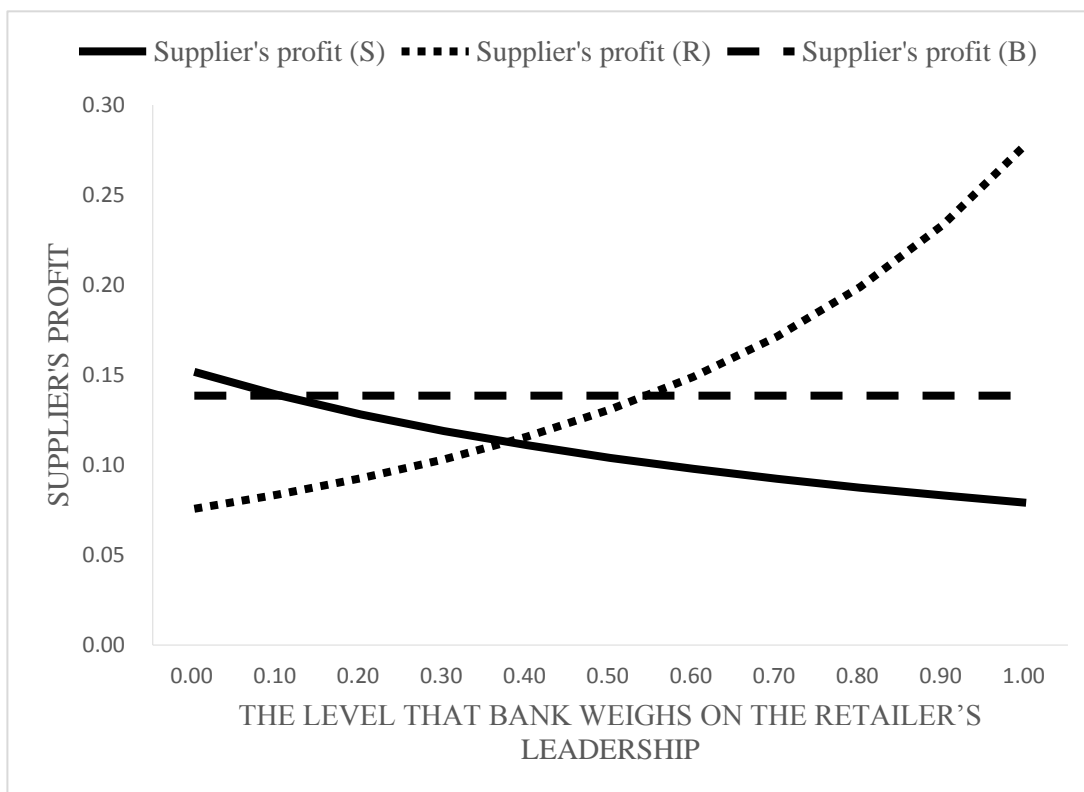


Fig 18. The impact of θ on π_S under three supply chain structures

When it comes to the supplier's profit, the interesting results can be summarized in the following Observation 14.

Observation 14:

- 1) *Under the Supplier Stackelberg, the supplier's profit keeps decreasing with θ , while keeps increasing under the Retailer Stackelberg. Moreover, the supplier's profit keeps unchanged with θ when it has the equal power with the retailer in the supply chain;*
- 2) *Initially, the supplier's profit under the Supplier Stackelberg is higher than that of under the Retailer Stackelberg. However, as the bank perceives the retailer's high leadership status (when θ is sufficiently high, $\theta > 0.38$ in the numerical example), the supplier's profit under Retailer Stackelberg is eventually higher than that of*

under the Supplier Stackelberg.

Observation 14 can be explained as: 1) since both the wholesale price (w) and the demand (D) increase with level of the bank weighs the retailer's leadership status under the Retailer Stackelberg, the supplier can earn more profit. Besides, since the wholesale price (w) decreases with level of bank weighs the retailer's leader status under the Supplier Stackelberg, the supplier's profit decreases as well; 2) under the Retailer Stackelberg supply chain, when the bank observes the a high level of retailer's leadership status, it will offer a lower interest rate to the retailer. Therefore, the retailer can set a lower retail price in order to attract the customers. As the demand is higher, the retailer will order more from the supplier. In this way the supplier can earn more profit, as compared to the game when the supplier is the Stackelberg leader in the supply chain.

The impact of the level that bank weighs the retailer's leadership status (θ) on the bank's revenue (C_F) is illustrated by Fig. 19.

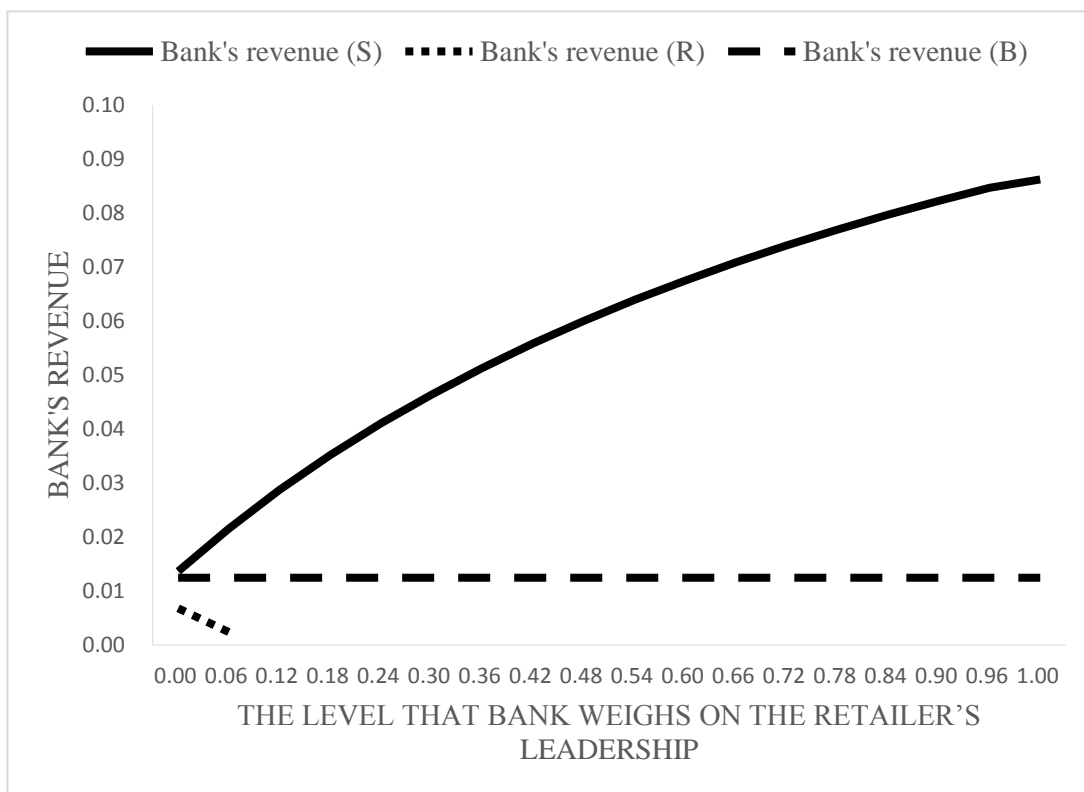


Fig 19. The impact of θ on R_F under three supply chain structures

In terms of the bank's revenue, it differs a lot under three different conditions, and the results can be summarized in Observation 15 as follows.

