FRANCHISING CONTRACTS IN FASHION SUPPLY CHAINS

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CERTIFICATE OF ORIGINALITY

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CHEN Yue (Name of student)

Abstract

The fashion industry is one of the most prosperous and dynamic industries with huge market value and rapid development. Fashion supply chains, regarded as the channel containing all the relevant functions to design, produce, transport and sell the fashion products, are complex and dynamic systems, require accuracy, efficiency, and flexibility to create the value for all the channel members and customers in an increasingly competitive market. In the fashion industry, franchising operations have also been advocated by many brands as the premier strategy for business expansion. Regarding the complexity of fashion supply chains and the different interests of various supply chain members, the application of franchise contracts, which is defined as a kind of contractual relationships that authorize the franchisees to use the franchisor's commercial assets or sell the franchisor's products under certain conditions, is crucial for franchising operations in the fashion industry. In the extant literature, however, the franchising contracts still have not been adequately explored yet, especially in the context of the fashion industry.

With the intensively rising consciousness of sustainability in practice, many sustainable fashion brands keep devoting to enhancing the sustainable operations during the process of expanding the franchising business, where the payment of the fixed royalty from the franchisee to the franchisor greatly influences the channel efficiency. In the fashion franchising supply chain, the practice of final product assembly (FPA) can be widely observed, which leads to the practical and timely problem on deciding whether and when this step should be conducted by the upstream franchisor or the downstream franchisee. As fashion retailing has stepped into the omni-channel retailing era, channel conflicts are inevitably induced within online-offline operations when the same products are sold through online and offline channels, respectively.

Motivated by the boosting application of franchising operations in the fashion industry and the lack of related study in the implementation of franchising contracts in fashion supply chains, this thesis aims to address the main research objectives as to

(i) analyze the impact of upfront or later payments of fixed royalties with the franchising contract package,

(ii) examine the effect of the decision on who should implement the final product assembly for the channel coordination achieved by the application

of different contracts,

(iii) explore the situation when channel conflicts are avoided as the product is sold online and offline in different seasons considering the options on ordering times and franchising contracts, and

(iv) investigate how the fashion brand owner utilizes franchising contracts in practice regarding three dimensions including the channel structure, channel operations, and channel interaction.

In this thesis, the analytical (i.e., mathematical) modeling approach is adopted with the integration of case study for the observations from the industrial practice of franchising operations in the fashion industry. We first conduct a comprehensive literature review on franchising contracts, analytical approaches and franchising operations. Then mathematical modeling including newsvendor model, Pareto-improving and mean-variance theory, is applied to derive the analytical results for the research questions. Afterward, an in-depth case study has been conducted on the specific fashion brand owner based in China market to examine the practical franchising operation and the various functions of franchising contracts and demonstrates the significant functions of franchising contracts in real-world practice and help to validate the findings integrated from the literature review and the industrial practice.

The findings derived from both the analytical and empirical research verify the significant functions carried by franchising contracts in the fashion industry. Different crucial influencing factors related to implementing the franchising contracts under the diverse dimensions within the fashion franchising operations are identified and analysed in this thesis. The insights generated in our research not only contribute to advancing the literature in franchising operations in fashion supply chain management but also are beneficial for the franchisors, franchisees, and whole industry.

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Table of Content

Chapter 1. Introduction

1.1 Research Background

The fashion industry is one of the most prosperous and dynamic industries with huge market value and rapid development. It has attracted the attention of researchers focusing on operations and supply chain management (SCM) for decades (Lowson et al., 1999; Christopher et al., 2004; Bruce et al., 2004).

From the operations perspective, various characteristics distinguish the fashion industry from other industries. As the business supplying daily wearing necessities, the segmentation of fashion industry varies greatly from the consumers of low-cost clothes to the buyers of luxury garments. To satisfy volatile market demands, fashion companies must carefully deploy suitable operations strategies with product portfolio, production arrangements and channel selection, which constructs a complicated system with interacting components and entities. With broad coverage, the production process of the fashion industry comprises cotton planting, fabric and accessory sourcing, weaving, dyeing, cutting and sewing, which leads to long lead time and challenging supply chain operations. As a result, fashion supply chains, which are complex and dynamic systems, require accuracy, efficiency and flexibility to create the value for all the channel members and customers in an increasingly competitive market. A fashion supply chain is regarded as the channel containing all the relevant functions to design, produce, transport and sell the fashion products including garments, footwears, jewelleries, watches etc. to the customers. With the involvement of huge investment, intensive labour and multiple channel members, the fashion supply chain covers the processes related to the fashion industry, including R&D of fashion products, sourcing of fabric and accessories, product manufacturing, delivery and distributing, and product recycling. According to the definition specified by The Council of Supply Chain Management Professionals (CSCMP 2013), fashion supply chain management covers the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities in the fashion retail supply chain. Facing the stochastic systems of inherent uncertainties and the short product life cycle, one crucial focus of fashion supply chain management is to seek optimal decisions within supply chain systems for achieving coordination and collaboration among supply chain members. In addition to the inventory and logistics management, and

facility control, fashion supply chain management also integrates supply and demand management within and across the fashion supply chain system with a goal of satisfying the customer requirements (Chiu et al., 2011; Choi, 2014a; Choi, 2014b; Xiao et al., 2014; Shi et al., 2017).

The fashion industry is one of the major sources of pollution in the world with an undeniable negative impact on the environment. Garment production is associated with huge consumption of water with heavy use of chemicals (e.g., for fabric production, bleaching, and wet processing). It damages the environment with untreated toxic wastewaters and brings dramatic ecological consequences. As an energy-intensive industry, the fashion industry leads to a large amount of carbon emissions and greenhouse gases globally. The issues of sustainability and environmental awareness keep rising in the fashion industry. More and more fashion companies integrate the responsibility of sustainability into their business with more sustainable production and operations patterns. In addition, the disposed garments and textile waste bring massive burden to the environment, which takes hundreds of years to decompose.

Franchising, defined by The International Franchise Association as a "continuing relationship in which the franchisor provides a licensed privilege to do business, plus assistance in organizing training, merchandising and management in return for a consideration from the franchisee", is a business operations model effective in business expansion and establishing collaborative relationships (Kaufmann and Dant, 1999; Clarkin and Rosa, 2005; Combs et al., 2011), and has significantly contributed to the development of the global business. The franchising business in 2016, for example, has reported reaching US$552 billion, which approximately accounts for 3% of US GDP with an annual increase of 5.6% (International Franchise Association Educational Foundation, 2016).

In the fashion industry, which is one of the biggest industries with a total value of US$ 3 trillion achieved in 2017 (Fashion United, 2018), franchising has also been advocated by many brands as the premier strategy for business expansion (Huang, 2000; Shane et al., 2006; Märzheuser-Wood and Chatwood, 2015). Benetton, Principles, Next, River Island, Etam, Mango and Esprit are all representative instances of franchisors in the fashion industry (Franchise Europe, 2017; MacCarthy & Jayarathne, 2013; Castelli and Brun, 2017). 14 fashion companies are even listed as top 100 global franchisors, among which PVH Corp., Iconix Brand Group and Authentic Brands Group are ranked as top 3rd, 6th and 10th respectively with the annual retail sales of US$ 18 billion,

US$ 7 billion and US$ 5.3 billion (License Global, 2017). In addition, franchising has also flourished the fashion industry in China (Peng et al., 2013).

The fashion distribution channels consist of both direct retailing and franchising distribution. Direct retailing refers to the retail channel in which all the shops are owned and managed by the fashion brand owner himself. While under the franchising distribution channel, the products are firstly distributed by the fashion brand owner to the regional agent and then further allocated by the regional agent to the franchisees. Comparing to the high operations costs of direct retailing, franchising distribution is advantageous as it can integrate the branding value of the franchisor with the commercial expertise in specific regions of the franchisee to make the best use of the channel resources for rapidly expanding the business and market share. Consequently, under the fashion distribution channels, some fashion brands choose both direct retailing and franchising distribution while some rely more on franchising distribution.

Figure 1.1 below elucidates the general structure of the fashion distribution channels. As shown in Fig.1, the fashion brand owner, as the franchisor, firstly chooses either direct retailing or franchising distribution. If under the direct retailing channel, the franchisor establishes his own retail shops, denoted as Shop (B) in Figure 1.1, which directly sells the products to the consumers. While if under the franchising distribution channel, the franchisor firstly sells the products to the regional agent who is responsible for the franchising business within a specific province or several cities. Afterwards, the regional agent allocates the products to the franchisees who further distribute the products to the consumers. Besides, to distinguish from the case of direct retailing, retail shops under the franchising distribution channel is denoted as Shop (F) in Figure 1.1. Usually, when the market scale of the fashion franchising system is relatively small, there exists competition between direct retailing (i.e., Shop B) and franchising distribution (i.e., Shop D) since all the shops locate near to each other and share nearly the same target consumers. In practice, the franchisor can lessen the direct competition between Shop (B) and Shop (F) through monitoring and coordinating. For example, the franchisor may propose commercial districts partition and differentiate product portfolios. Besides, in addition to the common structure of the franchising channel described in Figure 1.1, in the fashion industry, there also exist franchising channels without the regional agent, in which the franchisor directly cooperates with the franchisee to distribute the products, and one typical instance is Santa Barbara Polo & Racquet Club (S.B.P.R.C). Our research focuses on franchising distribution.

Different structures of the fashion franchising system can consequently induce differences in franchising operations.

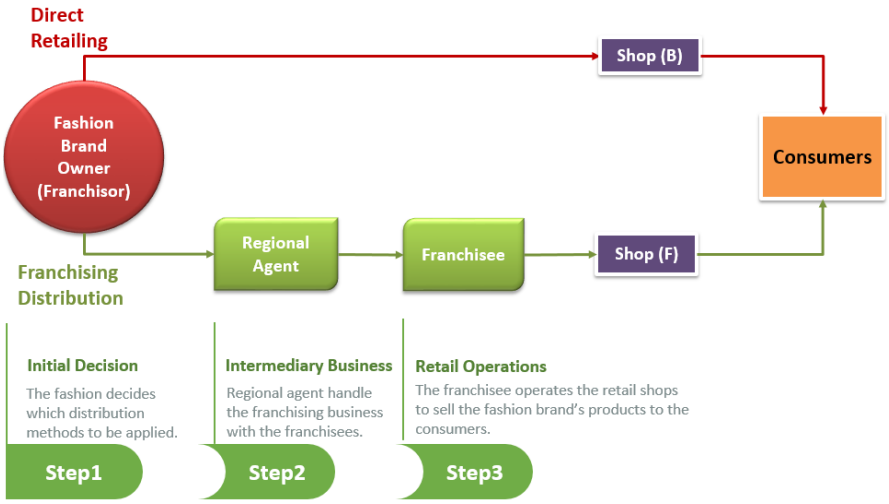

Figure 1.1. Fashion distribution channels.

Some similarities can be identified between the franchising operations of fashion industry and some other industries with perishable and seasonal products, e.g. the footwear industry, the accessories industry and the automobile industry, especially in channel structure and channel interaction. However, the difference is also non-trivial as there are more influencing factors in the franchising operations of fashion industry. Facing the diverse product variety and unique, market characteristics, the franchising operations of fashion industry rely more heavily on the resource of channel members, as well as the expertise and experience in the relevant business.

Since a complete fashion supply chain is comprised of fabric suppliers, garment manufacturers, fashion brand owners, fashion retailers and fashion franchisees (Newman and Cullen, 2002; de Brito et al., 2008; Choi, 2011; Kim, 2013), different interests of various supply chain members also make the franchising operations even more complex. This, therefore, highlights the application of franchising contracts in the channel, which is defined as a kind of contractual relationship that authorizes the franchisees to use the franchisor's commercial assets or sell the franchisor's products under certain conditions (Blair and Lafontaine, 2005). Franchising contracts are crucial for franchising operations. In the extant literature, however, the franchising contracts still have not been adequately explored yet, especially in the context of the fashion industry. As a result, considering this research gap, our study deeply explores the

implementation of various franchising contracts in the fashion industry.

With the intensively rising consciousness of sustainability in practice, many sustainable fashion brands keep devoting to enhancing the sustainable operations during the process of expanding the franchising business in both the international and domestic markets. In many cases, there is a fixed royalty charged by the franchisor. We observe that some franchisors insist on charging the fixed royalty as an upfront payment (named as URP, which is paid before starting the franchising operations), whereas some allow the franchisees to pay after the franchising operations started (named as LRP). Motivated by the fact that the sustainability issue becomes a critical part simultaneously interacting with the franchising business in the fashion industry, in this thesis, we explore the franchising operations of the sustainable fashion brands concentrating on the fixed royalty payment in the scenarios of the URP and LRP plans.

In the fashion franchising supply chain, the practice of final product assembly (FPA) can be widely observed, which is critical for some special garments including evening dresses, wedding dresses and even traditional clothing. For the evening dresses, the handmade decoration as the final processing is regarded as the most important factor influencing consumers' buying decisions. As such, deciding whether and when this step should be conducted by the upstream franchisor or the downstream franchisee is a practical and timely problem. In our research, we address this question by building analytical models with the use of game theory.

Regarding the distribution channel, fashion retailing has stepped into the omni-channel retailing era. Online and offline operations of many fashion brands and international retailers are both well-developed. However, online-offline operations are known to induce channel conflicts if the same products are offered by them. Motivated by the fact that online-offline operations are emerging as a critical part of fashion business, and avoiding channel conflicts is a critical issue, we explore the situation when channel conflicts are avoided as the product is sold online and offline in different seasons with the focal points on the choices of franchising contract and the ordering time.

1.2 Research Objectives

Motivated by the boosting application of franchising operations in the fashion industry and the lack of related study in the implementation of franchising contracts in fashion supply chains, the purpose of our research is to explore the application of

various franchising contracts in fashion supply chains, especially with the involvement of upfront or later payments of fixed royalties with sustainability concerns, operations of final product assembly (FPA) and the online-offline channel conflicts. To be specific, we aim to address the following research objectives:

(1) To conduct a comprehensive review of the literature of franchising contracts for the fashion industry and to examine the functions of franchising contracts in the fashion franchising system with respect to upfront or later payments of fixed royalties with sustainability concerns, operations of final product assembly (FPA) and the online-offline channel conflicts.

(2) To analyze impacts of upfront or later payments of fixed royalties on the channel efficiency and coordination, the consumer utility and the environmental sustainability with the consideration that the sustainable fashion brand offering two options in the franchising contract package.

(3) To examine the decision on who should implement the final assembly of the product in the supply chain, the effect caused by different costs of final product assembly on the order quantity and the whole supply chain's performance, and the channel coordination achieved by the application of different contracts.

(4) To explore the situation when channel conflicts are avoided as the product is sold online and offline in different seasons, the optimal ordering time and the best franchising contract to choose for the fashion brand, and the relevant influence on the supply chain.

(5) To investigate how the fashion brand owner utilizes franchising contracts in practice regarding three dimensions including the channel structure, channel operations and channel interaction

1.3 Outline of Methodology

In this thesis, the analytical (i.e., mathematical) modeling approach is adopted with the integration of case study for the observations from the industrial practice of franchising operations in the fashion industry. The managerial insights are generated from both the analytical and empirical approaches. The details of methodology are as follows:

(1) Mathematical modeling is the key approach to derive the analytical results for the research questions, which mainly includes newsvendor model, Pareto-improving and mean-variance theory. The derived results thoroughly explain and compare the

different situations where the franchising contracts are applied in various scenarios of the fashion industry.

(2) The in-depth case study has been conducted on the specific fashion brand owner based in China market to examine the practical franchising operations and the various functions of franchising contracts. The empirical analysis demonstrates the significant functions of franchising contracts in real-world practice and helps to validate the findings integrated from the literature review and the industrial practice.

Therefore, the integrated approaches of this thesis, as is addressed above, can help to construct a comprehensive understanding of the application of franchising contracts in the fashion industry and generate extensive insights in both the academic and industrial dimensions.

1.4 The Coherent of Different Topics in this Thesis Research

The coherence and interrelationships of different topics in this thesis research is an important aspect. With both the analytical and empirical approaches, the thesis comprises one case study section and three analytical sections. Our research focuses on franchising contracts in fashion supply chains. Stimulated by the comprehensive case study on the fashion franchising operations, the research questions are driven by the academic gaps and the industrial practice. The three analytical sections are organized within a progressive relationship. The first analytical section probes into fixed royalty payments, the core feature of franchising operations, to generate the insights from upfront or later payments in sustainable fashion brand operations. Then we proceed to explore the interaction of channel members considering improving the channel performance by investigating the decisions on who conducts final product assemblies for supply chain optimization. Afterward, we broaden the picture to cover the omni-channel of online-offline operations without channel conflicts to study the options of franchising contracts and ordering times with information updating in fashion franchising supply chains. The analytical findings derived from each section can also be validated in the real-world case study. Figure 1.2 demonstrates the relationships among different topics of this thesis research.