Observation 15:

- 1) *Under the Supplier Stackelberg, the bank's revenue keeps increasing with θ while keeps decreasing as the bank observes a high level of retailer's leadership status under the Retailer Stackelberg. Moreover, the bank's revenue does not change with θ in the Nash Equilibrium;*
- 2) *The bank's revenue is the highest when the retailer is the second mover while is the lowest when the retailer is the first mover in the supply chain;*
- 3) *Bank's revenue becomes zero after $\theta = 0.08$ under the Retailer Stackelberg supply chain.*

Based on Observation 15, the interesting results can be explained as: 1) when retailer is the second mover in the supply chain, the bank observes its leadership status and offers a high interest rate. Hence the bank's revenue increases with θ . When the retailer becomes the first mover, bank offers a lower interest rate instead. Therefore, even both the wholesale price and the demand increase with θ under the Retailer Stackelberg supply chain, with a low interest rate, the bank's revenue decreases with θ ; 2) this indicates that the bank prefers the retailer be the follower in the supply chain because it can receive a high revenue by offering high interest rate; 3) when retailer is the Stackelberg leader and θ sufficiently high ($\theta > 0.08$ in this numerical study), the bank is unwilling to offer loan to the retailer as it is not profitable.

The impact of the level that bank weighs the retailer's leadership status (θ) on the financing cost (C_F) is illustrated by Fig. 20.

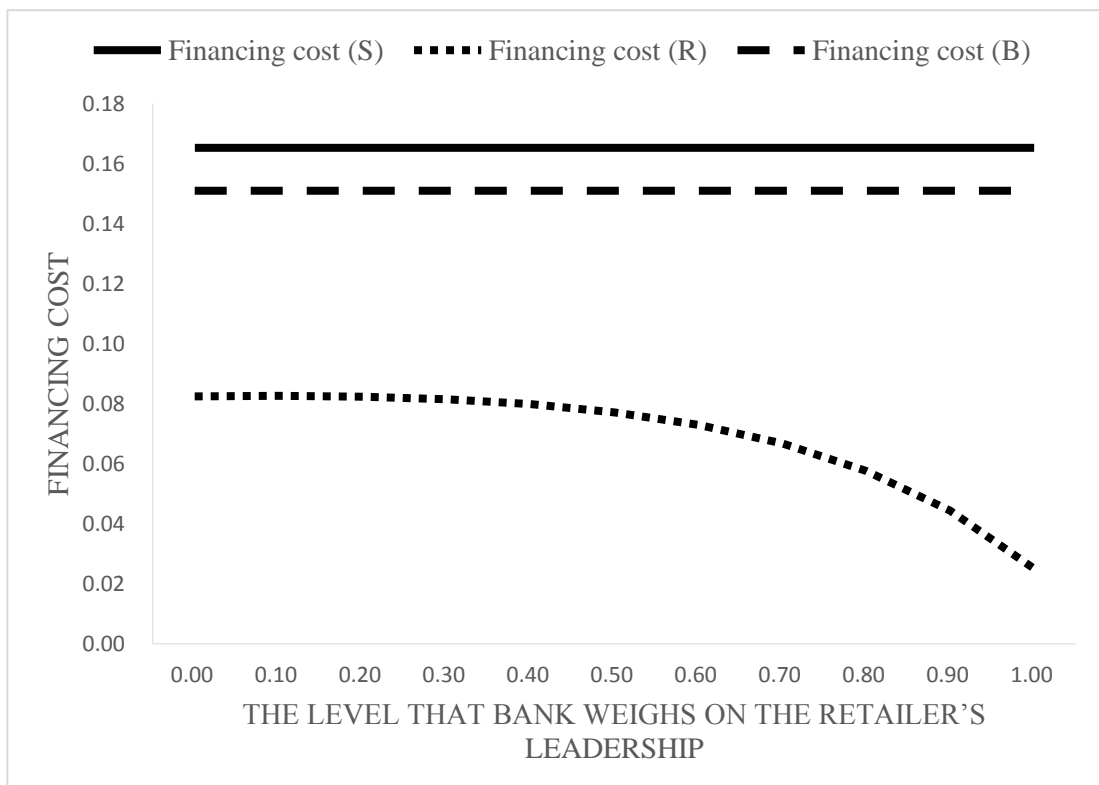


Fig 20. The impact of θ on C_F under three supply chain structures

For the retailer's financing cost, some interesting results can be concluded in the following Observation 16.

Observation 16:

- 1) *The retailer's financing cost increases with θ first till reaches the highest point (when θ is sufficiently high, $\theta = 0.08$ in this numerical example), then decreases with θ under the Retailer Stackelberg, while it keeps unchanged with θ under the Supplier Stackelberg and the Nash Equilibrium;*
- 2) *The retailer's financing cost is the highest under the Supplier Stackelberg while is the lowest when the retailer is the price leader in the supply chain.*

Observation 16 can be explained as: 1) even as bank observes retailer's leadership status more, it does not help the retailer to reduce its financing cost when retailer is the second mover. On the other hand, the financing cost increases first under the Retailer Stackelberg because both the wholesale price and the demand increase with θ . However, when the bank observes a high level of retailer's leadership status, the financing cost of the retailer starts decreasing due to a lower interest rate; 2) when the retailer is the leader and moves first in the supply chain, its financing cost will be lower as the interest rate from the bank is lower.

4.3.8 Hypotheses

This study tests the impact of different factors on both the retailer's profit and financing cost. Hence, in this section, I develop my theoretical hypotheses based on the discussions and observations above.

4.3.8.1 Retailer's profit

Hypothesis 7:

- 1) *All else equal, the retailer's profit is positively linear with respect to the level that bank weighs on the retailer's leadership under the Retailer Stackelberg while θ does not affect the retailer's profit under the Supplier Stackelberg and the Nash Equilibrium;*
- 2) *The retailer's profit is higher when the retailer is the leader in the supply chain as compared to the retailer's profit if it is a follower.*

4.3.8.2 Financing cost

Hypothesis 8:

- 1) *The retailer's financing cost decreases linearly with the increasing θ under the Retailer Stackelberg and remains unchanged under the Supplier Stackelberg and the Nash Equilibrium;*
- 2) *The retailer always has the lowest financing cost if it is the leader.*

4.3.9 The impact of the accelerating rate in the investment cost (k)

In this section, I use a numerical example to illustrate the impact of the accelerating rate in the investment cost on the retailer's profit (illustrated in Fig. 21) only since k does not affect the value of the supplier's profit, the bank's revenue, or the financing cost. For easy comparison and illustration, I set $\alpha = 0.30$, $r_0 = 0.15$, $b = 0.50$, $\delta = 0.20$, and $\theta = 0.05$.

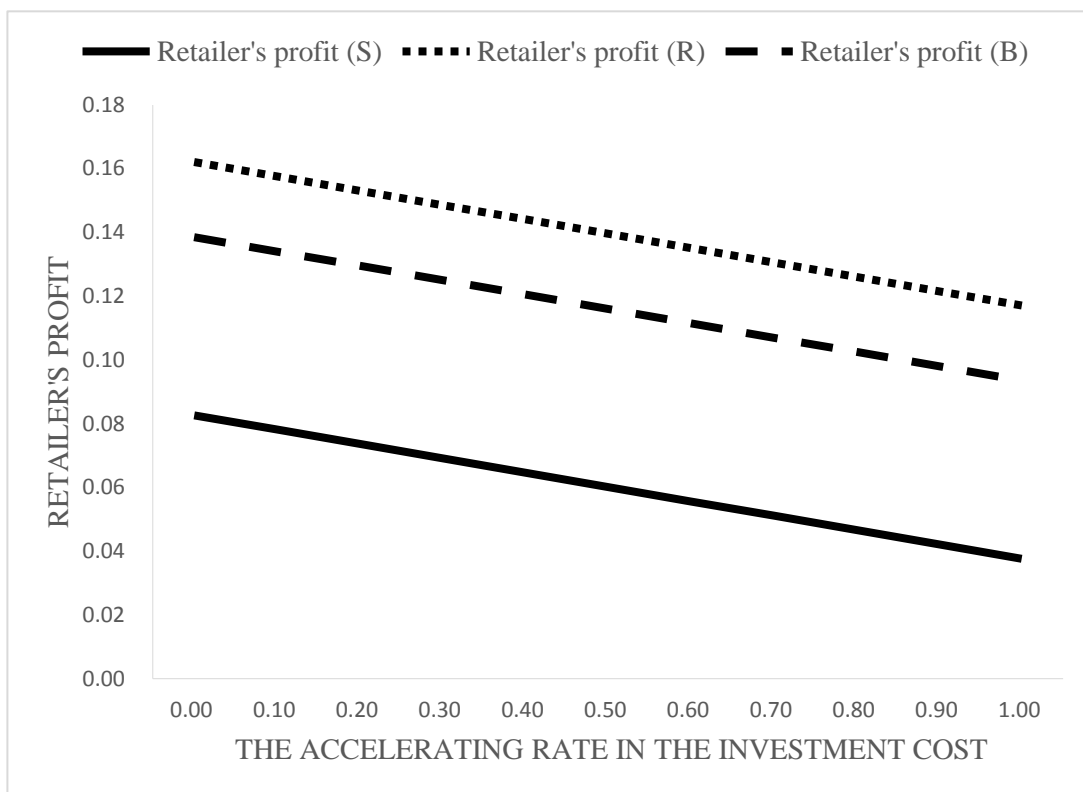


Fig 21. The impact of k on π_R under three supply chain structures

Interestingly, the retailer's profits have a similar pattern under different supply chain structures. The results are summarized in Observation 17 as follows.

Observation 17:

- 1) *The retailer's profits decrease with k under three games;*
- 2) *When the retailer is the leader in the supply chain, it always benefits from the first mover and gains the least profit from the second mover, as k increases.*

Based on the discussion, Observation 17 can be explained as: 1) due to a higher accelerating rate on the investment cost and all else equal, the retailer's profit decreases quicker with k no matter who is the Stackelberg leader in the supply chain; 2) when the retailer is the price leader, it receives a lower interest rate from the bank. Thus, the retailer earns a higher profit under the Retailer Stackelberg.

4.3.10 Hypotheses

This thesis focus on the impact of different factors on both the retailer's profit and financing cost. Hence, in this section, I develop my theoretical hypotheses based on the discussions and observations above.

4.3.10.1 Retailer's profit

Hypothesis 9:

- 1) *All else equal, the retailer's profit is negatively linear with respect to the accelerating rate in the investment cost;*
- 2) *The retailer's profit is always higher when retailer is the leader in the supply chain as compared to the retailer's profit if it is a follower.*

Chapter 5 Empirical evidence

5.1 Data description

The dataset is constructed from COMPUSTAT. The financial information of suppliers and customers is obtained from the COMPUSTAT customer segment database. The dataset spans 1950 to 2017, with the main financial variables largely occurring between the years 1985 and 2014. After using a name-matching algorithm, the unique identification information for suppliers and their customers (retailers) can be found and a dataset containing financial information of retailers and their suppliers in each year can be developed. The market share of the retailers from largest to smallest in each industry for each year is ranked. Thus, the top 20% and the bottom 20% are identified as the market leader and the market follower, respectively. Based on the availability of data, I restrict the empirical analysis to 2,856 companies from 359 different types of industries. It is noted that all variables are winsorized at the 1st and 99th percentiles.

5.2 Variables

5.2.1 Dependent variables

Based on the hypotheses developed in Chapter 4, I will determine how the retailer's profit and the financing cost will react in various conditions. Five measurements have been established for the retailer's profit. I first use the earnings before interest and taxes (*EBIT*) divided by the sales (*SALE*) of the retailers; this is a measurement of operating profit (denoted as *OP1*, $OP1 = \frac{EBIT}{SALE}$). Secondly, earnings before the interest (*EBITDA*) divided by sales (*SALE*) would be another measurement of operating profit. I denote

this as $OP2$ ($OP2 = \frac{EBITDA}{SALE}$). Moreover, I identify the return on asset (ROA) either by calculating earnings before interest ($EBITDA$) divided by the total assets (AT), which is $ROA1 = \frac{EBITDA}{AT}$; or by calculating net income (NI) divided by the total assets (AT), which is $ROA2 = \frac{NI}{AT}$. Finally, the net income divided by the total stockholders' equity (SEQ) provides the measurement of the return on equity ($ROE = \frac{NI}{SEQ}$).

I use the cost of debt to represent the retailer's financing cost, which can be calculated directly by the summation of the total debt in the current liability (DLC), the total interest and related expense ($XINT$) and the total long-term debt ($DLTT$). The equation of the cost of debt (COD) can be found as follow:

$$COD = DLT + XINT + DLTT. \quad (32)$$

All the dependent variables are normalized by dividing by the total assets (AT).

5.2.2 Independent variables

According to the hypotheses developed in Chapter 4, three factors that affect the retailer's profit as well as its financing cost need to be investigated: the initial investment level on the marketing influence (α), the level that customer can perceive on retailer's effort on promoting its marketing influence (b), and the accelerating rate of the investment cost (k).

I measure retailer's initial investment level on the marketing influence by using the advertising expense (XAD). The goodwill ($GDWL$) can represent the brand value that customers perceive for the retailer's products. For the accelerating rate in the investment cost, I first find difference between the gross property, plant and equipment ($PPEGT$)

and the net property, plant and equipment (*PPENT*), and then divide the difference by the gross property, plant and equipment. The equation of accelerating rate of the investment cost can be listed as:

$$k = \frac{PPEGT - PPENT}{PPEGT}. \quad (33)$$

Similar to dependent variables, I also normalized all the independent variables by the total assets (*AT*).

5.3 Empirical framework of analysis

After exploring on empirical study methods, I determine the regression methodology as the tool to start the empirical investigation. The basic regression model is as follow:

$$Y_1 = f(X_i) = f(\alpha, b, k) = \beta_0 + \beta_1 X_1 + e, \quad (\text{Model 1}) \quad (34)$$

$$\text{or } = \beta_0 + \beta_1 X_1 + \beta_2 X_2^2 + e, \quad (\text{Model 2}) \quad (35)$$

$$\text{or } = \beta_0 + \beta_1 X_1 + \mu_1 + e, \quad (\text{Model 3}) \quad (36)$$

where Y_1 is the dependent variable, while X_i are the independent variables.

One of the crucial assumptions is based on the normality of the data. To achieve normality, after conducting some initial graphical tests that are not reported here due to space constraints, I establish that winsorization of the variables would be significant to eliminate any outliers in the dataset. For convenience, it is essential to note that all tests and analyses are performed after being winsorized and normalized to all the variables.

5.3.1 Empirical result: the initial investment level on marketing influence (α)

I first test the influence of α on the retailer's profit (π_R) and its financing cost (C_F) when retailers are either the market leaders or market followers. To best verify the hypotheses, I use log transformation for the independent variable (α). After I establish that log transformation is the appropriate tool to ensure normality of independent variables in the dataset, I conduct further empirical tests.

The estimation results from the previous hypotheses are: 1) all else equal, when α increases, the retailer's profit is non-linear with respect to retailer's initial investment level on marketing influence; 2) when the retailer is the leader in the supply chain, its profit is higher.