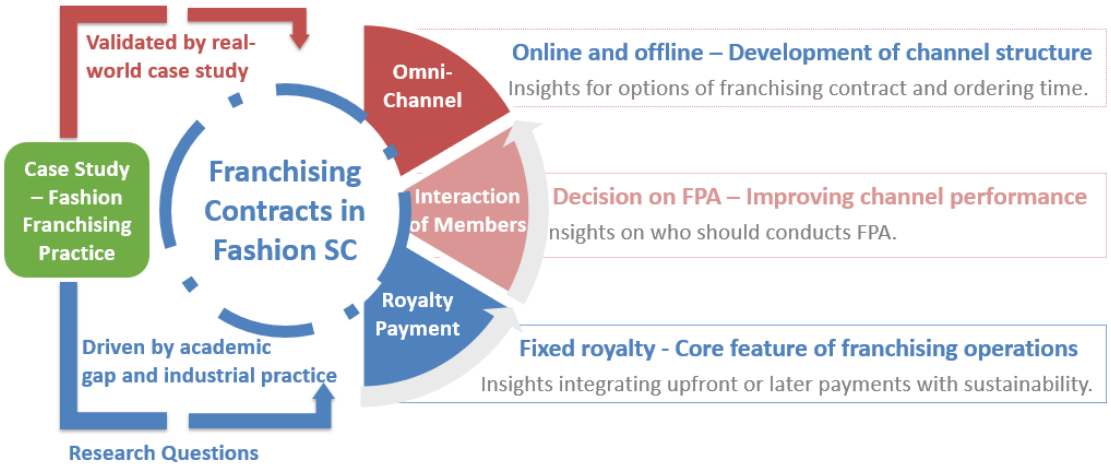

Figure 1.2. The relationships among different topics of this thesis research.

1.5 Significance of Contribution of the Research

In the existing literature, the application of franchising contracts has not been well discussed. Though the fashion business operations have drawn the attention of many scholars and being examined, the research on the specific implementation of franchising contracts has not been adequately addressed. This thesis contributes to the existing literature by specifically examining the implementation of various franchising contracts in the fashion industry via a multi-methodological approach. The analytical findings derived from the models exploring the behavioural decisions towards different franchising payment schemes considering sustainability-related issues and supply chain finance can greatly supplement the literature with a more in-depth understanding of the functions of franchising contracts in the fashion industry. Addressing the final product assembly under wholesale price contracts and buyback contracts, this thesis also enriches the literature with the analytical insights on the operations and coordination of franchising supply chains. Integrating the online and offline channels with the application of wholesale price contracts and profit-sharing contracts in fashion franchising supply chains, the thesis greatly contributes to the study on online-offline operations with the involvement of franchising agreements and ordering times. In addition, this thesis can be a helpful reference to the senior management and the decision-makers in the fashion industry to improve the franchising policies and enhance the franchising operations with the application of various franchising contracts.

1.6 Organization of the Thesis

This thesis consists of seven chapters and the organization is as follows. A

comprehensive literature review on franchising contracts, analytical approaches and franchising operations is presented in Chapter 2. In Chapter 3, a detailed analysis is conducted to explore the influence of the payment for fixed royalties in the franchising operations of the sustainable fashion brand with the involvement of variable royalty and channel coordination. In Chapter 4, we analytically examine the effect of the final product assembly (FPA) operations in franchising supply chain systems and derive the results for the channel coordination under different scenarios. In Chapter 5, we investigate the online-offline fashion franchising supply chains with channel conflicts and derive the optimal options of contracts and ordering time from the perspectives of the fashion brand owner, the franchisee and the whole supply chain. Afterwards, a thorough case study on a Chinese fashion brand company is conducted in Chapter 6 to demonstrate the findings on the implementation of franchising contracts in fashion supply chain operations and the validation of the analytical findings derived in Chapter 3, Chapter 4 and Chapter 5. Finally, the thesis is concluded with managerial insights and future research directions in Chapter 7.

1.7 Publications Derived from This PhD Thesis Research

(1) Chen, Y., Chung, S. H., & Guo, S. (2018). Franchising contracts in fashion supply chain operations: models, practices, and real case study. Annals of Operations Research., 1-46.

(2) Choi, T. M., Chen, Y., & Chung, S. H. (2017). Online-offline fashion franchising supply chains without channel conflicts: choices on postponement and contracts. International Journal of Production Economics., 215, 174-184.

(3) Cai, Y. J., Chen, Y., Siqin, T., Choi, T. M., & Chung, S. H. (2019). Pay upfront or pay later? Fixed royal payment in sustainable fashion brand franchising. International Journal of Production Economics, 214, 95-105.

(4) Chen, Y., Choi, T. M., Chung, S. H., & Guo, S. (2019). Up or Down? Final Product Assembly Operations in Supply Chain Systems in the Additive Manufacturing Era. IEEE Transactions on Systems, Man, and Cybernetics – Systems, passed the first round review, to be resubmitted.

Chapter 2. Literature Review

Commensurate with its industrial importance, franchising has captured the attention of a wide array of researchers in different fields. From the perspective of entrepreneurship, franchising is a vehicle for entering business ownership (Shane & Hoy, 1996). From the perspective of marketing, franchising is an important distribution channel (Kaufmann & Rangan, 1990). From the perspective of economics and engineering management, franchising is a leading venue for understanding the structure of contracts (Lafontaine, 1992). From the perspective of strategic management, franchising is an important organizational form (Combs & Ketchen, 1999a). Franchising is a series of research problems and features (see Blair and Lafontaine 2011), including questions of territory restrictions, number of franchise outlets, vertical integration, dual distribution channels, quality control, termination provisions, product tying, advertising and promotion, cost-sharing, risk-sharing, and others (Babich and Tang, 2016).

2.1 Applications of Contracts in Fashion Supply Chains

Eppen and Iyer (1997a) explore the application of backup contracts, according to which the manufacturer holds a portion of the committed quantity as the backup. The authors discover that backup contracts can impact the expected profit by inducing an increase in the committed quantity of fashion products. Donohue (2000) studies the design of supply contracts in fashion distribution channels considering the influences of the wholesale price, production modes and return price. The author derives the pricing conditions for coordinating the distribution system. Using a mean-variance model together with the empirical data, Chiu et al. (2012) examine the application of sales rebate contracts in fashion supply chains. The authors propose the optimal sales rebate contract to coordinate the retail sales efforts and achieve higher profits and lower risks for both the manufacturer and the retailer. Shen et al. (2013) investigate how the markdown contract coordinates fashion supply chains with different risk preferences of the members. The authors demonstrate that the risk tolerance level of the supplier can directly influences the performance of the retailer and the supply chain and develop the markdown contract to help the supplier to make an accurate decision. Xu et al. (2013) also apply the contracts to coordinate fashion supply chains with different risk-averse preferences. The authors explicate that either using the revenue-sharing contract and

the two-part tariff contract separately or jointly can achieve the coordination. Peng and Zhou (2013) study how the quantity discount contract coordinates the fashion supply chain under uncertain yields and random demands. The authors analytically elaborate that the proposed quantity discount contract can greatly decrease the negative effects of the uncertain yields and demands, and achieve the optimal supply chain performance. Li et al. (2014) illustrate that a two-echelon fast fashion supply chain with multiple retailers can be coordinated with the contract containing a simple return policy. The authors further explain that such contract is also applicable to realize the coordination even in the presence of multiple retailers. Shen et al. (2014) examine the markdown contract and the profit-sharing contract employed by the fashion department store. The authors analytically derive the conditions for the supply chain coordination addressing the cost-sharing mechanism for the sales efforts. Shen et al. (2015) further elucidate the application of markdown money policies in the fashion industry from a cross-cultural perspective. The authors discover that the Chinese fashion companies tend to offer the markdown money policy to the retailer to maintain their channel leadership while the American fashion suppliers would rather bargain with the retailers than offer the markdown money policy. Ren et al. (2017) conduct a comparative study on demand forecasting models with various sources of uncertainties in the fast fashion setting. With the computational models, the authors protract the perceived importance of different demand forecasting systems applied to the fashion industry. Choi et al. (2017) explore the online-offline fashion franchising supply chains with the wholesale price contract and the profit-sharing contract. The authors analyze different scenarios for the optimal decisions upon different order time points and contract selections.

2.2 The Prevalently Implemented Franchising Contracts

Franchising contracts are widely implemented in the distribution channel, especially in the fashion industry, which is offered by the franchisor to the franchisee to deal with pricing, ordering, inventory management and payment methods. In our research, we classify the franchising contracts into four different types according to their specific variables, contract structures and functions in the franchising channel. We characterize the first category as the simple franchising contracts. The contacts with simple variables for the single operations function are included in this category such as wholesale price contracts, buyback contracts, markdown money contracts, quantity discount contracts and quantity commitment contracts. The second category is

characterized as the two-part tariff franchising contracts referring to those contracts involving two independent business interactions with certain fixed parameters or dynamic variables. To be specific, the involvement of franchise fee is the distinctive feature for the two-part tariff franchising contract, e.g., franchise fee contracts and revenue or profit-sharing contracts in franchising operations. The third category comprises the integrated franchising contracts with more complexity and variables compared to the two-part tariff contracts. Some instances are service requirement contracts, retail price maintenance contracts, price rebate and returns contracts. In addition to the above three types of franchising contracts, other franchising contracts with different functionality are characterized as the fourth category, namely particular franchising contracts, including tying contracts, vertical contracts and incomplete contracts, which are designed for solving the volatile issues like the contract coverage and the channel relationship in the franchising system.

2.2.1 Simple Franchising Contracts

A wholesale price contract is a contract with a fixed amount of payment charged by the franchisor for each product (Cachon, 2003). Under the cooperative relationship regulated by the wholesale price contract, the franchisor acquires the profit margin by setting the wholesale price surpassing the total cost (Choi et al., 2017). Zhao et al. (2014) study the wholesale price contract with the risk preference of the retailer. The authors analytically assess the performance of such contract with value risks and derive the closed-form results.

The buyback contract is another example of simple franchising contracts. Chiu et al. (2011) incorporate the return policy, wholesale price and channel rebate for coordinating the supply chain. The authors derive sufficient conditions for the coordination via both the additive and multiplicative price-dependent demand models. Shen et al. (2013) study the retailer's conflicts between profitability and supply chain sustainability with the adoption of buyback contracts in fashion supply chains.

Different from the buyback contract, the markdown money contract does not involve the physical return of the unsold products after such products are paid by the supplier (Tsay, 2001; Shen and Li, 2015). Shen et al. (2013) examine the markdown policy in the fashion supply chain containing a risk-averse supplier. The authors argue that when the supply chain is coordinated, the wholesale price increases in the markdown price. Shen et al. (2014) further explain the application of the markdown contract between the fashion department store and the national brand. The analytical

results accentuate that the coordination can be realized only when the national brand can share the cost of the sales efforts. Chow et al. (2015) study the minimum profit share ratio (MPSR) in supply chains with markdown contracts through both the modeling and empirical approaches. The authors find that the average profit and absolute risk of the supplier decrease when the MPSR increases while those of the retailer increase under the same situation.

Besides, the quantity discount contract allows a certain rate of discount for the franchisee based on the order quantity (Cachon, 2003). Utilizing a two-period quantity flexibility model, Wang (2002) investigates the quantity commitment contract with the case of famous fashion brands as DKNY, Liz Claiborne and Catco. The author shows that the quantity commitment contract provides more flexibility for the manager to make decisions in a volatile market where temporary promotions or significant markdowns exist.

2.2.2 Two-part Tariff Franchising Contracts

2.2.2.1 Franchise Fee Contract

The franchise fee contract is a typical two-part tariff contract involving both the wholesale price and the franchising charge (Mukhopadhyay et al., 2009). Gurnani and Erkoc (2008) design a fixed-fee contract and a general franchise contract. With the analytical comparison of different contracting approaches, the authors reveal that the manufacturer may prefer to offer the fixed-fee individual contract in the case of high reservation utility and information asymmetry.

2.2.2.2 Revenue/Profit-sharing Contract

One distinctive feature of franchising contracts is the application of royalty, which specifies a sharing rule of the earnings or profits generated from the selling activities carried by the franchisee (Katz and Owen, 1992; Mukhopadhyay et al., 2009). Cachon (2003) proposes a revenue-sharing contract where the manufacturer can enjoy additional earnings from the distribution channel. Shen et al. (2014) focus on the coordination issue with the profit-sharing contract between fashion department stores and private labels. The authors address an equivalent relative level of risk but a different absolute level of risk between the scenarios of applying the profit-sharing contract and the markdown money contract. Giovanni (2017) establishes two incentive games upon a profit-sharing contract for combining the motivation of the manufacturer and the retailer in a closed-loop supply chain. The analytical findings substantiate the coordination realized by adjusting the sharing parameter in the scenarios of the

symmetric and asymmetric information. Liu et al. (2017) illustrate the coordination with the revenue-sharing contract and the government price regulation policy in a supply chain with a dominating retailer. The authors develop various optimal revenue-sharing contracts to coordinate the supply chain when the demand is disrupted. Choi et al. (2017) explicate how the profit-sharing contract influences the interaction between the franchisor and the franchisee as well as the profit of the whole franchising channel.

2.2.3 Integrated Franchising Contracts

2.2.3.1 Franchise Fee with Service Requirement Contract

The franchise fee with service requirement contract extends the two-part tariff contract by adding the service level. Xie et al. (2016) examine the franchise fee with service requirement (FFS) contract and the franchise fee with centralized service requirement (FFCS) contract in the supply chain with product service system (PSS). The authors prove that the decisions and profitability of the supply chain members are affected by such contracts, among which the FFCS contract can realize the maximal channel profit.

2.2.3.2 Retail Price Maintenance Contract

The retail price maintenance (RPM) contract is another instance of integrated franchising contracts. It extends the wholesale price contract by empowering the franchisor to specify the order quantity and even the retail price (Mukhopadhyay et al., 2009). The retail price maintenance contract is only applicable when the franchisor is adequately powerful to force the franchisee to accept the terms regulating her marketing activities (Gurnani and Xu, 2006). As is released by Mukhopadhyay et al. (2009), the retail price maintenance contract may be less dynamic than the franchise fee contract in stimulating marketing efforts. According to Gurnani and Xu (2006), given the dominating power of the franchisor, the retail price maintenance contract is popular among the giant fashion brands. Gucci applies fixed retail prices for its products in both the vertically integrated and independent channels. Nike sets the bottom prices for the products and does not allow any retailer to sell the products below the bottom price.

2.2.3.3 Price Rebate and Returns Contract

The price rebate and returns (PRR) contract integrates the wholesale price, channel rebate and return policy. Chiu et al. (2011) demonstrate the analytical conditions for the optimal price rebate and returns contract for coordinating the decentralized supply chain containing the risk-neutral manufacturer and retailer with the additive and multiplicative price-dependent demands. The authors further derive the maximal profit

for the manufacturer and the equilibrium for Pareto improvement.

2.2.4 Particular Franchising Contracts

2.2.4.1 Tying Contract

The tying contract is a special contractual agreement in the franchising channel. The franchisor supplies the franchisee with a product only when the franchisee agrees to purchase another product (Etro, 2010). Whinston (1990) explores the tying contract under the leverage theory. The author reveals that once a monopolistic franchisor in a primary market is also dominant in a secondary market, the tying contract helps to improve his competitive strength. If the market demand for the bundled product is close to that of the core product, the tying contract can even benefit the franchisor more.

2.2.4.2 Vertical Contract

The vertical contract mainly aims to deal with the hold-up problem[1] caused by the vertical separation in the franchising channel. It is effective in activating the internalization of the franchising channel and uniting the channel members into a common system (Etro, 2010). Both Bonanno and Vickers (1988) and Rey and Stiglitz (1995) discuss the profit issues with the vertical contract where the franchisor and the franchisee are vertically separated. The authors find that the franchisor may charge a certain amount of franchise fee in addition to the wholesale price below the cost to enhance the competitive strength.

2.2.4.3 Incomplete Contracts

Incomplete contracts can be applied to overcome the limitations of the transaction complexity or the vagueness of language. Hendrikse and Jiang (2011) develop an incomplete contract in dual distribution franchising. The authors conclude that whether a traditional franchise or a cooperative franchise can achieve the benefits of the dual distribution depends on whether the most value is added upstream or downstream.

2.3 Franchise Contracting Systems

The franchising system represents an entrepreneurial team between two dissimilar entrepreneurs, franchisors, and franchisees (Kaufmann and Dant 1999; Clarkin and Rosa 2005; Combs et al. 2011). Under a typical franchising arrangement, the franchisor will issue a contract to the franchisee who is granted the right to operate the retail

1 The hold-up problem is a situation where two parties may be able to work most efficiently by cooperating but refrain from doing so because of concerns that they may give the other party increased bargaining power, and thereby reduce their own profits.

business under the franchisor's brand and sell its products.

2.3.1 Franchising Contract Design and Contract Optimization

In the franchising system, contract optimization refers to the elimination of the drawbacks in maximizing the profits of both the franchisor and the franchisee. As a common practice, the franchisor formulates fundamental business standards like the franchise fee, the wholesale price, the royalty payment, the franchising territory and the duration to the franchisee. The franchisor may even specify some additional clauses on the retail price, the service level and the order quantity to induce the marketing efforts of the franchisee. The franchising contracts raised by Xie et al. (2016) help the franchisor to acquire more private information from the franchisee. In the meantime, the franchise fee with centralized service requirement (FFCS) contract is found to be optimal in maximizing the profit of the whole franchising channel. Further to the above findings, Lanchimba et al. (2017) show that the franchising contract with a risk-incentive adjusted royalty can substantially improve the channel performance. The analytical results of Babich and Tang (2016) suggest that the important property of the optimal franchising contract should be in the setting of positive royalties and no fees under the specific conditions.

2.3.2 Franchising Contract Offering and Selection

The contract offering and selection is also critically important in franchising operations. Katz and Owen (1992) construct franchise contracts based on the fixed fee and the royalty sharing mechanism. The authors find that it is more beneficial for the franchisor to offer separating contracts and offering a nonlinear contract can help the franchisor to stimulate more marketing efforts from the franchisee. Different methods for offering the contract provide various flexibility. According to Hempelmann (2006), the franchisor prefers to offer the menu contracts to detect the franchisee’s private information, especially the marginal cost of sales. Gurnani and Erkoc (2008) compare the different performances of the price-only contract, the fixed-fee contract and the general franchise contract. The authors prove that both the individual contract and the menu contract perform better than the pooling contract. The menu method is preferable for offering the price-only contract and the fixed fee contract. The contract selection can reveal the franchisee’s preference for the total reservation profit level and the cost type. The findings in Mukhopadhyay (2009) illuminate that the franchise fee contract is superior in driving marketing efforts and generating profits for the whole franchising channel while the retail price maintenance contract is preferred by the franchisor with

a high allocable profit level. Xie et al. (2016) provide insights for the franchisor to offer the menu franchising contracts under different circumstances. To be specific, the franchise fee (FF) contract gives the franchisee more freedom to choose the optimal service level, while the franchise fee with centralized service requirement (FFCS) contract squeezes the franchisee's profit to the minimum.

2.3.3 Coordination for The Franchising Channel

Another important role of franchising contracts is to coordinate the channel performance through various variables in the franchising system. Lal (1990) illustrates that a simple two-part tariff contract without the royalty payments and the monitoring can coordinate the franchising channel when the market demand fluctuates with the retail price and the retailer's service. Agrawal and Lal (1995) and Huang (1997) address the role of the royalty rate in coordinating the franchising channel. The authors argue that the internal coordinated relationships regulated by the franchising contract are also affected by the franchisee's risk preference. Xie et al. (2016) concentrate on the channel coordination problem upon three different franchising contracts implemented in an asymmetric information sharing environment. The authors discover that the maximum channel profit is achieved under the FFCS contract while the FFS contract presents the highest efficiency in stimulating more service effort.

2.3.4 Franchising Contract Evolution, Duration and Termination

Cochet and Garg (2008) empirically examine the evolution of franchising contracts and point out that the franchising contract should be gradually revised from time to time. The changes in the franchising contracts incurred by the change in the management can influence the efficiency of the contracts (Azoulay and Shane, 2001). The tendency for uniformity also accounts for the evolution of franchising contracts as a change in any clause may lead to the occurrence of the relevant changes in other clauses as well (Cochet and Garg, 2008). The interaction between different variants can affect the duration of franchising contracts (Rubin, 1978; Fudenberg et al., 1990). Vázquez (2010) concludes that the franchisor is apt to offer a shorter contract when facing the threat of free-riding but offer longer contract to alleviate the franchisee's concern on the hold-up problem. Moreover, the contracting experience has a positive influence on the time horizon of the franchising contract. Kaufmann and Lafontaine (1994) depict that terminating the franchising contract can be utilized as the punishment for those franchisees who caught free riding. Winsor et al. (2012) accentuate the chain effect that terminating the contract for one franchisee may cause other franchisees to

consider terminating their contracts as well.

2.3.5 Governance Structure and Ownership of The Franchising Channel

The franchising channel may consist of the wholly franchised shops, the shops in dual distribution and the wholly company-owned shops (Gallini and Lutz, 1992; Blair and Lafontaine, 2005). The franchisee's multi-unit propensity not only increases the risk of moral hazard and free-riding (Rubin, 1978; Eisenhardt, 1989; Vázquez, 2010) but also internalizes the externality that may trigger cheating (Brickley, 1999; Brickley and Dark, 1987). Consequently, the franchisor is forced to adopt stricter monitoring and punishment terms. According to Combs et al. (2011), the franchisor learning, the franchisor goals and the geographical setting are the key moderators for the ownership redirection. The franchisor expects to merge the franchised outlets concerning the factors of size, age, and resources that are accessible to create unique long-term competitiveness in a franchise system under the minimum risk of failure (Dant and Kaufmann 2003; Chabowski et al., 2011).

2.4 Analytical Approaches for The Contracts in Fashion Supply Chains

2.4.1 Game Theory

Game theory is widely applied in contract analysis in fashion supply chains. Desai and Srinivasan (1995) employ game theory to analyze a two-part price contract and a three-part contract for the problem of two-sided information to achieve the first-best pricing scheme. Mukhopadhyay et al. (2009) examine the optimal design for the franchise contract with a two-part price schedule and the retail price maintenance contract specifying the retail price and the service level with game theory under the scenario of asymmetric information and double marginalization. Yan and Wang (2012) apply a game theory model to demonstrate how the franchisor uses the wholesale discount and profit-sharing mechanism as the incentive to encourage the franchisee to share the private information. Zhao et al. (2017) explore the issue of coordinating a two-echelon fuzzy closed-loop supply chain with symmetric and asymmetric information contracts on the basis of game theory. The analytical results show that the low-collecting-scale-level retailer's maximal expected profit is higher under the asymmetric information contract than that under the symmetric information contract. Giovanni (2017) substantiates the coordination in the closed-loop supply chain through incentives under information asymmetry applying a dynamic game model. The author

discovers that within the specific sharing parameter scope, both the manufacturer and the retailer can economically better-off with an exogenous incentive. Xie et al. (2016) develop the contract regarding product service system (PSS) under a game-theoretic framework to reduce the loss caused by information asymmetry and the double marginalization. Huang (1997), Huang (2000) and Li et al. (2002) develop the basic game theory to the cross-constrained game theory for the respective research. Huang (1997) and Huang (2000) apply the cross-constrained game theory to study how the franchising compensation schemes influence the channel coordination and the cooperative problem together with the impact on the behavior of the channel members. Li et al. (2002) employ the chance-constrained game theory to examine the transaction between the franchisor and the franchisee regarding the interaction among fixed fees, royalties, wholesale prices and retail prices.

2.4.2 Bargaining-related Model

Bargaining-related model is another approach commonly used in analyzing contracts in fashion supply chains. Lal (1990) constitutes the Nash equilibrium in a mixed strategy to explore the issue of improving channel coordination through franchising. The author addresses that the optimal frequency of monitoring increases in the monitoring cost while when the penalty size decreases, the optimal frequency of monitoring also increases. Gallini and Lutz (1992) integrate the Bayesian Nash equilibrium into the analytical approach aiming at the information asymmetry problem in dual distribution. The authors explain how the franchisor signals the private information by distributing the new products via both the company-owned and the franchised channels. Bargaining theory also can be found in Huang (1997) that comprises the Nash bargaining model and the Kalai and Smordinsky model to solve the problem of allocating the profit between the channel members. The author suggests that the franchisor and the franchisee can equally share the additional channel profits via cooperation under the Nash bargaining model while the Kalai and Smordinsky model instructs the channel members to share the additional channel profits to achieve the cooperation. The similar setting can be found in Li et al. (2002) that utilize the Nash bargaining model to analyze profit sharing between the franchisor and the franchisee to achieve the cooperation, where the franchisor imposes the fixed franchise fee, the wholesale price and the royalty payment while the franchisee determines the retail price and the order quantity. In Hempelmann (2006), the Nash equilibrium is developed when designing the contract to motivate the franchisee to share the cost information

considering the profit margin and the advertising effectiveness. Peng and Zhou (2013) establish new quantity discount models based on the Nash equilibrium between the supplier and the manufacturer to achieve the optimal profit margin in a centralized supply chain. Pan and Choi (2016) propose an agent-based negotiation model comprising of the competitive negotiation and the cooperative negotiation for a two-period bargaining scheme in a make-to-order supply chain. The authors prove that the model is effective to optimize the utility of the channel members and reach a win-win outcome for both members. Liu et al. (2017) construct the Nash equilibrium on the optimal decisions for the coordination in the centralized supply chain compared to the decentralized one. The authors find that the subsidies should be offered by the government to encourage the channel members to accept the contract for improving the profitability of the whole supply chain.

Newsvendor model, as a classic approach aiming at the analytical problems, can be integrated for studying the bargaining on operations management of fashion supply chains. Eppen and Iyer (1997b) combine the newsvendor model and the Bayesian model for updating a distribution upon the fashion buying problem. The authors elaborate on the importance of updating as demand uncertainty increases. Donohue (2000) employs a two-stage newsvendor model to study the efficiency of contracts in the supply chain with two production modes regarding the forecast information and the production decisions of the manufacturer and the distributor. The author proposes the coordinating contract covering the wholesale prices of the two production modes and the return price. Chiu et al. (2011) integrate the wholesale price, channel rebate, and returns to the newsvendor model for the supply chain coordination. The authors prove the existence of multiple equilibrium policies for the channel coordination and further delineate Pareto improvement achieved by adjusting such policies. Niu et al. (2017) adopt a single-period newsvendor model to study the policies of punishing and subsidizing under two procurement outsourcing modes - control and agency. With a logistics service provider in fashion supply chains, the authors show that the order size decreases with the punishment while the retailer is apt to adopt agency as the procurement strategy when the subsidy reaches a certain level.

Stackelberg game is another important bargaining-related approach widely applied in the research of contracts. In Huang (2000), the Stackelberg game structure is constructed. The author explicates the situation that the franchisor, as the leader, cooperates with the franchisee, as the follower, to decide the retailer price and the order

quantity. Yan and Wang (2012) apply the Stackelberg game to demonstrate how the wholesale price contract is offered by the franchisor and how the profit-sharing mechanism is proposed as the incentive for information sharing. Shen and Li (2015), Chow et al. (2015) and Shen et al. (2017) consider the newsvendor model as Stackelberg setting, where all the suppliers are the leaders. The papers investigate the optimal quantity with return prices and return cost, the effect of minimum profit share ratio (MPSR) and the supply chain coordination under the all-unit quantity discount policy, the capacitated linear pricing policy, and the profit-sharing policy.

2.4.3 Mean-variance Analysis

Mean-variance approach is broadly employed for risk analysis in the recent literature related to stochastic supply chain operations and management. Katz and Owen (1992) study a common contract among multiple agents with various risk and effort features with mean-variance analysis. The authors elucidate the conditions of the franchise contract to maximize the expected utility. Burkle and Posselt (2008) study the franchising systems from the risk perspective. The authors highlight that having plural franchising systems can be optimal with risk considerations. Chiu et al. (2012) apply mean-variance approaches together with real empirical data to examine the performance of sales rebate contracts in fashion supply chains. The authors propose an optimal sales rebate to increase the profit and decrease the risk of both channel members. Under the mean-variance framework, Xu et al. (2013) investigate single contracts and joint contracts for coordinating the fashion supply chain containing a risk-averse retailer with price-dependent demand. The authors derive the optimal conditions for the revenue-sharing contract and the two-part tariff contract to achieve the coordination. Shen et al. (2013) portray how the markdown policy performs in fashion supply chains where the members have different risk preferences. The authors explore the optimal decisions for both the markdown money policy variables and the ordering with mean-variance analysis. Li et al. (2014) employ the mean-variance framework in a fast fashion supply chain with return policies. By developing a mean-variance optimization model, the authors delineate the channel coordination realized by a simple return policy. Zhao et al. (2014) analyze the wholesale price contract in supply chains with the mean-risk approach, considering the price-dependent demand, the contract value risk and the risk-aversion of the retailer. The authors address the existence of the equilibrium between the expected profit and the contract-related value risk. Chiu and Choi (2014) develop a comprehensive review on the application of mean-variance models in supply

chain risk analysis. Focusing on 52 papers related to mean-risk supply chain models with respect to single-echelon problems, multi-echelon supply chain problems, and supply chain problems with information updating, the authors generate valuable insights for better understanding the application of mean-variance approaches and provide the suggestions on the future research for employing mean-variance supply chain models for risk analysis. Choi (2016a) and Choi (2016b) incorporate the risk-averse behavior of the retailer within a quick response fashion supply chain into the optimization model under a mean-risk framework. The optimal decision of the retailer and the optimal inventory service level is analytically obtained. Choi (2016c) extends the mean-variance approach to multi-period risk minimization inventory models for fashion merchandising involving the factors of interest rate, budget and profit target. The author concludes that with the application of the fixed-fee contract, the wholesale pricing contract and the product variety contract, the optimal ordering quantity increases in both the profit target and the market interest rate.

2.5 Franchising Supply Chain Operations

Franchising is a method of manufacturer–sales agent relationship (Kaufmann and Dant 2001), which can be defined as the network of a contract-giving firm (franchisor) with independent contract takers (franchisees) (Hempelmann, 2006). Franchising is a business arrangement wherein a firm (the franchisor) collects up-front and ongoing fees in exchange for allowing other firms (franchisees) to offer products and services under its brand name and using its processes (Combs et al., 2011).

2.5.1 Fixed and Variable Franchising Fees

Fixed and variable franchising fees are addressed as the most important feature in franchising operations, which differentiates franchising from other forms of distribution channels (Huang, 1997). In the literature, Huang (1997) examines the impact of the fixed lump sum fees and royalties as the compensation schemes in a franchising supply chain. With the use of game theory and bargaining theory, the author analytically shows how the franchising arrangement operates. The franchisee pays a fixed one-time lump-sum fee to the franchisor in exchange for the right to market the product or service. The franchisee is also assumed to pay the franchisor a royalty fee, as a percentage of total gross sales generated at the retail level (Elango & Fried, 1997). Huang (2000) further investigates the role of franchising contracts by considering the presence of fixed lump-sum fees, royalties, wholesale price, and retail price. Considering the channel leadership,

the author explores the cooperative situation between the franchisor and the franchisee. They derive a Pareto-efficient payment scheme under Nash's bargaining model. Notably, Li et al. (2002) demonstrate a shift of retailing power from manufacturers to retailers in the franchisor-franchisee supply chain operations. The authors develop two franchising gaming models to analyze the franchising efficiency with respect to transactions between the channel members and address how effective channel cooperation can be achieved. Shane et al. (2006) conduct empirical research on franchising. The authors find that lowering the up-front franchise fee and royalty could help the franchisor grow larger. Pfeiffer (2016) explores the coordination of effort decisions in a decentralized supply chain. The author studies the use of simple two-part supply chain contracts. The author concludes that the upfront payment can help effectively facilitate the allocation of the total channel profit. Xie et al. (2016) study the issue of how different contracts affect the decisions and profitability of the supply chain and its members with three different types of contracts involving the franchise fee, the wholesale price and the service requirement. The authors argue that the franchise fee with "centralized service requirement" contract can maximize the channel profit. Choi et al. (2017) analyze the franchising contracts with the involvement of the profit-sharing royalty and derive the optimal contract types. Similar to the above-reviewed literature on franchising, we also explore the application of fixed and variable franchising fees in the franchising supply chain. Different from them, we focus on how the different payment times of the franchising fees would influence the performances of the channel members and whole supply chain. Besides, we also consider sustainability-related issues.

2.5.2 Supply Chain Finance

Supply chain finance has drawn the attention of researchers in recent years as credit payment, risk and cash flow management are all critical in business operations. In the related literature, Sarmah et al. (2007) develop a coordination mechanism through credit options. The authors propose a coordination model in which the credit period is used as an incentive to coordinate the activities of the two members of the supply chain. The authors also find that when the manufacturer is financially strong, it should prefer the use of credit policy to a discount contract. Chen and Wang (2012) analyze the trade credit and the limited liability on the performance of a two-level supply chain with budget constraints. The authors discover that the value of the whole supply chain can be increased by properly using the trade credit contract, with which

the supply chain can also be coordinated. Chan et al. (2012) examine the achievement in the research on green supply chain management. They examine the relevant literature with a focal point on those enhancing the financial performance and boosting the implementation of green supply chains. Babich and Tang (2016) study the timing option in the franchising contract with financial considerations. The authors substantiate that the franchisor should use the royalty instead of the franchise fee to "extract value" from the franchisee. Tang et al. (2017) build a game-theoretical model to analyze two supply chain financing schemes, namely the purchase order financing (POF) and buyer direct financing (BDF). They discover that BDF is preferable for the supplier (who has information advantages) if the supplier is financially constrained. Tsao (2017) explores the channel coordination problem in a decentralized supply chain. With the newsvendor model, the author develops four composite contracts considering the trade credit cost-sharing with either the buyback contract or the quantity flexibility contract. Heydari et al. (2017) examine the coordination in a two-echelon supply chain under a stochastic and credit-dependent demand with an incentive alignment scheme of a two-level delaying payment contract for both ordering and marketing decisions. The authors illustrate that the proposed model not only increases the expected profit of the channel members but also improves the sales volume. Unlike the mentioned literature which concentrates on the credit schemes without considering the behaviors of supply chain members towards these schemes, we model the situation when the franchisee will have different behaviors under different payment options, which supplements the existing literature in supply chain finance.