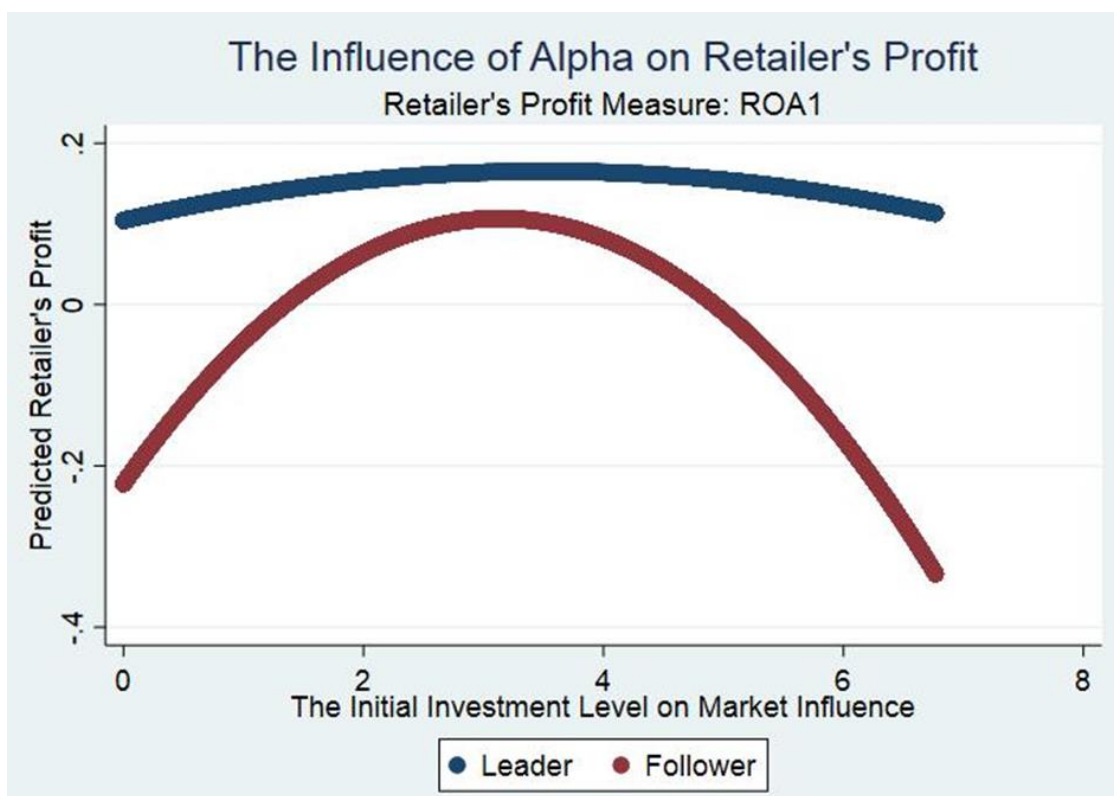


Fig 22. The empirical result: the influence of α on π_R (ROA1)

Fig. 22 illustrates the relationship between the retailer's initial investment level and profit. The retailer's profit is measured as the return on asset in this case. The results

indicate that when the retailer is the leader in the supply chain, it can gain higher profit, as compared with the profit if it is a follower. Moreover, the retailer's profit increases with its initial investment level on marketing influence first and then decreases.

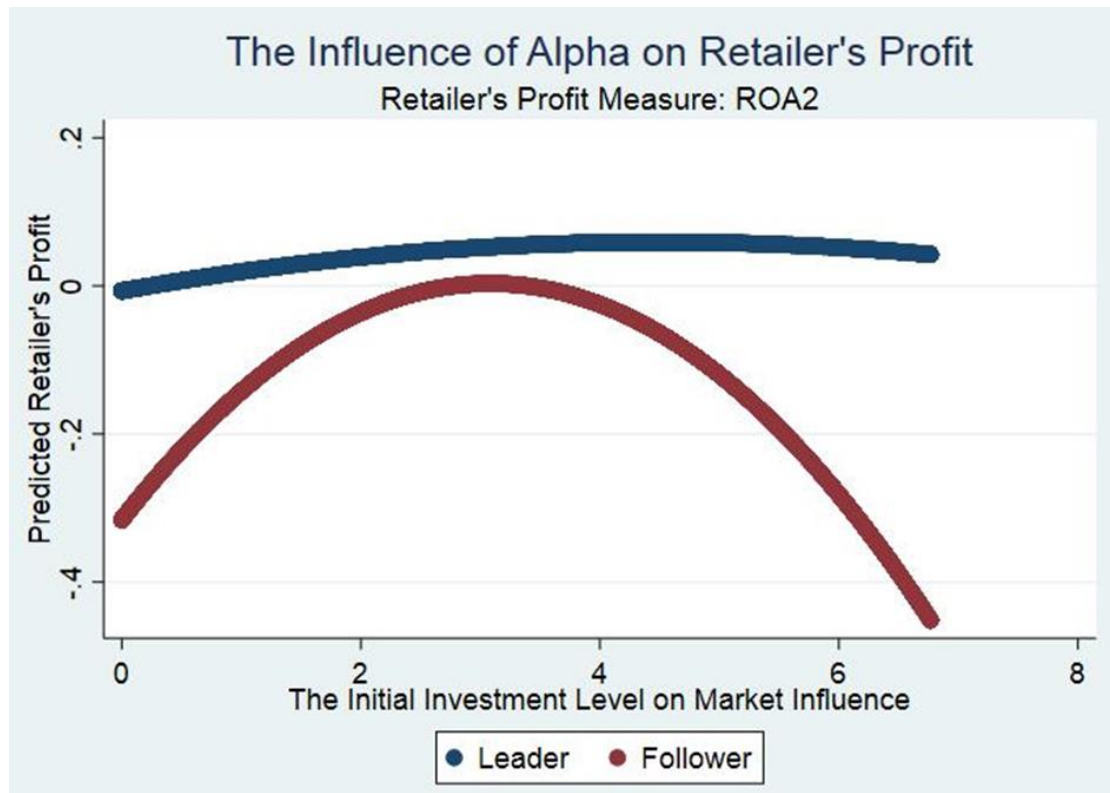


Fig 23. The empirical result: the influence of α on π_R (ROA2)

Fig. 23 shows the impact of the retailer's initial investment level on its profit. The retailer's profit is measured as return on asset in this case. The results show that when the retailer is the leader in the supply chain, it can obtain a higher profit. In addition, the retailer's profit is non-linear associated with its initial investment level on the marketing influence.

It is obvious from the above figures that the empirical results can reasonably explain the hypotheses 1 developed in Chapter 4. With more market power in the supply chain, the retailer's profit will be higher because the retailer receives a lower interest rate from the bank. However, there is a non-linear relationship between the initial investment level that the retailer puts on its marketing influence and its profit. This result suggests that when the retailer starts investing on the marketing influence, the

impact of the marketing influence on the retailer's revenue is larger than on both investment cost and financing cost. Therefore, the profit starts increasing first. As the retailer invests more, the impact of marketing influence on the revenue is less than that on the costs; as a result, the retailer's profit then declines.

When it comes to the estimation result for the retailer's financing cost, there is not much difference between the log transformations variable and the original variable. Thus, I will illustrate the results only in terms of the original variable. The estimation results are: 1) the retailer has the lowest financing cost if it is the leader in the supply chain; 2) however, financing cost increases linearly with α . After testing the empirical data, the empirical results for the influence of α on the retailer's financing cost (COD) can be obtained.