2.5.3 Sustainability in The Fashion Franchising Supply Chain

Sustainability, which relates to the environment (Chan et al. 2013, 2016) and society, is a timely issue. In fact, sustainability is calling forth more and more concerns in the fashion industry, both in practice and academic. De Brito et al. (2008) conduct an empirical study on the sustainability issues in fashion supply chains to discuss how the sustainability movement influences the fashion retail supply chain's organization and performance. According to the views of stakeholders of the fashion industry, the authors address the challenges and conflicts of the different dimensions of sustainability in the fashion supply chain in Europe. Nagurney and Yu (2012) design a model of oligopolistic competition in fashion supply chains involving differentiated products with the inclusion of environmental concerns. The authors apply the network-based competitive supply chain model and variational inequality theory to explore the effects

of changes in the demand functions, the total cost and total emission functions. Maccarthy and Jayarathne (2012) examine the characteristics and operations of collaborative clothing supply networks of two formats from a sustainability perspective. The authors highlight the challenges in assessing the economic, social and environmental aspects of sustainability. They elucidate that the level of proactive and positive sustainability practices is higher for the leading clothing brand retailer than that of the supermarket supply network. Shen (2014) demonstrates the significance of sustainability in the fashion industry with a case study on H&M, a well-established fast fashion brand. The author describes the structure of sustainable fashion supply chains and highlights the lessons learned from H&M's sustainable fashion supply chain management. Calderonmonge et al. (2017) construct a model with "Lasso regression" to elaborate on the success or failure of franchisors regarding the economic sustainability. The authors explain that for franchisees to succeed and "survive", the franchise fees and the ratio of company-owned to franchised outlets should be properly set concerning the age of the franchise. Yang et al. (2017) conduct a systematic review of the literature on sustainability in the fashion industry to identify the major academic findings on sustainable fashion retailing. The authors depict the most prominent areas in fashion retailing. Following this stream of research, we also consider sustainability issues in this thesis. To be specific, we analytically explore both the consumer utility and the environmental impact behind the franchising operations. We also derive the decision to optimize the social welfare. However, the perspective and analytical models of this thesis are different from the ones reported and reviewed in the above literature.

2.5.4 Channel Leadership

Channel leadership is widely addressed in the literature of operations and supply chain management. Majumder and Srinivasan (2006) examine the effect of contract leadership on the performance of multi-stage serial supply chains. The authors prove that the leadership in supply chains is a great driver of supply chain behaviour and a two-part tariff contract can coordinate supply chains with different leadership policies. Choi et al. (2013) explore the performance of different closed-loop supply chains under different channel leadership. The authors analytically reveal that the retailer-led model dominates the manufacturer-led and collector-led model with a systematic comparison and propose the two-tariff and new revenue-sharing contract for channel coordination with different channel leadership. Xiao et al. (2014) study the product variety and channel structure strategies in different channel leadership scenarios. With a retailer-

Stackelberg pricing model, the authors discover that the preference of channel leadership scenarios is influenced by the cost of offering product varieties. Xiao et al. (2015) further investigate the issues of product variety and pricing under different channel leadership with the retailer(-led) Stackelberg (RS) model and manufacturer(-led) Stackelberg (MS) model. The authors address that the retail price under the RS model is higher than that under MS model. Chen and Xiao (2015) study the uncertainty risks on both sides of the manufacturer-retailer relationship under two channel leadership structures. Under the Stackelberg game model, the authors find that the dominant retailer can better use the demand information and handle the uncertainties. Chiu et al. (2015) develop three all-units quantity discount (QD) contracts for different channel leaderships to explicate how channel leadership affects supply chain coordination under both the information symmetric and asymmetric situations. Yu and Xiao (2017) construct two game scenarios to analyze the impacts of channel leadership on the price and service level decisions and profits with the existence of a third-party logistics provider. The authors show that the channel leadership of the supplier fails to ensure a higher profit. Zheng et al. (2017) examine how channel leadership affects the decisions within dual-channel closed-loop supply chains. The authors explain the significance of channel power structure on the channel efficiency. Guo et al. (2017) conduct a comprehensive review of supply chain contracts regarding supply chain structure and channel leadership in reverse logistics systems. According to the insight generated by the authors, who should be the leader in the channel is worthy of further research attention. Li et al. (2018) concentrate on the effect of product substitutability on pricing decisions under different channel leadership scenarios. The authors conclude that channel members can achieve more profit by taking the leader's role in spite of the competition and the asymmetric channel status. Different from the reviewed literature, one dimension of our research focuses on how the channel leadership influences the implementation of final product assembly. As the supplier and the retailer hold different costs for the final product assembly, the channel leadership can eventually affect the respective profit of individual channel members and the total profit of the whole supply chain. Our research pioneers the study on the revenue of integrating the channel leadership with assembly cost for coordinating the supply chain under the scenarios that either the supplier or the retailer dominates the channel.

2.5.5 Final Product Assembly and Mass Customization

Final product assembly with customer-specific components focusing on tailored

customer preferences is an important module encompassed in customization (Hoek et al., 1999; Mikkola and Skjøtt-Larsen, 2014), which is widely observed in the fashion industry. In the literature, Kotha (1995) demonstrates that the availability and geographical proximity of suppliers to the final product assembly plant are crucial for the success of a mass customization strategy. Marx et al. (1997) and Pires (1998) both examine long-term contractual relationships between the supplier and the final assembler. They observe that suppliers tend to share the same physical infrastructure with the final product assembly line that is responsible for module fabrication and installation. The cost consideration is critical for the final product assembly, too. Da Cunha (2004) explores the cost for the final product assembly with demand data and design the modules to significantly minimize the final product assembly cost. Da Cunha et al. (2007) study the assemble-to-order (ATO) production strategy for module-based mass customization. The authors uncover the impact of allocating final product assembly operations in the supply chain on the overall cost structure. Our research bases on the literature of final product assembly in industrial systems engineering and aims to advance our knowledge regarding the critical decision on who should be responsible for conducting the final product assembly in the supply chain system. This is an under-explored topic in the related literature.

2.5.6 Online-offline Operations in The Fashion Franchising Supply Chain

Online-offline operations are widely seen nowadays and have been known as an emerging trend in the fashion industry. In the literature, many studies explore how dual channel strategies can be implemented in a supply chain context. For example, recently, Yan and Pei (2015) study the strategic value of cooperative advertisement in a dual channel system with competition. Taleizadeh et al. (2016) explore the impacts of marketing effort decisions on a dual channel closed-loop supply chain. However, channel conflicts exist between the online and offline channels which would lead to serious problems which include harmful channel competition, losing profit margins and even the cannibalization problem. In operations management, Tsay and Agrawal (2004a, b) pioneer an important study on the channel conflict and channel coordination issues when the manufacturer adds a direct sales channel online. The authors propose that a change in the supply contract might help dampen the channel conflicts. Luo et al. (2016) explore the free-riding effect in a dual-channel supply chain. In the presence of e-commerce, the authors analytically study the supply chain coordination challenge. Even though there are reports showing that the existence of dual channels can be

beneficial to the supplier and the original retailer (e.g., Soysal and Krishnamurthi, 2015), it is commonly known that franchisees usually do not prefer to have competition with the franchisor in the same market. This calls for including terms and measures in the franchise contracts to avoid channel conflicts. In our research, we consider the situation under which the franchisor and the franchisee will adopt an operations mode where no channel conflicts exist.

2.5.7 The Use of Information in Franchising Supply Chain Operations

In supply chain management, the use of information is a big topic which receives a lot of attention over the past several decades (Scarf, 1959; Murray and Silver, 1966; Azoury, 1985; Bourland et al., 1996; Yue and Liu, 2006; Mishra et al., 2009; Shaltayev and Sox, 2010). In many cases, by postponing the final inventory decision, operational improvement can be made by using market information (Saghiri and Barnes, 2016; Edirisinghe and Atkins, 2017) which also helps to reduce risk (Asian and Nie, 2014; Paul et al., 2017). Among the different related fields of studies, the use of market information to improve demand forecast via "information updating" is a very important and popular area (Gurnani and Tang (1999); Vlachos and Tagaras (2001); Choi et al. (2003, 2006); see the review by Choi and Sethi (2010) for more information). For example, based on the fashion industry's practices on accurate response and quick response, Hammond (1990), Fisher and Raman (1996), Iyer and Bergen (1997), Eppen and Iyer (1997a, 1997b), Kim (2003), Tang et al. (2004), Choi (2007), and Cachon and Swinney (2011) all study the use of market information, usually with the concept of postponing the ordering decision time point, to improve inventory planning in fashion operations. They derive the optimal inventory policies under the respective setting and generate insights by examining how the use of information improves the supply chain performance and/or the measures to coordinate the channel. In the recent few years, several papers have explored the use of market information in a quick response environment. For example, Lin and Parlakturk (2012) investigate the role played by quick response in a competitive market environment. Yang et al. (2015) study the quick response policy in the presence of strategic forward-looking consumers. Choi (2016) investigates the impacts of inventory service targets on quick response fashion supply chains. Chen et al. (2016) reveal how the inventory subsidizing contract can be used to coordinate a just-in-time quick response supply chain with multiple shipments. Following the above stream of literature, our research also studies the use of market information in improving demand forecast. Different from all of the above studies on

quick response and information updating, we consider the franchising arrangement and the online-offline operations.

Some notes should be added for the above literature review. The prevalent franchising contracts we examined in the literature can actually be observed in practice, especially in the fashion industry of China. Many fashion franchisors tend to employ revenue-sharing contracts to integrate the resources of the channel members to increase the order quantity and boost marketing efforts, especially in e-business. For example, as the retail price is fixed in the ERP system, the revenue-sharing contract, as a mechanism of sharing the market opportunity (i.e., benefit) and risk, is effective in encouraging the franchisee to increase the order quantity and put more marketing efforts to boost the sales. Franchise fee contracts have not been adequately mainly because the franchising operations remain a niche area in OM research. In addition, franchise fee contracts are generally explored for investigating the issue of information asymmetry which are mainly examined by the researchers with many other types of contracts (such as the buyback contract, two-part nonlinear contract and collection effort requirement contract).

Chapter 3. The Influence of The Payment for Fixed Royalties in Franchising Operations of The Sustainable Fashion Brand

3.1 Research Background

In the fashion industry, many brands operate under different kinds of franchising systems. In many cases, there is a fixed royalty charged by the franchisor. The fixed royalty is the payment charged by the franchisor from the franchisee to authorize the franchisee to enter the franchising system, use the franchisor's brand name, and sell the products of the franchisor with the unique franchising rights in a specific region. Undeniably, the fixed royalty as the franchise fee is regarded as the decisive core issue that distinguishes the characteristic of franchising operations. As the fixed royalty serves not only as a criterion to select the qualified franchisees but also as a mechanism to balance the risk and profit allocation within the franchising channel, the payment method brings a great influence on the operations of different members in the franchising channel. Meanwhile, sustainability issue is very critical in the fashion industry, which is regarded as one of the most pollutant industrial sectors. More and more environmentally conscious consumers are aware of this big issue and call for green and responsible fashion brands, which pushes fashion companies to reflect their operations and accordingly make a difference. Under this background, sustainable fashion brands emerge to fill in the gap in the fashion market to meet the consumers' increasing demand for sustainable operations. To this end, we explore how sustainable fashion brands expand in this emerging market with properly designed franchising contracts from a supply chain finance perspective with the involvement of the payment of the fixed royalties.

In the practice of fashion franchising operations, most of the brand owners as the franchisors prefer to collect the payment for the fixed royalty once the franchise contract is negotiated, especially the international brands with more power in the franchising fashion brand owner, employs the policy that the fixed royalty must be paid within five days after the franchising contract is confirmed. The company believes such a mechanism can guarantee stable business operations. Meanwhile, such payment can be realized in multiple methods including additional revenue sharing, deduction in the value of return products and exemption as a bonus for opening new shops. With the

intensively rising consciousness of sustainability in practice, many sustainable fashion brands keep devoting to enhancing the sustainable operations during the process of expanding the franchising business in both the international and domestic markets. We observe that some franchisors insist on charging the fixed royalty as an upfront payment (before starting the franchising operations), whereas some request the franchisees to pay after the franchising operations started. For the following demonstration, we name the first scenario as the upfront payment (URP) plan and the later one as the later payment (LRP) plan.

Motivated by the fact that the sustainability issue becomes very critical, and more and more sustainable fashion brands are expanding their business via franchising system and passionately participating in the sustainable industrial practice, we explore the franchising operations of the sustainable fashion brands concentrating on the fixed royalty payment. Further motivated by the business interaction of franchising from the perspective of improving the channel efficiency and achieving the coordination, we focus our research on the different performances in the scenarios of the early and later payment of the fixed royalty.

To be specific, we consider that the sustainable fashion brand (franchisor) provides two options for its franchisees in the franchising contract package. One specifies that the fixed royalty is paid early and the other mentions that fixed royalty is paid later. Integrating the findings of the discussion with the industrialists, we notice that these two scenarios exist in the real world, and the first option seems more appealing to the franchisor. However, is it true and always the case? In particular, for the franchisee, its behavioural reactions to these two options are probably different and their respective behavioural decisions should be considered. As we will illustrate later, the two scenarios will have different impacts on the performances of the franchisor and the franchisee. Our research applies an analytical modeling method and employs the classic newsvendor model to explore the topic and address the research questions. We also investigate its impact on consumer utility and the environmental impact under the two scenarios.

3.2 Problem Description and Model Formulation

We consider a sustainable fashion brand, called Brand S, which operates as both the franchisor and supplier in a supply chain. There is a franchisee who wants to be authorized with the franchise right to operate Brand S in its market. The franchisee

needs to place an order before the selling season. Demand in the season, denoted by x, is uncertain and follows a certain distribution F(x). The franchisor supplies a seasonal fashion product to the franchisee, and the respective order quantity q is decided by the franchisee. The unit manufacturing cost for the product is m and the unit retail price is r. The franchisor charges the franchisee a wholesale price w on each unit. To be granted the authorized right to run the franchising operations, the franchisee usually needs to pay a fixed royalty R to the franchisor. We consider in our research that the sustainable fashion brand (franchisor) provides two options for its franchisee in the franchising contract package. One is to have the fixed royalty paid early (i.e., an "upfront payment") and the other is to have the fixed royalty paid later (called "later royalty payment"). In the two scenarios, the franchisee may react by behaving differently, which is reflected by the respective "behavioural" optimization problem and hence the optimal order quality. As a remark, we assume the seasonal selling period is short and we may consider the time value of the royalty payment in the future. We use the classical newsvendor model to study this problem because of the seasonal short-life nature of the fashion product. In addition, using the newsvendor problem can help derive more analytically tractable results and facilitate comparisons with the literature's findings. We consider an end of season salvage value $v$for each unit of overstocked unsold product. The details are shown in Figure 3.1.

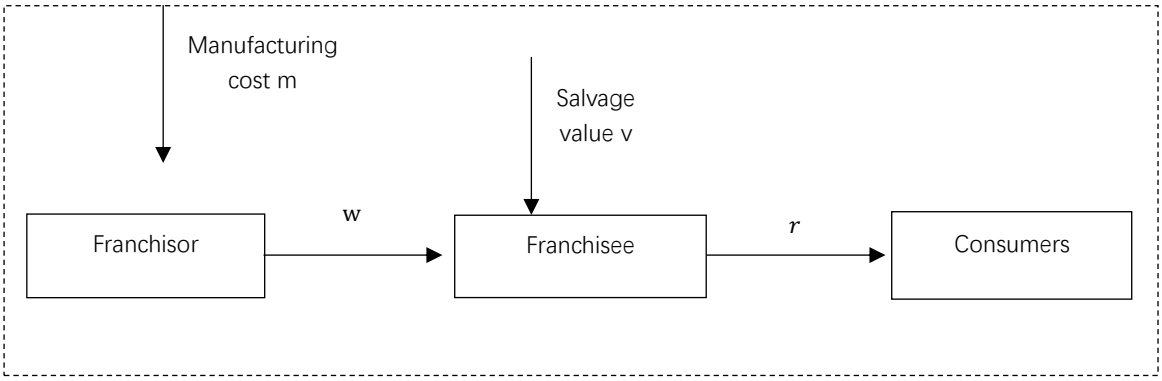

Figure 3.1. Basic model.

In the scenario of upfront royalty payment (URP), the franchisee is required to pay the royalty before the franchise operates in the selling season. Thus, we argue that under URP, there will be a strong anchoring effect on the franchisee towards the upfront payment. This effect can be explored in Chen et al. (2013), who study how payment

schemes affect the inventory decisions under mental accounting. Thus, under URP, we argue that the franchisee would want to maximize the probability of achieving a profit of at least $R + \xi$, where R is the royalty payment and ξ is the desirable profit of selling the product during the season. Under URP, the franchisee's operations profit under franchising (not counting the paid fixed royalty) is given as follows: $\pi_{FE,URP}(q) = r\,min(q, x) - wq + v\,max(q - x, 0)$

The optimization problem is hence given below:

The problem (P1) $\max_q Pr(\pi_{FE,URP}(q) \geq R + \xi)$.