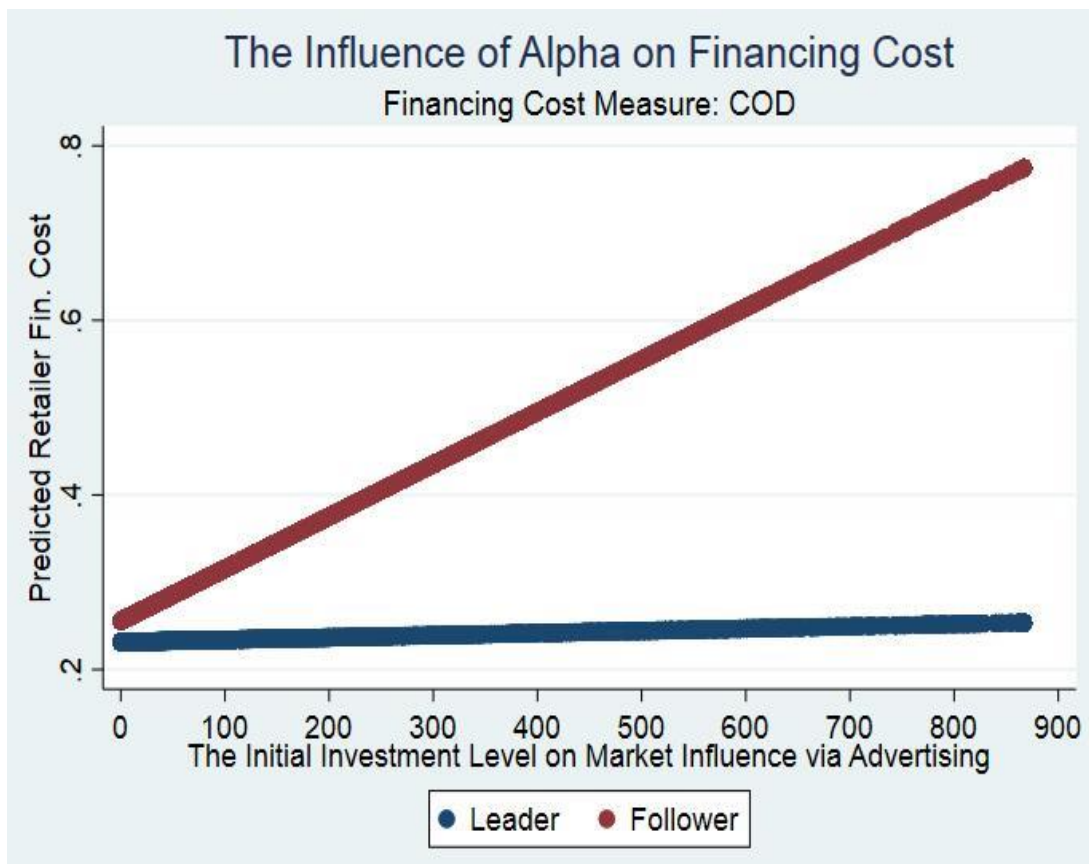


Fig 24. The empirical result: the influence of α on C_F (COD)

Fig. 24 represents the influence of the retailer's initial investment level on its financing cost. The retailer's financing cost is measured as the cost of debt. The results demonstrate that when the retailer has more supply chain power, it has lower financing cost as compared to the retailer's financing cost if it is a follower. Besides, the retailer's financing cost is positively associated with its initial investment level on the marketing influence.

This figure also illustrates that the empirical test can reasonably match the theoretical hypotheses 2 developed in Chapter 4 when the cost of debt (COD) is used to measure the retailer's financing cost. Clearly, when the retailer spends more money on promoting its products, borrowing costs become higher as both the wholesale price and the demand increase with α . In addition, when the retailer is the Stackelberg leader in the supply chain, it has lower financing costs due to a lower interest rate.

5.3.2 Empirical result: the level of customer perceived on marketing influence (b)

In this section the impact of the level that customer can perceive on retailer's effort to promote the products (b) will be investigated. In terms of the retailer's profit, I conclude the estimation results: 1) all else equal, when b increases, the retailer's profit is positively linear with respect to retailer's effort on promoting marketing influence; 2) when the retailer is the leader in the supply chain, the retailer's profit is higher. After the empirical test, below is the empirical results.

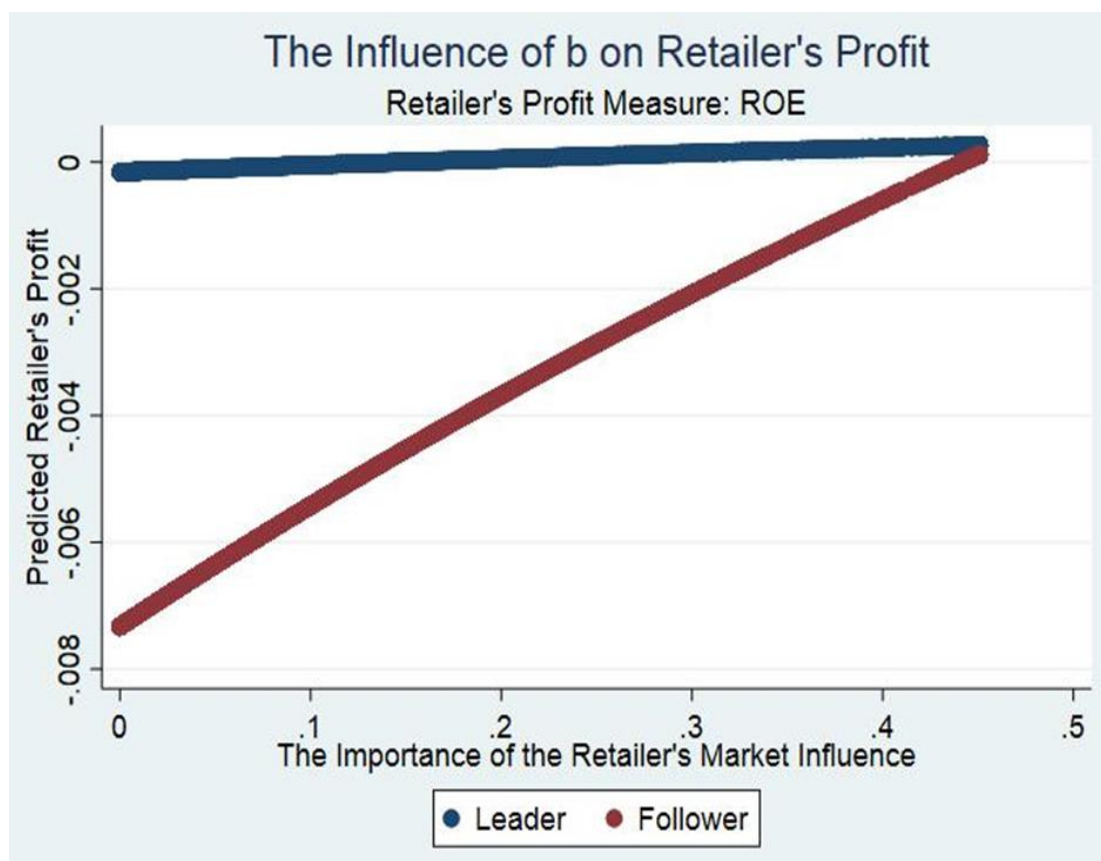


Fig 25. The empirical result: the influence of b on π_R (ROE)

Fig. 25 represents the relationship between the retailer's marketing influence level that customers can perceive and the retailer's profit. The retailer's profit is measured as return on equity in this case. The results concludes that when the retailer is the Stackelberg leader in the supply chain, it can have higher profit, as compared to that of if it is a follower. Also, the retailer's profit is positively associated with the marketing influence level that customers observe.

The figure demonstrates that with higher market power in the supply chain, the retailer's profit is higher because the bank offers a lower interest rate. Also, when customers perceive improved store/product image resulting from the retailer's promotion activities, the retailer's profit increases as customers demand is higher. These empirical results support the hypotheses.

Also, I want to test the relationship between b and C_F . The previous estimation results are: 1) the retailer has the lowest financing cost if it is the leader in the supply chain; 2) the financing cost increases linearly with an increasing b . The empirical results have been found as follow.

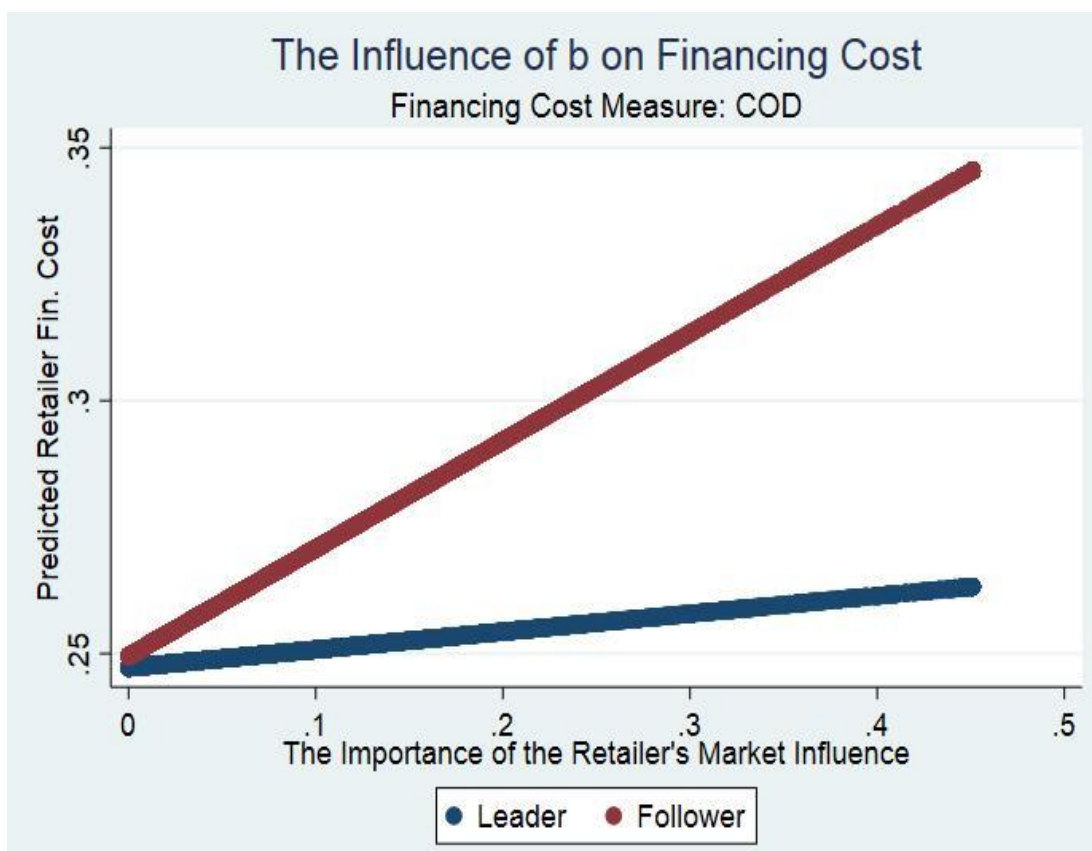


Fig 26. The empirical result: the influence of b on C_F (COD)

Fig. 26 illustrates the impact of the retailer's marketing influence level that customer can perceive on the retailer's financing cost. The retailer's financing cost is measured as cost of debt in this case. The results indicate that when the retailer has more power in the supply chain, it can have a lower financing cost, as compared to that of if it is a follower. Besides, the retailer's financing cost increases with the marketing influence level that customers can observe.

These empirical results show a good match with the theoretical results. The financing cost is measured as the cost of debt. That is, when customers perceive more effort by the retailer on the marketing influence, the retailer has a higher financing cost because both the wholesale price and demand increase with b . If the retailer is leader in the supply chain, it will benefit from its status by having a lower interest rate. Hence its financing cost is lower.

5.3.3 Empirical result: the accelerating rate in the investment cost (k)

Finally, the relationship between the accelerating rate in the investment cost (k) and the retailer's profit is tested. The hypotheses I propose from the previous chapter are: 1) all else equal, the retailer's profit is negatively linear with respect to the accelerating rate in the investment cost; 2) the retailer's profit is higher when the retailer is the leader in the supply chain. Below are the empirical results.

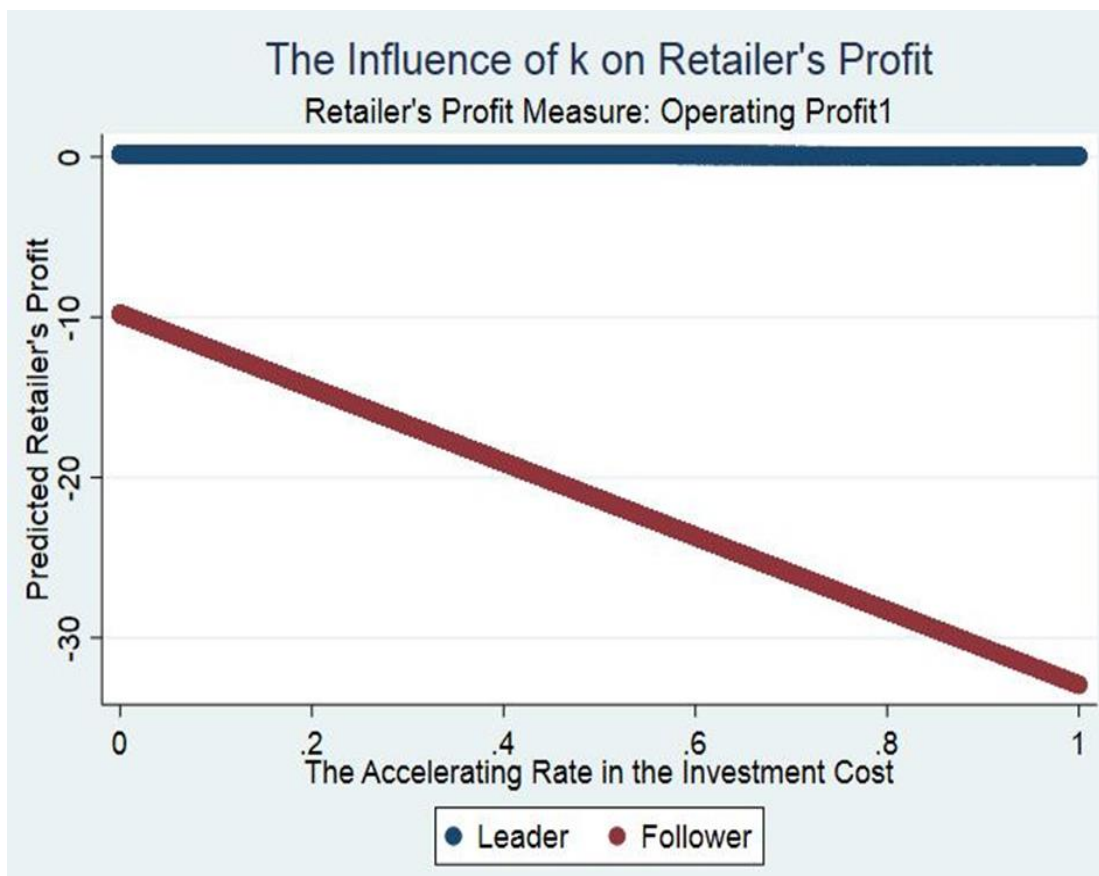


Fig 27. The empirical result: the influence of k on π_R (OPI)

Fig. 27 demonstrates the relationship between the accelerating rate in the investment cost and the retailer's profit. The retailer's profit is measured as operating profit. The results show that when the retailer is the Stackelberg leader in the supply chain, it can gain a higher profit. Nevertheless, the retailer's profit is negatively associated when the retailer invests more.