The optimal order quantity which solves Problem (P1) can be expressed as follows (see Lau (1980) for the details):

$$q^*_{FE,1} = \frac{R+\xi}{r-w}. \quad (3.1)$$

Note that from (3.1), $q^*_{FE,1}$ is independent of the specific market demand x's distribution and it is a very neat and simple closed-form solution. In fact, to maximize the chance of hitting or exceeding the profit target under the standard newsvendor problem is equivalent to finding the quantity which could just hit (but not exceed) the respective profit target, which is the physical meaning behind the optimal ordering quantity in (3.1).

In the scenario of later royalty payment (LRP), the franchisee will pay the royalty after the selling season. The profit of the franchisee under the LRP scenario is found as follows:

$$\pi_{FE}(q) = r\,min(q, x) - wq + v\,max(q - x, 0) - R. \quad (3.2)$$

The expected profit of the franchisee in LRP scenario is

$$E(\pi_{FE}) = (r - w)q - (r - v)\int_0^q F(x)dx - R. \quad (3.3)$$

To maximize the expected profit of the franchisee in LRP scenario, we have the optimal order quantity of the franchisee in LRP scenario as

$$q^*_{FE,2} = F^{-1}\left(\frac{r-w}{r-v}\right) \quad (3.4)$$

where $F^{-1}(\cdot)$is the inverse function of $F(\cdot)$.

After deriving the optimal order quantity in the two scenarios, we establish the expected profit function of the franchisor, which is denoted as $\overline{\pi}_{FS,i}$ and $i = 1,2$.

$$\overline{\pi}_{FS,i} = (w - m)q^*_{FE,i} + R. \quad (3.5)$$

Accordingly, the expected profit function of the franchisee under the two scenarios can be expressed as:

$$\overline{\pi}_{FE,i} = (r - w)q^*_{FE,i} - (r - v)\int_0^{q^*_{FE,i}} F(x)dx - R. \quad (3.6)$$

The expected supply chain profit under the two scenarios can be expressed as:

$$\overline{\pi}_{SC,i} = (r - m)q^*_{FE,i} - (r - v)\int_0^{q^*_{FE,i}} F(x)dx. \quad (3.7)$$

During the apparel production and distribution period, it brings a burden to the environment, such as carbon emission. Since it is a sustainably-operated brand, compared to the traditional fashion brand, it should produce less pollution to the environment. We assume the environmental impact of each unit sustainable apparel is denoted as θ. If θ is large, we say the degree of sustainability of the sustainable fashion brand is low; If θ is small, we say the degree of sustainability of the sustainable fashion brand is high.

The total environmental impact under the two scenarios can be expressed as:

$$EB_i = -\theta q^*_{FE,i}. \quad (3.8)$$

In addition, we also consider consumer surplus as an important influencing factor. In the fashion industry, consumers are benefited if the chance of stockout is low. As the retail price is not an operational variable in the fashion industry, which has been clearly determined before the selling season starts and kept fixed during the business operations, we keep the price fixed in our analysis. Following Choi (2016), we consider the consumer surplus (or consumer welfare) is related to the inventory service level. We define the consumer surplus as the product of ε and service level, where ε is the coefficient for modelling the service-level. When the inventory service level is high, the chance of stock out is low, and the consumers can purchase the fashion products in most cases. This creates consumer utility. The inventory service levels are denoted as s_i. Thus, the consumer surplus is defined as follows:

$$CS_i = \varepsilon s_i, \quad (3.9)$$

where s_1 is the inventory service level of $q^*_{FE,1}$ and s_2 is the inventory service level of $q^*_{FE,2}$.

We also consider the performance of social welfare. As for social welfare, the consumer surplus is a constant term. The optimization problem is to determine the optimal quantities to maximize profits. We also compare the performances of social welfare under different optimal quantities. We model the social welfare, including the supply chain profit, the consumer surplus and the environmental impact (which is also in line with the literature, e.g., Atasu et al. 2009 and Krass et al. 2013).

The social welfare function can be expressed as follows:

$$SW_i(q) = r\,min(q, x) - mq + v\,max(q - x, 0) + \varepsilon s_i - \theta q. \quad (3.10)$$

Thus, the expected social welfare function can be expressed as follows:

$$\overline{SW}_i(q^*_{FE,i}) = (r - m - \theta)q^*_{FE,i} - (r - v)\int_0^{q^*_{FE,i}} F(x)dx + \varepsilon s_i. \quad (3.11)$$

3.3 Optimal Decisions

In this section, we explore the performances of the social welfare under both the URP and LRP scenarios.

In the URP scenario, the social welfare can be expressed as:

$$\overline{SW}_1(q^*_{FE,1}) = (r - m - \theta)q^*_{FE,1} - (r - v)\int_0^{q^*_{FE,1}} F(x)dx + \varepsilon s_1. \quad (3.12)$$

In the LRP scenario, the social welfare can be expressed as:

$$\overline{SW}_2(q^*_{FE,2}) = (r - m - \theta)q^*_{FE,2} - (r - v)\int_0^{q^*_{FE,2}} F(x)dx + \varepsilon s_2. \quad (3.13)$$

The difference between $\overline{SW}_1$ and $\overline{SW}_2$ is defined as $\Delta_{SW} \equiv \overline{SW}_1 - \overline{SW}_2$.

$$\Delta_{SW} = (r - m - \theta)(q^*_{FE,1} - q^*_{FE,2}) - (r - v)\left(\int_0^{q^*_{FE,1}} F(x)dx - \int_0^{q^*_{FE,2}} F(x)dx\right) + \varepsilon(s_1 - s_2). \quad (3.14)$$

DefineR_1as the threshold of fixed royalty payment, which allows $q^*_{FE,1} = q^*_{FE,2}$, and $R_1 = (r - w)\left[F^{-1}\left(\frac{r-w}{r-v}\right)\right] - \xi$. When $R < R_1$, we have $q^*_{FE,1} < q^*_{FE,2}$. When $R > R_1$, we have $q^*_{FE,1} > q^*_{FE,2}$. Define θ^* as the threshold of the environmental impact, which allows $\Delta_{SW} = 0$, and $\theta^* = (r - m) - \frac{(r-v)\left(\int_0^{q^*_{FE,1}} F(x)dx - \int_0^{q^*_{FE,2}} F(x)dx\right) - \varepsilon(s_1 - s_2)}{q^*_{FE,1} - q^*_{FE,2}}$. By comparing $\overline{SW}_1(q^*_{FE,1})$ and $\overline{SW}_2(q^*_{FE,2})$, we obtain Proposition 3.1.

Propositions 3.1. *(a) When $R < R_1$, we have $\overline{SW}_1(q^*_{FE,1}) > \overline{SW}_2(q^*_{FE,2})$, if and only if $\theta > \theta^*$. (b) When $R = R_1$, we $\overline{SW}_1(q^*_{FE,1}) = \overline{SW}_2(q^*_{FE,2})$. (c) When $R > R_1$, we have $\overline{SW}_1(q^*_{FE,1}) > \overline{SW}_2(q^*_{FE,2})$, if and only if $\theta < \theta^*$.* (See Figure 3.2)

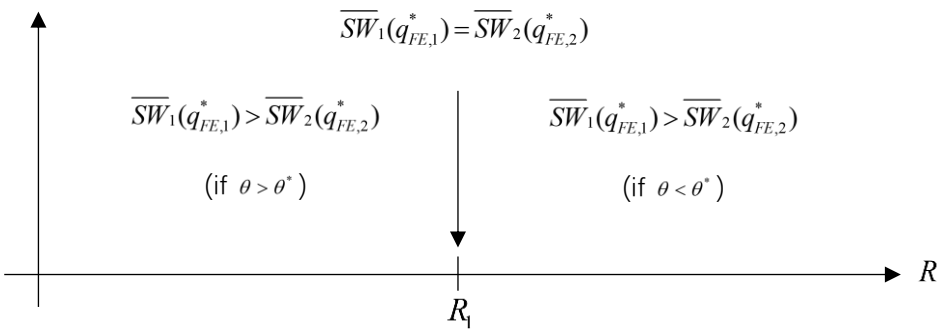

Figure 3.2. The relationships of $\overline{SW}_1(q^*_{FE,1})$ and $\overline{SW}_2(q^*_{FE,2})$ in Proposition 3.1.

We learn from Proposition 1 that the value of royalty payment R greatly the social welfares under the URP and LRP scenarios. When the royalty payment is small, the anchoring effect is also small, and the franchisor will place a small order under the URP scenario. Thus, the market demand is underestimated, and the social welfare is better than the case of LRP, if and only if the environmental impact of producing the sustainable apparel is sufficiently large. It is understandable the smaller quantity of apparel produced will lead to less harm to the environment. Accordingly, the social welfare may be higher with the reduced environmental impact. When the royalty payment is medium, the optimal order quantities in the two scenarios can be equal. Thus, the social welfare is also the same. When the royalty payment is large, the anchoring effect is also high, and the franchisor will order more to target its expected profit under the URP scenario. However, the order quantity may exceed the real market demand and the franchisor may get into "overstock". The social welfare will better off if and only if the environmental impact of producing the sustainable apparel is sufficiently low. It is understandable that when the environmental impact is little, even a large quantity of apparel produced will not do great harm to the environment. As a result, the social welfare may be higher with the enhanced service level (large inventory means high service level). The derived results demonstrate that the social welfare performance under the URP scenario is quite dependent on the value of royalty payment, while the social welfare performance under the LRP scenario is not affected by the royalty payment.

After exploring how the different royalty values affect the optimal ordering quantity of the franchisee and the performance of social welfare, we then investigate the impacts of different royalty values on other decisions. As the results show, different royalty

values also have different impacts on the inventory service level, the franchisor's profit, franchisee's profit, consumer surplus, and the environment benefit. The details are shown in Table 3.1.

From Table 3.1, we learn that when the royalty payment R is small, compared to the LRP scenario, the inventory service level is lower under the URP scenario. Moreover, the franchisor's profit, the franchisee's profit and the consumer surplus are all worse off under the LRP scenario than those under the URP scenario. However, the environmental impact is smaller under the LRP scenario than that under the URP scenario.

Table 3.1. The impacts of different royalty values.

	$R < R_1$	$R = R_1$	$R > R_1$
Inventory service level	$s_1 < s_2$	$s_1 = s_2$	$s_1 > s_2$
Franchisor's expected profit	$\overline{\pi}_{FS,1} < \overline{\pi}_{FS,2}$	$\overline{\pi}_{FS,1} = \overline{\pi}_{FS,2}$	$\overline{\pi}_{FS,1} > \overline{\pi}_{FS,2}$
Franchisee's expected profit	$\overline{\pi}_{FE,1} < \overline{\pi}_{FE,2}$	$\overline{\pi}_{FE,1} = \overline{\pi}_{FE,2}$	$\overline{\pi}_{FE,1} < \overline{\pi}_{FE,2}$
Consumer surplus	$CS_1 < CS_2$	$CS_1 = CS_2$	$CS_1 > CS_2$
Environment impact	$EB_1 < EB_2$	$EB_1 = EB_2$	$EB_1 > EB_2$

When the royalty payment is equal to a certain threshold, the order quantities under both the URP and LRP scenarios can be equal, which implies that the inventory service level and other performances will be the same under the two scenarios.

When the royalty payment is large, compared to the LRP scenario, the inventory service level is higher under the URP scenario. With the higher order quantity in the URP scenario, the franchisor will earn more profit, while "overstock" causes the franchisee to earn less. Moreover, compared to the LRP scenario, the consumers can benefit from the high inventory service level under the URP scenario. But, the environmental impact is larger with the high quantity of apparel produced under the

URP scenario (compared to the LRP scenario).

To conclude, in terms of expected profit, when $R = R_1$, the expected profit yielded under the URP scenario is the same as the expected profit yielded under the LRP scenario. Otherwise, the franchisee is always a loser in the URP scenario, whether the royalty payment is high or low.

3.4 Profit Risk Analysis

In this section, we analyze the franchisee's profit risks under both the URP and LRP scenarios by conducting a mean-variance (MV) analysis (Choi et al. 2008).

The variance of the franchisee's profit can be expressed as:

$$V(\overline{\pi}_{FE,i}) = E\left[(\overline{\pi}_{FE,i})^2\right] - \left[E(\overline{\pi}_{FE,i})\right]^2. \quad (3.15)$$

Putting (3.2) & (3.3) into (5.1), we have

$$V(\overline{\pi}_{FE,i}) = (r-v)^2(2q_{FE,i}n(q_{FE,i}) - 2\int_0^{q_{FE,i}} xF(x)dx - \left[n(q_{FE,i})\right]^2), \quad (3.16)$$

where $n(q_{FE,i}) = \int_0^{q_{FE,i}} F(x)dx$.

For $V(\overline{\pi}_{FE,i})$, we have $dV(\overline{\pi}_{FE,i})/dq_{FE,i} = 2(r-v)^2(1-F(q_{FE,i}))n(q_{FE,i}) \geq 0$. Thus, $V(\overline{\pi}_{FE,i})$ is a monotone increasing function of $q_{FE,i}$, which is a known result (Choi et al. 2008).

The variance of supply chain profit can be expressed as:

$$V(\overline{\pi}_{SC,i}) = (r-v)^2(2q_{FE,i}n(q_{FE,i}) - 2\int_0^{q_{FE,i}} xF(x)dx - \left[n(q_{FE,i})\right]^2), \quad (3.17)$$

where $n(q_{FE,i}) = \int_0^{q_{FE,i}} F(x)dx$.

The variance of social welfare can be expressed as:

$$V(\overline{\pi}_{SW,i}) = (r-v)^2(2q_{FE,i}n(q_{FE,i}) - 2\int_0^{q_{FE,i}} xF(x)dx - \left[n(q_{FE,i})\right]^2), \quad (3.18)$$

where $n(q_{FE,i}) = \int_0^{q_{FE,i}} F(x)dx$.

Comparing the variances of the franchisee's profit, the supply chain profit and the social welfare, we conclude the finding in Lemma 1.

Lemma 3.1. *(a)$V(\overline{\pi}_{FE,i})$, $V(\overline{\pi}_{SC,i})$ and $V(\overline{\pi}_{SW,i})$ are increasing functions of $q_{FE,i}$. (b) $V(\overline{\pi}_{FE,i}) = V(\overline{\pi}_{SC,i}) = V(\overline{\pi}_{SW,i})$.*

We can learn from Lemma 3.1(a) that the profit risks of the franchisee, the supply chain and the social welfare all increase with the order quantity, which means the higher order quantity will lead to higher profit risks. Lemma 3.1(b) shows the profit risks of the franchisee, the supply chain and the social welfare are equal, which implies profit risk of the franchisee determines the risk of the supply chain together with the social

welfare.

After identifying the relationship of profit risk and the order quantity, the franchisee will make a trade-off between the two financing options (under URP and LRP) to maximize its profit. However, the risk attitude will influence the franchisee's decision on the order quantity. There are three groups of decision-makers under the MV objectives: risk-averse, risk-neutral, and risk-seeking newsvendors (Choi et al. 2008). To show the results, we have Proposition 2.

Proposition 3.2. *(a) If* $R < R_1$*, we have* $q^*_{FE,1} < q^*_{FE,2}$ *and hence* $V(\overline{\pi}_{FE,1}) < V(\overline{\pi}_{FE,2})$. *(b) If* $R = R_1$*, we have* $q^*_{FE,1} = q^*_{FE,2}$ *and hence* $V(\overline{\pi}_{FE,1}) = V(\overline{\pi}_{FE,2})$. *(c) If* $R > R_1$*, we have* $q^*_{FE,1} > q^*_{FE,2}$ *and hence* $V(\overline{\pi}_{FE,1}) > V(\overline{\pi}_{FE,2})$.(See Figure 3.3)

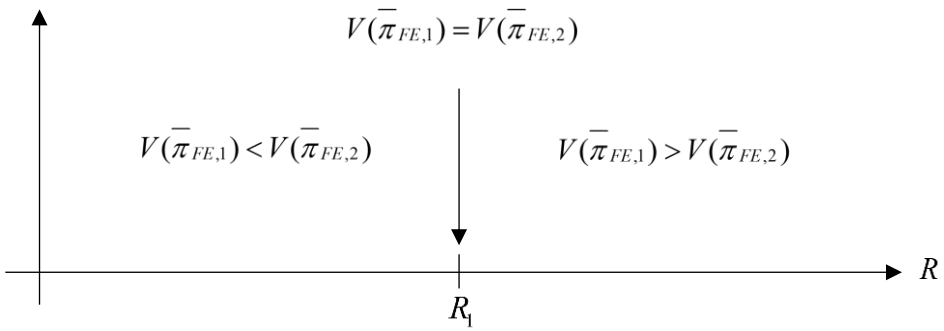

Figure 3.3. The profit risks of franchisee under both scenarios of URP and LRP.