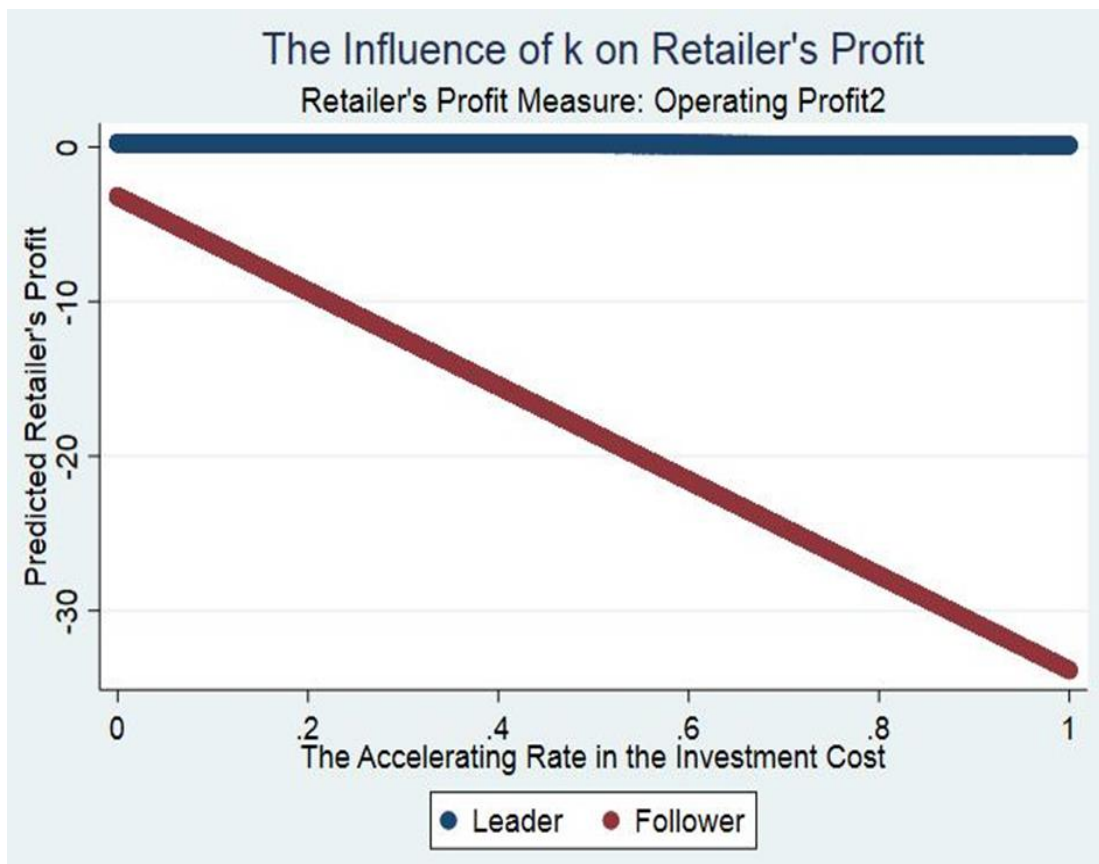


Fig 28. The empirical result: the influence of k on π_R ($OP2$)

Fig. 28 represents the influence of the accelerating rate in the investment cost on the retailer's profit. The retailer's profit is measured as operating profit in this case. The results indicate that when the retailer is the market leader, it can achieve a higher profit compared to that of if it is a follower. In addition, the retailer's profit decreases with the accelerating rate in the investment cost.

After testing the linear regression model, the estimation results have a good match with the hypotheses 9 when the retailer's profit is measured as operating profit (both $OP1$ and $OP2$). It is clear from the figures: when the rate that retailer invests on marketing influence grows quicker, the profit will decrease due to a higher investment cost; also, when the retailer has more market power in the supply chain, it will gain more profit since the bank offers a lower interest rate.

5.4 Summary

After the empirical test, I find a reasonable match to all the theoretical hypotheses

developed in Chapter 4. Here is the summary:

- 1) From the aspect of the retailer's profit: all else equal, when the retailer invests more on the marketing influence, the retailer's profit is non-linear with respect to retailer's initial investment level on marketing influence; when customers perceive that retailer puts more effort on promoting marketing influence, the retailer's profit is positively linear with respect to the level that customers can observe on the retailer's effort; for the accelerating rate in the investment cost, the retailer's profit is negatively linear with respect to the accelerating rate in the investment cost;
- 2) From the perspective of the retailer's financing cost: all else equal, financing cost increases linearly when the retailer puts more efforts on promoting its marketing influence or when the customers perceive that the retailer invests more on the marketing influence;
- 3) In terms of the retailer's leadership status: when the retailer is the leader in the supply chain, its profit is higher; besides, the retailer has the lowest financing cost if it is the Stackelberg leader in the supply chain.

Chapter 6 Conclusion and future work

6.1 Conclusion

This research studies the impact of supply chain bargain strategies on the retailer's debt financing from a bank. A supply chain in which there is one supplier, one retailer, and one bank, is considered. The retailer is budget constrained and requests loan from the bank. In return, the bank evaluates the payoff ability of the retailer and adjusts its offer of interest rate to the retailer. In this thesis, two factors that the bank considers in making the lending decisions: the retailer's initial investment level on marketing influence and its leadership status in the supply chain. The rationale is that it is crucial for the retailer to gain more marketing influence to be the leader in a highly competitive market. It not only allows the retailer to set a higher price, but also helps the retailer to expand the market shares. In this way, when the bank needs to respond the retailer's loan request, it will offer the interest rate based on retailer's marketing influence and the leadership status as these two factors are commonly observed in practice. To sum up, the impacts of both retailer's marketing influence and leadership status in the supply chain on the bank loan are investigated in this research.

To address the research questions, a basic single period cash flow model is developed. The model considers a supplier provides a product to a finance constrained retailer. The retailer needs finance assistance to pay the order payments to the supplier and to sell products to the customers. In order to gain more marketing influence, the retailer has to put effort on investing its promotion activities. Hence, the level of effort

that the retailer puts on earning its marketing influence and its leadership status can be perceived by the bank. As a result, the bank offers the interest rate based on the retailer's marketing influence and leadership status. To best examine the impacts of these two factors on the bank's lending decisions, as well as the financial performance of each member in the supply chain, the model is discussed in three different supply chain structures: 1) the Supplier Stackelberg game, in which the supplier is the leader; 2) the Retailer Stackelberg game, in which the retailer is the leader; 3) Nash equilibrium, in which both the supplier and the retailer have the same level of market power. For example, they are the similar in firm's size. Based on the optimal solutions under three different games, the numerical examples as well as the empirical analysis are conducted to demonstrate the effects of marketing influence, leadership status, and other factors on the profits of both retailer and supplier, the bank's revenue and the loan that the retailer can receive. Several interesting insights have been identified.

The study reveals the retailer's initial investment level on promoting its marketing influence affects both its profit and the loan it can borrow from the bank. From the perspective of the retailer, with more investment on marketing influence, the retail price, the wholesale price, and the demand increase. However, the retailer's profit increases at first and then decreases. This result suggests that the retailer needs to find the balance between the benefit from marketing expansion due to the promotion and the cost it expends on. In terms of the financing cost, it keeps increasing with the marketing influence due to the higher wholesale price and the demand. Hence, this result shows

that the retailer also needs to deal carefully with the trade-off relationship between the higher marketing influence and the higher financing cost. In addition, when the investment cost increases quicker, the retailer's profit decreases because the revenue that the retailer earns cannot offset the increasing investment cost. The insight from this result is that although the retailer has the goals to earn more market power and expand the market share, the pace that it invests on promotion should not be too quick. Otherwise, the retailer will suffer from the shortage of revenue to compensate the investment cost.

For the supplier, the result indicates that the supplier benefits from the retailer's investment. That is, the supplier's profit keeps increasing with the retailer's initial investment on marketing influence as both wholesale price and demand increase. Thus, the recommendation for the supplier is to encourage the retailer that invests more on gaining market power since it can achieve a higher profit.

In terms of the customers, this research finds that when the customers observe that the retailer puts more effort on promoting its marketing influence, the retailer's profit keeps increasing. The result provides the suggestion that the retailer should make a good plan on promoting its products through various advertising activities so that the customers can better perceive the product image. The result proves that these promotion activities can boost the profit of the retailer. Also, both the wholesale price and the demand increases if the customers perceive the retailer invests more. This can be explained as the higher customers' perceived values, the more customers will buy the

products. With more demand, the supplier can charge a high wholesale price as the retailer will order more. As a result, the financing cost increases with the level that customers can perceive on retailer's marketing influence. Hence, the implication of this result is that the retailer needs to work on a good balance between a higher profit and a higher financing cost when the customers observe and weight more on its marketing influence.

The bank has the highest revenue under the Supplier Stackelberg supply chain and the lowest when the retailer is the Stackelberg leader. Therefore, the bank prefers the retailer to be a follower in the supply chain so it can charge a higher rate of interest and increase its revenue. However, the bank has to endure the risk which the retailer has a great possibility that it cannot pay back the loan as a second mover due to the lower retailer's profit and the higher financing cost.

This study finds that the leadership status of the retailer in the supply chain plays a significant role. When the retailer is the supply chain leader and moves first, its profit is higher than it would be as a follower. This demonstrates that the retailer is able to set a higher price when it has more power in the supply chain. Moreover, the retailer's financing cost will be lower under the Retailer Stackelberg supply chain because when the retailer is the Stackelberg leader, the bank will offer a lower interest rate.

6.2 Limitation and future work

Although the models in this thesis provide with new insights on supply chain bargaining strategies, there are several limitations to this research and the current study

can be extended for future work.

For the theoretical part, here are the aspects that future study can focus on.

- 1) This thesis assumes there is only one supplier and one retailer and ignore the intensified competition in the capital market. Future study can extend the current model by adding more competitors in the capital market into consideration. It is worth examining the lending decisions the bank makes when the retailers are from different business types in a highly competitive market;
- 2) The research results are tested in a single period time model. It would be interesting to investigate the bargaining strategy of the retailers with the suppliers and the bank under a dynamic model for a multi-period;
- 3) The production cost is zero and the research ignores the transportation cost. In practice, such costs are always considered when executives make financial decisions nowadays. Thus, it may offer other managerial insights. Future extensions may include other costs, such as production cost and transportation cost in the model and provide the empirical analysis to capture such costs;
- 4) The demand is assumed to be the same amount that the supplier produces to the retailer in this thesis. However, it is not always the case when the retailer sells out all products and has nothing in stock. It is common for the retailer to suffer from either out-of-stock conditions due to suddenly high demand or high inventory levels. An extension would be to consider that the retailer needs to

deal with inventory management to ensure the daily operation and minimize the inventory cost;

- 5) This research takes only two factors into consideration that might affect the bank's lending decisions. In practice, the bank may evaluate the retailer's whole business package. The model could be extended by including other factors in the bank's investigation, such as firm size and business viability.

In terms of the empirical evidence, the limitation is summarized and future work is proposed as follow.

This study uses the cost of debt to represent the financing cost for the retailer. In practice, the term cost of debt can represent the money that firms not only borrow from the bank but also from other financial institution. In other words, the financing cost that this research investigates is only partial of the real cost of debt. Besides, in the annual report, the loan that companies borrow from the bank can be distinguished in terms of several forms, such as amortization of discounts or premiums that are related to the borrowings. That is, the financing cost can be identified in a complicated way for the reality concern. Thus, future study could be extended to figure out a better accurate measurement of financing cost to ensure precise results.

Appendix

Proof of Proposition 1. Taking partial derivatives of (5) w.r.t. p^S : $\frac{\partial \pi_R^S}{\partial p^S} = 1 + b\alpha + w^S(1 + \theta + r_0 - \delta\alpha) - 2p^S$, $\frac{\partial^2 \pi_R^S}{\partial p^{S2}} = -2 < 0$. Therefore, there exists a unique optimal $p^S(w)^*$ by setting the first order condition to zero:

$$p^S(w)^* = \frac{1 + \alpha b + w^S(1 + \theta + r_0 - \delta\alpha)}{2}. \quad (\text{A1})$$

Substituting (A1) into (6) and then taking partial derivatives of (6) w.r.t. w^S : $\frac{\partial \pi_S^S}{\partial w^S} = \frac{1 + b\alpha - (1 + w^S)(1 + \theta + r_0 - \delta\alpha)}{2}$, $\frac{\partial^2 \pi_S^S}{\partial w^{S2}} = -(1 + r_0 + \theta - \delta\alpha) < 0$. Hence, there exists a unique optimal w^{S*} by setting $\frac{\partial \pi_S^S}{\partial w^S} = \frac{1 + b\alpha - (1 + w^S)(1 + \theta + r_0 - \delta\alpha)}{2} = 0$:

$$w^{S*} = \frac{1 + \alpha b}{2(1 + r_0 + \theta - \delta\alpha)}. \quad (\text{A2})$$

Substituting (A2) into (A1), I can derive:

$$p^{S*} = \frac{3(1 + \alpha b)}{4}. \quad (\text{A3})$$

Proof of Proposition 2. For a given $m^R = p^R - w^R$, taking partial derivatives of (6) w.r.t. w^R : $\frac{\partial \pi_S^R}{\partial w^R} = 1 + b\alpha - 2w^R - m^R$, $\frac{\partial^2 \pi_S^R}{\partial w^{R2}} = -2 < 0$. Thus, there exists a unique optimal $w^R(m)^*$ by setting the first order condition to zero:

$$w^R(m)^* = \frac{1 + \alpha b - m^R}{2}. \quad (\text{A4})$$

Substituting (A4) into (5) and then taking partial derivatives of (5) w.r.t. m^R : $\frac{\partial \pi_R^R}{\partial m^R} = \frac{-m^R - (1 + b\alpha - m^R)(1 + \theta + \delta\alpha - r_0)}{2}$, $\frac{\partial^2 \pi_R^R}{\partial m^{R2}} = -(1 + \frac{r_0 - \theta - \delta\alpha}{2}) < 0$. Therefore, there exists a unique optimal m^{R*} by setting $\frac{\partial \pi_R^R}{\partial m^R} = 0$:

$$m^{R*} = \frac{(1 + \alpha b)(1 + r_0 - \theta - \delta\alpha)}{(2 + r_0 - \theta - \delta\alpha)}. \quad (\text{A5})$$

Substituting (A5) into (A4),

$$w^{R*} = \frac{1 + b\alpha}{2(2 + r_0 - \delta\alpha - \theta)}. \quad (\text{A6})$$

With (A5) and (A6), I can derive:

$$p^{R*} = \frac{(1+b\alpha)(3+2r_0-2\theta-2\delta\alpha)}{2(2+r_0-\theta-\delta\alpha)}. \quad (\text{A7})$$

Proof of Proposition 3. For a given $m^B = p^B - w^B$, taking partial derivatives of (5)

and (6) w.r.t. w^B and m^B : $\frac{\partial \pi_S^B}{\partial w^B} = 1 + b\alpha - 2w^B - m^B$, $\frac{\partial \pi_R^B}{\partial m^B} = 1 + b\alpha + w^B(1 + r_0 - \delta\alpha) - 2w^B - 2m^B$, $\frac{\partial^2 \pi_S^B}{\partial w^{B2}} = -2 < 0$, $\frac{\partial^2 \pi_R^B}{\partial m^{B2}} = -2 < 0$, $\frac{\partial^2 \pi_S^B}{\partial w^B \partial m^B} = -1$, and $\frac{\partial^2 \pi_R^B}{\partial m^B \partial w^B} = -(1 + \delta\alpha - r_0)$. This gives that $\frac{\partial^2 \pi_S^B}{\partial w^{B2}} \frac{\partial^2 \pi_R^B}{\partial m^{B2}} - \frac{\partial^2 \pi_S^B}{\partial w^B \partial m^B} \frac{\partial^2 \pi_R^B}{\partial m^B \partial w^B} = 3 + r_0 - \delta\alpha > 0$. Thus, there exists a unique $(w^{B*}$ and $m^{B*})$ by setting $\frac{\partial \pi_S^B}{\partial w^B} = 0$ and $\frac{\partial \pi_R^B}{\partial m^B} =$

0:

$$w^{B*} = \frac{1+b\alpha}{3+r_0-\delta\alpha}, \quad (\text{A8})$$

and

$$m^{B*} = \frac{(1+b\alpha)(1+r_0-\delta\alpha)}{3+r_0-\delta\alpha}. \quad (\text{A9})$$

With (A8) and (A9), I can derive:

$$p^{B*} = \frac{(1+b\alpha)(2+r_0-\delta\alpha)}{3+r_0-\delta\alpha}. \quad (\text{A10})$$

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