Proposition 3.2 shows that firstly when the fixed royalty payment is sufficiently small ($R < R_1$), the franchisee will place a small order quantity under the URP plan. Thus, the risk under the URP plan is lower than that under the LRP. For the risk-averse franchisee, it is better to choose the URP plan. For the risk-neutral franchisee, it is better to choose the LRP plan. Under the small fixed royalty payment, both the URP plan and LRP plan are not suitable for the risk-seeking franchisee. Second, when the fixed royalty payment is medium ($R = R_1$), the risk levels are the same under both the URP plan and the LRP plan. Third, when the royalty payment is sufficiently large ($R > R_1$), the franchisee will place a large order quantity under the URP plan. Thus, the risk under the URP plan is higher than that under the LRP. For the risk-seeking franchisee, it is better to choose the URP plan. For the risk-neutral franchisee, it is better to choose the LRP plan. Under the large fixed royalty payment, both the URP plan and LRP plan are

not suitable for the risk-averse franchisee.

To conclude, we have Theorem 3.1 which shows that the risk preference of the franchisee will affect the optimal choice of the payment scenario (i.e., URP or LRP).

Theorem 3.1. (a) *For a risk-averse franchisee, if the royalty payment is sufficiently small, the franchisee will choose the URP plan; if the royalty payment is sufficiently large, the franchisee will choose the LRP plan. (b) For a risk-seeking franchisee, if the royalty payment is sufficiently small, the franchisee will choose the LRP plan; if the royalty payment is sufficiently large, the franchisee will choose the URP plan.*

Theorem 3.1 implies that depending on whether the royalty payment is sufficiently big or small as well as the franchisee's risk preference, the optimal payment plan is different. This highlights the importance of first understanding the real risk preference of the franchisee (and whether the royalty payment is sufficiently big or small) before we can decide the optimal payment scheme for the fixed royalty.

3.5 Extended Model with The Integration of Fixed Royalty and Variable Royalty

In the extended model, we consider the fixed royalty R, combined with a shared royalty, the variable royalty in which the franchisor will share α percent of the revenue of the franchisee. The fixed royalty R here is consistent with that in the basic model. Thus, the expected profit of the franchisee can be expressed as follows:

$$\hat{\pi}_{FE,i} = (r(1-\alpha) - w)\hat{q}_{FE,i} - (r(1-\alpha) - v)\int_0^{\hat{q}_{FE,i}} F(x)dx - R. \quad (3.19)$$

The expected profit of the franchisor can be expressed as follows:

$$\hat{\pi}_{FS,i} = (w - m)\hat{q}_{FE,i} + \alpha r(q - \int_0^{\hat{q}_{FE,i}} F(x)dx) + R. \quad (3.20)$$

In the scenario of URP, the optimal order quantity of the franchisee is shown below:

$$\hat{q}^*_{FE,1} = \frac{R+\xi}{r(1-\alpha)-w}. \quad (3.21)$$

In the scenario of URP, the optimal order quantity of the franchisee is shown below:

$$\hat{q}^*_{FE,2} = F^{-1}(\frac{r(1-\alpha)-w}{r(1-\alpha)-v}). \quad (3.22)$$

Comparing the optimal order quantities in the basic model and that in the extended model, we have Lemma 3.2.

Lemma 3.2. *When the franchisor shares α ($\alpha < 1$) proportion of the revenue of the franchisee, we have (a)$\hat{q}^*_{FE,1} > q^*_{FE,1}$ under the URP scenario, and $\hat{q}^*_{FE,2} < q^*_{FE,2}$ under the LRP scenario. (b) $V(\hat{\pi}_{FE,1}) > V(\overline{\pi}_{FE,1})$ under the URP scenario, and $V(\hat{\pi}_{FE,2}) <$*

$V(\overline{\pi}_{FE,2})$ *under the LRP scenario.*

Lemma 3.2(a) shows when both the fixed royalty and the variable royalty exist, the franchisee will increase the optimal order quantity for maximizing the profit under the URP scenario. It is understandable that due to the high anchoring effect (high royalty payment), the franchisee has to order more to obtain the target profit under the URP scenario. However, under the LRP scenario, the optimal order quantity of the franchisee will be reduced due to the extra royalty payment. Selling more implies a higher variable royalty payment. Therefore, the franchisee will reduce its order quantity. We summarize the results in Theorem 3.2.

Theorem 3.2. *The presence of a variable royalty will increase the profit risk of the franchisee under the URP scenario, while the presence of a variable royalty will decrease the profit risk of the franchisee under the LRP scenario.*

After identifying the changes of the order quantity of the franchisee between the extended model and the basic model, we will explore the performances of the service level, the franchisee's profit, the franchisor's profit, the consumer surplus and the social welfare under the URP scenario and LRP scenario, respectively. The results are concluded in Table 3.2.

Denote $\overline{\alpha}_{URP}$ as the threshold of the variable royalty in the URP scenario, which makes $\hat{\pi}_{FE,1}(\hat{q}^*_{FE,1}) = \overline{\pi}_{FE,1}(q^*_{FE,1})$ and $\overline{\alpha}_{URP} = \frac{(r-w)(\hat{q}^*_{FE,1}-q^*_{FE,1})-(r-v)(\int_0^{\hat{q}^*_{FE,1}} F(x)dx-\int_0^{q^*_{FE,1}} F(x)dx)}{r(\hat{q}^*_{FE,1}-\int_0^{\hat{q}^*_{FE,1}} F(x)dx)}$. $\overline{\alpha}_{LRP}$ is denoted as the threshold of the variable royalty in the LRP scenario, which gives $\hat{\pi}_{FS,2}(\hat{q}^*_{FE,2}) = \overline{\pi}_{FS,2}(q^*_{FE,2})$ and $\overline{\alpha}_{LRP} = \frac{(w-m)(q^*_{FE,2}-\hat{q}^*_{FE,2})}{r(\hat{q}^*_{FE,2}-\int_0^{\hat{q}^*_{FE,2}} F(x)dx)}$. Denote θ_3^* as the threshold of the environmental impact in the URP scenario, which allows $\widehat{SW}_1(\hat{q}^*_{FE,1}) = SW_1(q^*_{FE,1})$ and $\theta_3^* = (r-m) - \frac{(r-v)(\int_0^{\hat{q}^*_{FE,1}} F(x)dx-\int_0^{q^*_{FE,1}} F(x)dx)-\varepsilon(s_1-s_2)}{\hat{q}^*_{FE,1}-q^*_{FE,1}}$. Denote θ_4^* as the threshold of the environmental impact in the LRP scenario, which yields $\widehat{SW}_2(\hat{q}^*_{FE,2}) = SW_2(q^*_{FE,2})$ and $\theta_4^* = (r-m) - \frac{(r-v)(\int_0^{\hat{q}^*_{FE,2}} F(x)dx-\int_0^{q^*_{FE,2}} F(x)dx)-\varepsilon(\hat{s}_2-s_2)}{\hat{q}^*_{FE,2}-q^*_{FE,2}}$.

Table 3.2. Performance changes between the extended model and the basic model.

	URP Scenario	*LRP Scenario*
Inventory service level	$\hat{s}_1 > s_1$	$\hat{s}_2 < s_2$
Franchisor's expected profit	$\hat{\pi}_{FS,1}(\hat{q}^*_{FE,1}) > \overline{\pi}_{FS,1}(q^*_{FE,1})$	$\hat{\pi}_{FS,2}(\hat{q}^*_{FE,2}) > \overline{\pi}_{FS,2}(q^*_{FE,2})$, if and only if $\alpha > \overline{\alpha}_{LRP}$.
Franchisee's expected profit	$\hat{\pi}_{FE,1}(\hat{q}^*_{FE,1}) > \overline{\pi}_{FE,1}(q^*_{FE,1})$, if and only if $\alpha < \overline{\alpha}_{URP}$.	$\hat{\pi}_{FE,2}(\hat{q}^*_{FE,2}) < \overline{\pi}_{FE,2}(q^*_{FE,2})$
Consumer surplus	$\widehat{CS}_1 > CS_1$	$\widehat{CS}_2 < CS_2$
Environment impact	$\widehat{EB}_1 > EB_1$	$\widehat{EB}_2 < EB_2$
Social welfare	$\widehat{SW}_1(\hat{q}^*_{FE,1}) > SW_1(q^*_{FE,1})$, if and only if $\theta < \theta^*_3$.	$\widehat{SW}_2(\hat{q}^*_{FE,2}) > SW_2(q^*_{FE,2})$, if and only if $\theta > \theta^*_4$.

From Table 3.2, compared to the basic model, in the extended model in which both the fixed royalty and the variable royalty co-exist, we find some differences. First, under the URP scenario, with the increased order quantity, the inventory service level, franchisor's profit and consumer surplus are enhanced, while the environment benefit declines. The franchisee's profit depends on the value of the variable royalty α. The franchisee's profit can be increased if and only if the variable royalty is sufficiently small ($\alpha < \overline{\alpha}_{URP}$); vice versa. For the social welfare, the social welfare under the variable royalty payment can be better off if and only if the environmental impact is sufficiently low. Second, under the LRP scenario, with the decreased order quantity, the inventory service level, franchisee's profit, consumer surplus and the environmental impact are reduced. The franchisor's profit depends on the value of the variable royalty α. The franchisor can earn more profit if and only if the variable royalty is sufficiently large ($\alpha > \overline{\alpha}_{LRP}$); vice versa. For the social welfare, if and only if the environmental impact is sufficiently large, the social welfare under the variable royalty payment can be better off.

3.6 Channel Coordination

Supply chain (SC) coordination is a core topic of supply chain management. When the individual supply chain agents' decisions are exactly equal to the supply chain's optimal decision, supply chain coordination is achieved (Choi et al. 2018).

In this section, we investigate the SC coordination problem and examine which scheme (URP or LRP) is better for SC coordination. We hence explore the issues under URP and LRP scenarios, respectively.

From Section 3.3, the expected supply chain profit can be expressed as:

$$\overline{\pi}_{SC} = (r - m)q - (r - v)\int_0^q F(x)dx. \quad (3.23)$$

To maximize the supply chain profit and the social welfare, we derive the optimal order quantities in Lemma 3.3.

Lemma 3.3. *In the centralized setting, the optimal order quantity for maximizing the supply chain profit is* $q_{SC}^* = F^{-1}(\frac{r-m}{r-v})$.

Lemma 3.3 shows the optimal order quantity for maximizing the supply chain profit is determined by the retail price, the manufacturing cost and the salvage value of the sustainable fashion product. We will further respectively explore if the URP plan and LPR plan can coordinate the supply chain.

3.6.1 Coordination under The URP Scenario

In the scenario of URP, the optimization problem of the franchisee is to achieve at least $R + \xi$ profit, where $R$is the paid fixed royalty and ξ is the desirable profit of selling the sustainable fashion product during the season. The sequence of the events is 1) the franchisor first determines the fixed royalty $R$for the SC coordination ($R$is a decision variable); 2) the franchisee then places the order quantity to achieve the profit. Therefore, the optimal order quantity of the franchisee is $q_{FE,1}^* = \frac{R+\xi}{r-w}$ (see Section 3). Define $R_{SC}$is the threshold of the fixed royalty payment, which allows $q_{FE,1}^* = q_{SC}^*$ and $R_{SC} = (r - w)F^{-1}(\frac{r-m}{r-v}) - \xi$. We have Proposition 3.3 to show the supply chain coordination under the URP scenario.

Proposition 3.3. *Under the URP scenario, (a) The supply chain coordination can be achieved, if and only if* $R = R_{SC}$. *(b)* $R_{SC} > R_1$, *which implies a higher fixed royalty payment is helpful for the supply chain coordination.*

Proposition 3.3 shows that the supply chain can be coordinated under the URP scenario by setting an appropriate fixed royalty value R_{SC}. Moreover, the fixed royalty

value R_{SC} for the supply chain coordination is higher than the threshold R_1, which can maximize the franchisee's profit in the decentralized setting. Although the supply chain profit can be maximized with R_{SC}, the franchisee's profit is reduced. However, under such circumstances, the franchisor can make more profit with the increased order quantity.

3.6.2 Coordination under The LRP Scenario

In the scenario of LRP, the franchisee will pay the royalty after the selling season. The sequence of the events is listed as follows:1) The franchisor first determines a fixed royalty R ($R$is a constant), which is quite different from the URP scenario; 2) The franchisee places an optimal order quantity based on the forecast of the market demand. Therefore, the optimal order quantity is $q_{FE,2}^{*} = F^{-1}(\frac{r-w}{r-v})$ (see Section 3). Comparing between $q_{FE,2}^{*}$ and q_{SC}^{*}, we have Lemma 3.4.

Lemma 3.4. *In the scenario of LRP,* $q_{FE,2}^{*} < q_{SC}^{*}$.

Lemma 3.4 shows that under the LRP scenario, the supply chain cannot be coordinated. We employ three widely-used coordination contracts to deal with the above problem, including the buyback contract, the consignment contract and the markdown sponsor contract.

3.6.4.1 Buyback Contract

In the buyback contract, the franchisor promises to buy back the leftovers at the end of selling season at a price $b$and $b > v$. Thus, the franchisee is encouraged to purchase more in the ordering stage. The optimal order quantity of the franchisee in the decentralized setting is denoted as $q_{FE,b}^{*}$.

The expected profit of the franchisee under the buyback contract can be expressed as follows:

$$E(\pi_{FE}) = (r-w)q - (r-b)\int_0^q F(x)dx - R. \quad (3.24)$$

Thus, we have the optimal order quantity of the franchisee under the buyback contract is $q_{FE,b}^{*} = F^{-1}(\frac{r-w}{r-b})$. We have Lemma 3.5.

Lemma 3.5. *Under the buyback contract, the optimal buyback price for the SC coordination is* $b_{SC} = r - \frac{(r-w)(r-v)}{r-m}$.

Lemma 3.5 demonstrates the common business practice in the fashion industry with the operations of buyback contracts. The buyback price is negatively correlated with the wholesale price and the salvage value. If the salvage value is sufficiently big,

the franchisee would rather salvage all the unsold products to obtain the immediate payment. Only when the franchisor increases the buyback price to the threshold level, the franchisee may accept the buyback contract. On the other hand, some fashion brand owners, especially those targeting the high-end market, tend to offer a high buyback price due to a relatively high wholesale price, which is an effective approach to avoid exposing their products in the salvage market or clearance market and ensure all the unsold products to be safely returned.

3.6.4.2 Consignment Contract

In the consignment contract, the franchisor offers a wholesale price that equals the manufacturing cost. As $w = m$, it means yielding a zero-profit margin for the franchisor. The franchisee will intuitively place a larger order quantity than before. But the franchisor will require to share a proportion of the franchisee's profit, which is denoted as β.

The expected profit of the franchisee under the consignment contract can be expressed as follows:

$$E(\pi_{FE,\beta}) = (1-\beta)\left[(r-m)q - (r-v)\int_0^q F(x)dx - R\right]. \quad (3.25)$$

Thus, we have the optimal order quantity of the franchisee under the consignment contract is $q_{FE,C}^* = F^{-1}(\frac{r-m}{r-v})$.

Lemma 3.6. *Under the consignment contract, we have $q_{FE,C}^* = q_{SC}^*$, which implies the supply chain can be coordinated.*

Lemma 3.6 explains the implementation of the consignment contract in the fashion industry. As the franchisor sets the wholesale price equal to the production cost, the double marginalization can be eliminated, where the operations are similar to the centralized scenario. The profits of both the franchisor and the franchisee are generated by the retailing operations conducted by the franchisee. As a result, the optimal order quantity of the franchisee can create the largest profits for both the franchisor and the franchisee, which means the maximal profit of the whole supply chain is also achieved. The consignment contract is regarded as the incentive offered by the franchisor to the franchisee as it bundles the interest of both parties. Such operations can be widely observed in the fashion franchising channel, especially in the regional market with fierce competition for the market share, where the implementation of consignment contract can be preferred by both the franchisor and the franchisee to balance the market situation in the specific markets.

3.6.4.3 Markdown Sponsor Contract

In the markdown sponsor contract, the franchisor provides the franchisee with a markdown sponsor money y to support the franchisee during the leftover clearance stage. The markdown sponsor money is also regarded as the right incentive alignment to encourage the franchisee to increase the order quantity.

The expected profit of the franchisee under the markdown sponsor contract is:

$$E(\pi_{FE,y}) = (r-w)q - (r-v-y)\int_0^q F(x)dx - R. \quad (3.26)$$

Thus, we have the optimal order quantity of the franchisee under the markdown sponsor contract is $q^*_{FE,y} = F^{-1}(\frac{r-m}{r-v-y})$. Let $q^*_{FE,y} = q^*_{SC}$ and we have Lemma 3.7.

Lemma 3.7. *Under the markdown sponsor contract, we have the optimal markdown sponsor money for the SC coordination is* $y_{SC} = \frac{(r-v)(w-m)}{r-m}$.

Lemma 3.7 substantiates the effect of the markdown sponsor money considering the wholesale price and the salvage value. For those franchisors who charge the franchisees with a high wholesale price, they are willing to offer a relatively high markdown sponsor money to compensate the franchisees for the cost of ordering the products that are unsold during the selling season, which covers some lost of the franchisees. On the other hand, if the franchisor believes the salvage value is adequately satisfactory for the franchisee, he tends to reduce the markdown sponsor money to protect his own interest. In the fashion industry, the markdown sponsor contract is often offered by the trendy fashion brand owners targeting the mass market with quick response operations. The markdown sponsor money is utilized as the incentive to encourage the franchisee to increase the order quantity for a short selling season.

3.7 Conclusion and Summary

Our research explores the effects of fixed royal payment in franchising of sustainable fashion brands. The fixed royalty is the payment charged by the franchisor to authorize the franchisee to enter the franchising system, use the franchisor's brand name, and sell the products of the franchisor with the unique franchising rights in a specific region. As the fixed royalty serves not only as a criterion to select the qualified franchisees but also as a mechanism to balance the risk and profit allocation within the franchising channel, the payment method brings a great influence on the operations of different members in the franchising channel.

We consider in our research that the sustainable fashion brand (franchisor) provides two options for its franchisees in the franchising contract package. One is that the fixed royalty is paid early and the other is that fixed royalty is paid later. Different effects on the order quantity, the social welfare and the risk levels can be identified in the two scenarios. The findings and results can be summarized as follows:

Social welfare performance: The social welfare performance under the URP scenario depends on the value of royalty payment, while the social welfare performance under the LRP scenario is not affected by the royalty payment. When the value of royalty payment is reasonably set, the social welfare performances under the two scenarios can be the same. However, when the value of royalty payment is large, the social welfare performance under the URP scenario will become better off than that under the LRP scenario if and only if the environmental impact of producing the sustainable apparel is sufficiently low. When the value of royalty payment is small, the social welfare performance under the URP scenario will become better off than that under the LRP scenario if and only if the environmental impact of producing the sustainable apparel is sufficiently high.

Profit risks: Profit risks of the franchisee, the supply chain and the social welfare all increase with the order quantity, which means that a higher order quantity will lead to a higher level of profit risk. The profit risk of the franchisee determines the social welfare, and the risk faced by the supply chain Our results show the risks under the URP scenario and LRP scenario are different. For a risk-averse franchisee, when the royalty payment is sufficiently small, the franchisee will choose the URP plan; while when the royalty payment is sufficiently large, the franchisee will choose the LRP plan. For a risk-seeking franchisee, when the royalty payment is sufficiently small, the franchisee will choose the LRP plan; while when the royalty payment is sufficiently large, the franchisee will choose the URP plan. The results show the risk preference of the franchisee is critically important as it affects the choice of the URP or LRP plan.

Co-existence of fixed and variable royalties: When both the fixed royalty and the variable royalty co-exist, the franchisee will increase the optimal order quantity for maximizing the profit under the URP scenario. It is understandable that owing to the high anchoring effect caused by the high royalty payment, the franchisee should order more to obtain the target profit under the URP scenario. However, under the LRP scenario, the optimal order quantity of the franchisee will be reduced due to the extra royalty payment. Selling more implies more variable royalty payment. Therefore, the

franchisee tends to reduce its order quantity. Moreover, the variable royalty will increase the profit risk of the franchisee under the URP scenario, while the variable royalty will decrease the profit risk of the franchisee under the LRP scenario.

Supply chain coordination: Our results show that the supply chain can be coordinated under the URP scenario by setting an appropriate fixed royalty value R_{SC}. And the fixed royalty value for attaining supply chain coordination is much higher than the threshold R_1 in the decentralized setting. Although the supply chain profit is maximized with R_{SC}, the franchisee's profit is reduced while the franchisor can make more profit with the increased order quantity. Under the LRP scenario, the supply chain cannot be coordinated due to the double marginalization effect. Thus, we employ three widely-used franchising contracts to deal with the coordination problems, which include the buyback contract, the consignment contract and the markdown sponsor contract. Finally, the proposed three contracts are proved to be effective for supply chain coordination.

Chapter 4. Final Product Assembly (FPA) Operations in Franchising Supply Chain Systems

4.1 Research Background

Nowadays, the rapid development of consumers' demand for exquisite and delicate products calls for flexible final product assembly operations in supply chain systems. In particular, the fast-developing technology in additive manufacturing significantly impacts the franchising supply chain including both an upstream supplier (franchisor) and a downstream retailer (franchisee), which boosts the final product assembly with flexibility and rapidness. It is important to note that the final product assembly operations, which can be implemented by either the supplier or the retailer, enable the products to better satisfy the market needs with more specific functionalities, processing and added value. Such practices can be widely observed in many industries. For example, in the decoration industry, the retail further processes the banquets with various sourced flowers and plants for the final product assembly. In the fashion industry, the final product assembly is critical for some special garments including evening dresses, wedding dresses and even traditional clothing. For the evening dresses, the handmade decoration as the final processing is regarded as the most important factor influencing consumers' buying decision[2]. In the agriculture industry, the initial products, such as coffee beans, nuts and tea may be further processed as a final product assembly including roasting, decladding and packaging to enhance the efficiency of distributing and selling. For example, roasting the coffee can substantially help the retailer to raise the menu price and obtain more profit[3]. Canning and packaging the tea is regarded as an added value for marketing and improving consumer satisfaction4. In the desktop PC industry, the consumer can choose branded PC that is assembled by the brand owner or the integrated PC assembled by the retailer on DIY base. From the perspective of PC brands, economies of scale in the crucial impetus for them to provide the service of

[2] https://cn.businessoffashion.com, accessed on 16 Nov 2018

[3] http://www.scanews.coffee, accessed on 16 Nov 2018

[4] http://rw.czonline.net, accessed on 16 Nov 2018

final product assembly[5]. In the hardware industry, the supplier or retailer tends to reprocess the products as a final product assembly into various specifications to better meet the market demand, especially for the seasonal mass household hardware. In the digital electronics industry, the final product assembly occurs in equipping the devices, such as mobile or automotive navigation, with some chips or electronic parts and components or installing covers and holders for the devices, which can help the product to be sold at a higher price and adapt to the regional market. Though the industrial practice of the supply chain with products of two-stage processing has been growing mature, few research efforts have been devoted to such area.

Final product assembly operations can be implemented by either the supplier or the retailer but the cost for such operations can be different for the respective channel member. Also, the different final product assembly costs and the incurred different wholesale prices offered by the supplier to the retailer affect the order quantity and lead to the different profit allocation between the channel members. Supply chain contracts can be an effective mechanism to facilitate and maintain the healthy operations of final product assembly. In addition to the simple wholesale price contract, buyback contracts can also be applied to deal with the interaction of final product assembly cost and profit allocation. The buyback contract is widely observed and discussed in supply chain management. Under the buyback mechanism, the supplier procures the unsold products, partly and totally, at a buyback price, which is effective to motivate the retailer to increase the order quantity. Buyback contracts are also prevalent in practice in the above-mentioned industries. For example, in the fashion industry, the supplier often offers buyback contracts to encourage the retailer to increase order quantity and achieve channel coordination. However, little research efforts are contributed to the study on buyback contracts for the supply chain with the implementation of the final product assembly.

Motivated by the observed industrial practice, we address the effects of the respective costs of channel members on final product assembly and the incurred different wholesale prices and explore how such effects influence the profits of channel members and the performance of the whole supply chain with the application of buyback contracts. Our research focuses on the supply chain with one supplier and one

[5] https://www.entrepreneur.com, accessed on 18 Nov 2018

retailer with the implementation of the final product assembly, which brings significant insights to the fashion franchising operations. To be specific, the objectives of our research are to address the following major research questions.

(1) How to determine who should implement the final assembly of the product in the supply chain: the supplier or the retailer?

(2) How do different costs of final product assembly affect the order quantity and the whole supply chain's performance? Can channel coordination be achieved by using the incentive alignment contract such as buyback contract? If yes, then how to properly set the parameters so that coordination can be achieved?

(3) Are the findings robust if we consider the cases when (i) the retailer can operate in a make-to-order (MTO) model; (ii) there are two products in the supply chain?

4.2 Problem Description and Model Formulation

To explore the research issues, we conduct an analytical study on the application of the final product assembly in the supply chain for a single type of seasonal product. A classic single-period newsvendor problem is employed to establish a two-echelon supply chain containing one upstream supplier and one downstream retailer. The supplier is a Stackelberg leader offering a product to the retailer who is the follower in the supply chain. The product is a seasonal item with a single short selling period life cycle. The product needs some final processing before selling it to the consumer. Note that the above supply chain is classic in the literature. This final product assembly can be implemented by either the supplier or the retailer while the costs of the final product assembly can be different for the respective channel member.

For the decision-making process, we consider that the supplier first provides the product to the retailer at the unit wholesale price w. The retailer decides the ordering quantity q then sells the product to consumers at the unit retail price p. The unit production cost is m which is burdened by the supplier. The unsold product has a unit salvage value *v*. To avoid trivial cases, we assume $v < m < w < p$. The product demand *x* is uncertain and follows a certain distribution with a known probability density function $f(x)$ and cumulative distribution function $(\text{cdf})F(x)$. The implementation of the final product assembly can be conducted by either the supplier or the retailer at different costs. The cost for the supplier to conduct final product assembly is c_s. The such cost at the retailer is c_r. As the supply chain operations are

significantly affected by the different implementation of the final product assembly, we consider the cases when the final product assembly is implemented by the supplier and the retailer respectively. We start with the discussion of the benchmark case i.e., the wholesale price contract. For the wholesale price contract, the supplier offers a fixed wholesale price which is higher than the production cost for each item provided to the retailer. Thus, the wholesale pricing contract is a simple mechanism ensuring the supplier can obtain the profit margin (Shen et al., 2016). With the above setting, we can derive the profit function of the supplier and the retailer in different scenarios. (See Figure 4.1)

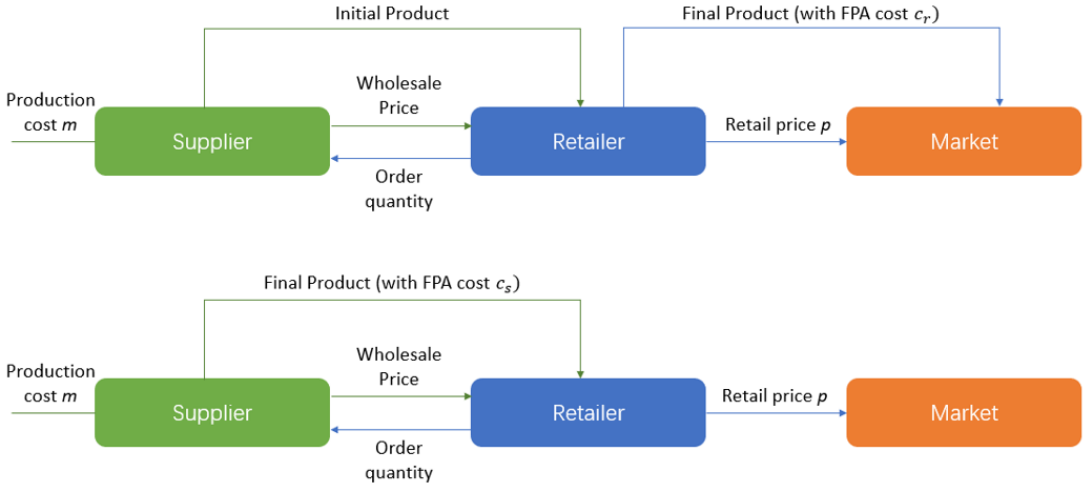

Figure 4.1. Basic model setting.

4.2.1 Situation under Scenario WS - The Supply Chain Implements The Wholesale Pricing Contract and The Supplier Conducts The Final Product Assembly

Under Scenario WS, the supply chain implements the wholesale pricing contract and final product assembly is conducted by the supplier with the unit cost c_s. Let $\tilde{\pi}_S^{WS}$, $\tilde{\pi}_R^{WS}$ and $\tilde{\pi}_{SC}^{WS}$ denote the profits of the supplier, the retailer and the whole supply chain. Let q_R^{WS} and q_{SC}^{WS} respectively denote the ordering quantity of the retailer and the production quantity of the whole supply chain. The profit functions are as follows:

$\tilde{\pi}_S^{WS} = (w^{WS} - m - c_S)q,$

$\tilde{\pi}_R^{WS} = p\min(q, x) + v\max(q - x, 0) - w^{WS}q,$

$\tilde{\pi}_{SC}^{WS} = p\min(q, x) + v\max(q - x, 0) - q(m + c_S).$

Note that in above profit functions, $p\min(q,x)$ is the revenue generated from selling the products in the market. mq is the ordering cost of the retailer and $q(m+c_S)$ is the production cost of the whole supply chain. Taking expectation, the expected profits can be derived as:

$\pi_S^{WS} = (w^{WS} - m - c_S)q,$

$\pi_R^{WS} = (p - w^{WS})q - (p - v)\int_0^q F(x)dx,$

$\pi_{SC}^{WS} = (p - m - c_S)q - (p - v)\int_0^q F(x)dx.$

It is straightforward to find the respectively expected profit-maximizing quantities for the retailer and the supply chain by solving the corresponding first-order conditions as follows:

$q_R^{WS^*} = F^{-1}\left(\frac{p-w^{WS}}{p-v}\right),\ q_{SC}^{WS^*} = F^{-1}\left(\frac{p-m-c_S}{p-v}\right).$

4.2.2 Situation under Scenario WS - The Supply Chain Implements The Wholesale Pricing Contract and The Retailer Conducts The Final Product Assembly

Under Scenario WR, the final product assembly is conducted by the retailer with the unit cost c_R, and similar to Scenario WS, the supply chain also implements the wholesale pricing contract. Let $\tilde{\pi}_S^{WR}$, $\tilde{\pi}_R^{WR}$ and $\tilde{\pi}_{SC}^{WR}$ denote the profits of the supplier, the retailer and the whole supply chain. Let q_R^{WR} and q_{SC}^{WR} respectively denote the ordering quantity of the retailer and the production quantity of the whole supply chain. The profit functions are as follows:

$\tilde{\pi}_S^{WR} = (w^{WR} - m)q,$

$\tilde{\pi}_R^{WR} = p\min(q,x) + v\max(q-x,0) - q(w^{WR} + c_R),$

$\tilde{\pi}_{SC}^{WR} = p\min(q,x) + v\max(q-x,0) - q(m + c_S).$

The expected profits can be further derived to be the following:

$\pi_S^{WR} = (w^{WR} - m)q,$

$\pi_R^{WR} = (p - w^{WR} - c_R)q - (p - v)\int_0^q F(x)dx,$

$\pi_{SC}^{WR} = (p - m - c_R)q - (p - v)\int_0^q F(x)dx.$

Following the newsvendor model, it is straightforward to find the respectively expected profit-maximizing quantities for the retailer and the supply chain by solving the corresponding first-order conditions as follows:

$q_R^{WR^*} = F^{-1}\left(\frac{p-w^{WR}-c_R}{p-v}\right),\ q_{SC}^{WR^*} = F^{-1}\left(\frac{p-m-c_R}{p-v}\right).$

4.3 Analyses: Centralized and Decentralized

4.3.1 Decentralized Setting

In this section, we first examine the decentralized setting. In the decentralized system, the supplier decides the wholesale price and the retailer is the decision-maker for the ordering quantity, where final product assembly is implemented by either the supplier or the retailer. The retailer aims to maximize her own profit rather than the profit of the whole supply chain. As derived in the basic model, for Scenario WS, where the supplier conducts final product assembly. The optimal ordering quantity of the retailer is $q_R^{WS^*} = F^{-1}\left(\frac{p-w^{WS}}{p-v}\right)$ while the optimal production quantity of the whole supply chain is $q_{SC}^{WS^*} = F^{-1}\left(\frac{p-m-c_S}{p-v}\right)$. Let $s_R^{WS} = \frac{p-w^{WS}}{p-v}$ and $s_{SC}^{WS} = \frac{p-m-c_S}{p-v}$ denote the inventory service level for the retailer and the whole supply chain, respectively. To compare the optimal retailer's ordering quantity and the optimal supply chain's product quantity in Scenario WS, we set $\Delta\alpha^1$ to express the difference between s_R^{WS} and s_{SC}^{WS}: $\Delta\alpha_1 = s_{SC}^{WS} - s_R^{WS} = \frac{w^{WS}-m-c_s}{p-v}$.

For Scenario WR, where the retailer conducts final product assembly, the optimal ordering quantities of the retailer is $q_R^{WR^*} = F^{-1}\left(\frac{p-w^{WR}-c_R}{p-v}\right)$ while the optimal production quantity of the whole supply chain is $q_{SC}^{WR^*} = F^{-1}\left(\frac{p-m-c_R}{p-v}\right)$. Let $s_R^{WR} = \frac{p-w^{WR}-c_R}{p-v}$ and $s_{SC}^{WR} = \frac{p-m-c_R}{p-v}$. To compare the optimal ordering quantity and the optimal product quantity in Scenario WR, we set $\Delta\alpha^2$ to express the difference between s_R^{WR} and s_{SC}^{WR}: $\Delta\alpha_2 = s_{SC}^{WR} - s_R^{WR} = \frac{w^{WR}-m}{p-v}$.

Proposition 4.1. *Under the decentralized supply chain system with the wholesale pricing contract, comparing Scenario WR and Scenario WS , for a given wholesale price, the double marginalization effect is larger under Scenario WR, where the retailer conducts the final product assembly.*

Proposition 4.1 reveals an inherent shortcoming brought under Scenario WR in the decentralized setting from the supply chain system's perspective. To be specific, when the final product assembly is assigned to the retailer, the double marginalization effect in the supply chain is larger than the case when the supplier is responsible for conducting final product assembly (under the wholesale pricing contract with the same wholesale price). This hurts the whole supply chain. However, it does not mean that it

is always not beneficial to let the retailer be the final product assembler. In fact, if we can dampen the double marginalization effect by other means (e.g., via an incentive alignment scheme such as buyback), then it is still beneficial to let the retailer take up the role as the final product assembler. Proposition 4.1 hence motivates us to further explore the use of buyback contract in Section 4.4.

4.3.2 Centralized Setting

In the centralized setting, the upstream supplier is supposed to be integrated with the downstream retailer with a central decision-maker to determine all the relevant decisions to maximize the profit of the whole supply chain system. The optimal profits for the whole supply chain under the scenarios where the final product assembly is implemented by the supplier and the retailer are respectively given as follows.

$$\pi_{SC}^{WS}\left(q_{SC}^{WS^*}\right) = (p - m - c_S)q_{SC}^{WS^*} - (p - v)\int_0^{q_{SC}^{WS^*}} F(x)dx, \quad (4.1)$$

$$\pi_{SC}^{WR}\left(q_{SC}^{WR^*}\right) = (p - m - c_R)q_{SC}^{WR^*} - (p - v)\int_0^{q_{SC}^{WR^*}} F(x)dx. \quad (4.2)$$

Case 3.1: $c_R > c_S$, let $c_R = c_S + \delta$, where $\delta > 0$

As $c_R > c_S$, we have $q_{SC}^{WS^*} > q_{SC}^{WR^*}$. Let $\Delta q_{SC}^* = q_{SC}^{WS^*} - q_{SC}^{WR^*} > 0$.

$$\pi_{SC}^{WS}\left(q_{SC}^{WS^*}\right) - \pi_{SC}^{WR}\left(q_{SC}^{WR^*}\right) = (p - m - c_S)\Delta q_{SC}^* - \delta q_{SC}^{WS^*} - (p - v)\int_0^{\Delta q_{SC}^*} F(x)dx.$$

As $\int_0^{\Delta q_{SC}^*} F(x)dx < \Delta q_{SC}^*$, we have $\pi_{SC}^{WS}\left(q_{SC}^{WS^*}\right) - \pi_{SC}^{WR}\left(q_{SC}^{WR^*}\right) < 0$. We can conclude that if $c_R > c_S$, then $\pi_{SC}^{WS}\left(q_{SC}^{WS^*}\right) < \pi_{SC}^{WR}\left(q_{SC}^{WR^*}\right)$.

Case 3.2: $c_R < c_S$, let $c_S = c_R + \gamma$, where $\gamma > 0$

Similar to Case 1, We can conclude that if $c_R < c_S$, then $\pi_{SC}^{WS}\left(q_{SC}^{WS^*}\right) > \pi_{SC}^{WR}\left(q_{SC}^{WR^*}\right)$. From the analysis of Case 3.1 and Case 3.2 above, we have Proposition 2.

Proposition 4.2. *In the centralized supply chain, the optimal choice of final product assembly depends on the values of c_s and c_R. The scenario with the smaller cost of final product assembly should be chosen as the optimal solution from the whole centralized supply chain system's perspective.*

Proposition 4.2 presents an important finding. It tells us that the simple decision rule regarding who should take up the final product assembly task is by checking the final product assembly cost: The party which is more efficient (i.e. lower cost) should be selected. This finding is intuitive and also in line with industrial wisdom where the central-decision maker always assigns the task of final product assembly to the channel member with a lower cost to maximize the profit of the whole system.

4.4 Pareto-improving Coordination

From the above section, we explore which member should implement the final product assembly from the perspective of both the centralized supply chain and the decentralized supply chain. It is known that the supply chain system is not ensured to be coordinated with simple wholesale price contracts. We hence study in this section the use of contractual agreement for achieving Pareto-improving coordination. Under Pareto improving coordination, at least one channel member is strictly better off without the other channel member is NOT worse off. Meanwhile, the whole supply chain system can be optimized. For supply chains selling short-life seasonal products, buyback contracts are widely applied, and it is known that they can help coordinate the supply chains. With the buyback contract, the retailer is incentivized to increase the ordering quantity as the leftover can be returned to the supplier at certain buyback price. The supplier can obtain more profit with the increased ordering quantity. Then the total profit of the supply chain system can be optimized. In order to achieve Pareto-improving coordination for the supply chain members considering the different channel members' costs on implementing final product assembly, we examine in this section the application of buyback contract on realizing Pareto-improving coordination for the supply chain. Here, we identify that Pareto-improving coordination when applying buyback can be achieved (i.e., both channel members are all benefited and the whole supply chain system is also optimized). To achieve Pareto-improving coordination, we integrate the buyback contract to the simple wholesale price contract with the unit buyback price b. All the unsold products will be bought back by the supplier by the end of the selling season at a unit price b. With the buyback contract, the profit allocation can be adjusted under different conditions. We further discuss Pareto-improving coordination in the scenarios where either the supplier or the retailer conducts the final product assembly.

4.4.1 Situation under Scenario BS - The Supply Chain Implements The Buyback Contract and The Supplier Conducts The Final Product Assembly

In Scenario BS, the supply chain implements the buyback contract and the final product assembly is implemented by the supplier at the unit cost c_S. Let π_S^{BS}, π_R^{BS} and π_{SC}^{BS} denote the expected profits of the supplier, the retailer and the whole supply chains, respectively. Let q_R^{BS} and q_{SC}^{BS} respectively denote the ordering quantity and the product quantity from the perspectives of the retailer and the whole supply chains. With the

wholesale price w^{BS} and the buyback price b^{BS}, the expected profits of the supplier, the retailer and the whole supply chains can be derived as follows:

$\pi_S^{BS} = (w^{BS} - m - c_S)q - (b^{BS} - v)\int_0^q F(x)dx,$

$\pi_R^{BS} = (p - w^{BS})q - (p - b^{BS})\int_0^q F(x)dx,$

$\pi_{SC}^{BS} = (p - m - c_S)q - (p - v)\int_0^q F(x)dx.$

The optimal ordering quantity and product quantity for the retailer and the supply chain can be listed as follows:

$q_R^{BS^*} = F^{-1}\left(\frac{p-w^{BS^*}}{p-b^{BS^*}}\right)$, $q_{SC}^{BS^*} = F^{-1}\left(\frac{p-m-c_S}{p-v}\right)$.

To coordinate the supply chain, the optimal ordering quantity of the retailer should be equal to the production quantity of the supply chain: $q_R^{BS^*} = q_{SC}^{BS^*}$. In order to better identify the conditions for the supply chain coordination, we derive the w^{BS^*} and b^{BS^*} as (4.3) and (4.4):

$$w^{BS^*} = p - \frac{(p-m-c_S)\left(p-b^{BS^*}\right)}{p-v}, \tag{4.3}$$

$$b^{BS^*} = p - \frac{(p-v)\left(p-w^{BS^*}\right)}{(p-m-c_S)}. \tag{4.4}$$

Note that (4.3) and (4.4) are in fact the same. We arrange them differently because in subsequent analyses, we want to determine the range of coordinating contract parameters by substituting variables and they will both be useful.

Let Ω^{BS*} be the set of buyback contract parameters (b^{BS^*}, w^{BS^*}), which achieves coordination under Scenario BS. Here, coordination means the retailer's optimal ordering quantity is the same as the supply chain's optimal product quantity, and the supply chain members' minimum (expected) profit requirements are satisfied.

Under Scenario BS, the final product assembly is implemented by the supplier at the unit cost c_S. The supplier sets the wholesale price w^{BS} sufficient enough to cover the production cost m and the final product assembly cost c_S. The retailer decides the ordering quantity accordingly. As all the unsold products are returned to the supplier, the supplier should also properly set the buyback cost b^{BS}, which is larger than the salvage value v, to maximize the profit. Under Pareto-improving coordination, the supplier adjusts the wholesale price and the buyback price regarding certain boundary to achieve the optimal profit while does not harm the retailer's profit. Let K_S denote the minimal expected profit requirement of the supplier.

$$\pi_S^{BS}\big|_{\Omega^{BS*}} = \left(w^{BS^*} - m - c_S\right)q_{SC}^{BS^*} - \left(b^{BS^*} - v\right)\int_0^{q_{SC}^{BS^*}} F\,(x)dx \geq K_S. \tag{4.5}$$

Put (4.3) and (4.4) into (4.5), let $B = \left[p - F\left(q_{SC}^{BS^*}\right)p - m - c_S\right]q_{SC}^{BS^*} + v\int_0^{q_{SC}^{BS^*}} F\,(x)dx$ and $C = (m + c_S)q_{SC}^{BS^*} + \left[p - \frac{p}{F\left(q_{SC}^{BS^*}\right)} + -v\right]\int_0^{q_{SC}^{BS^*}} F\,(x)dx$. We have

$$b^{BS^*} \geq \frac{K_S - B}{\int_0^{\frac{p-m-c_S}{p-v}} xf(x)dx}, \tag{4.6}$$

$$w^{BS^*} \geq (K_S + C)\,\frac{\frac{p-m-c_S}{p-v}}{\int_0^{\frac{p-m-c_S}{p-v}} xf(x)dx}. \tag{4.7}$$

Now, we check the retailer's requirement. Under Scenario BS, the final product assembly is implemented by the supplier. The retailer only needs to decide the ordering quantity based on the buyback contract offered by the supplier. As all the leftovers can be returned to the supplier at the buyback price b^{BS}, the retailer is encouraged to increase the ordering quantity for more profit. As the retail price is an exogenous variable which is determined by the market rather than an individual channel member, under Pareto-improving coordination, the retailer places the order only considering the wholesale price and the buyback price to maximize her own profit. Let K_R denote the minimal expected profit requirement of the retailer.

$$\pi_R^{BS}|_{\Omega^{BS*}} = \left(p - w^{BS^*}\right)q_{SC}^{BS^*} - \left(p - b^{BS^*}\right)\int_0^{q_{SC}^{BS^*}} F\,(x)dx \geq K_R. \tag{4.8}$$

Put (4.2) and (4.3) into (4.5). We have

$$b^{BS^*} \leq p - \frac{K_R}{\int_0^{\frac{p-m-c_S}{p-v}} xf(x)dx}, \tag{4.9}$$

$$w^{BS^*} \leq p - \frac{F\left(q_{SC}^{BS^*}\right)K_R}{\int_0^{\frac{p-m-c_S}{p-v}} xf(x)dx}. \tag{4.10}$$

Proposition 4.3. *Under Scenario BS, to make the buyback contract Ω^{BS*} a Pareto improving coordination contract, we require* $(K_S + C)\,\frac{F\left(q_{SC}^{BS^*}\right)}{\int_0^{q_{SC}^{BS^*}} xf(x)dx} \leq w^{BS^*} \leq p - \frac{F\left(q_{SC}^{BS^*}\right)K_R}{\int_0^{\frac{p-m-c_S}{p-v}} xf(x)dx}$, *and* $\frac{K_S - B}{\int_0^{q_{SC}^{BS^*}} xf(x)dx} \leq b^{BS^*} \leq p - \frac{K_R}{\int_0^{\frac{p-m-c_S}{p-v}} xf(x)dx}$.

As can be seen in Proposition 4.3, K_S and K_R, the minimal expected profit requirements of the supplier and retailer are critical to the optimal value of w^{BS^*} and b^{BS^*} under Scenario BS. If the supplier's minimal expected profit increases, the supplier tends to raise the wholesale price to achieve a higher profit level. However, if the

retailer's expected profit also increases, which constrains the growth space of the wholesale price, the supplier must consider the profit margin of the retailer and restricts the wholesale price under certain boundary values. On the contrary, the decrease of the supplier's minimal expected profit requirement can push down the wholesale price. While the decrease in the retailer's minimal expected profit requirement may encourage the supplier to raise the wholesale price. As for the buyback price, the increase of the supplier's minimal expected profit requirement means the supplier strives for better profit with bigger quantity, which induces the supplier to offer a higher buyback price to encourage the retailer to increase the ordering quantity.

4.4.2 Situation under Scenario BR - The Supply Chain Implements The Buyback Contract and The Retailer Conducts The Final Product Assembly

In Scenario BR, the final product assembly is implemented by the retailer at the cost c_S, and the supply chain implements the buyback contract. Let π_S^{BR}, π_R^{BR} and π_{SC}^{BR} denote the expected profits of the supplier, the retailer and the whole supply chains. Let q_R^{BR} and q_{SC}^{BR} denote the ordering quantity and product quantity from the perspective of the retailer and the whole supply chain. With the wholesale price w^{BR} and the buyback price b^{BR}, the expected profits of the supplier, the retailer and the whole supply chain can be derived as follows:

$$\pi_S^{BR} = (w^{BR} - m)q - (b^{BR} - v)\int_0^q F(x)dx,$$

$$\pi_R^{BR} = (p - w^{BR} - c_R)q - (p - b^{BR})\int_0^q F(x)dx,$$

$$\pi_{SC}^{BR} = (p - m - c_R)q - (p - v)\int_0^q F(x)dx.$$

The optimal ordering quantity and product quantity for the retailer and the supply chain can be listed as follows:

$$q_R^{BR^*} = F^{-1}\left(\frac{p - w^{BR^*} - c_R}{p - b^{BR^*}}\right),\ q_{SC}^{BR^*} = F^{-1}\left(\frac{p - m - c_R}{p - v}\right).$$

Similar to Scenario BS, we can the w^{BR^*} and b^{BR^*} as (4.11) and (4.12):

$$w^{BR^*} = (p - c_R) - \frac{(p - m - c_R)\left(p - b^{BR^*}\right)}{p - v}, \tag{4.11}$$

$$b^{BR^*} = p - \frac{(p - v)\left(p - w^{BR^*} - c_R\right)}{(p - m - c_R)}. \tag{4.12}$$

Let Ω^{BR*}express be the set of buyback contract parameters $\left(b^{BR^*}, w^{BR^*}\right)$, which achieves coordination for the Scenario BR.

Under Scenario BR, the supplier does not implement the final product assembly.

As a result, the supplier only needs to keep the wholesale price w^{BR} sufficiently larger than the production cost m to generate the profit. Similar to Scenario BS, the retailer decides the ordering quantity at the wholesale price before the selling season starts and return all the leftover to the supplier at the buyback price b^{BR}. To achieve Pareto-improving coordination, the supplier adjusts the wholesale price and the buyback price regarding certain boundary disregarding the final product assembly cost, which can maximize his own profit while satisfying the minimal profit requirement for the retailer.

$$\pi_S^{BR}|_{\Omega^{BR*}} = \left(w^{BR^*} - m\right)q_{SC}^{BR^*} - \left(b^{BR^*} - v\right)\int_0^{q_{SC}^{BR^*}} F(x)dx \geq K_S. \tag{4.13}$$

Put (4.11) and (4.12) into (4.13), let $D = (p - m - c_R)q_{SC}^{BR^*} - pF\left(q_{SC}^{BR^*}\right)q_{SC}^{BR^*} + v\int_0^{q_{SC}^{BR^*}} F(x)dx$ and $E = mq_{SC}^{BR^*} + \left[p - v - \frac{p-1}{F\left(q_{SC}^{BR^*}\right)} - \frac{c_R}{(p-m-c_R)}\right]\int_0^{q_{SC}^{BR^*}} F(x)dx$. We have

$$b^{BR^*} \geq \frac{K_S - D}{\int_0^{q_{SC}^{BR^*}} xf(x)dx}, \tag{4.14}$$

$$w^{BR^*} \geq \frac{(K_S+E)F\left(q_{SC}^{BR^*}\right)}{\int_0^{q_{SC}^{BR^*}} xf(x)dx}. \tag{4.15}$$

As for the retailer, under Scenario BR, the final product assembly is implemented by the retailer at the unit cost c_R. Once the retailer places the order in accordance with the buyback contract offered by the supplier, the retailer should take the final product assembly cost into account for realizing the profit. With the buyback price b^{1_R}, the retailer can return all the unsold products at the end of the selling season. To achieve Pareto-improving coordination, the retailer places the order considering the wholesale price and the buyback price, and also the final product assembly cost to maximize her own profit.

$$\pi_R^{BR}|_{\Omega^{BR*}} = \left(p - w^{BR^*} - c_R\right)q_{SC}^{BR^*} - \left(p - b^{BR^*}\right)\int_0^{q_{SC}^{BR^*}} F(x)dx \geq K_R. \tag{4.16}$$

Put (4.14) and (4.15) into (4.16), we have

$$b^{BR^*} \leq p - \frac{K_R}{\int_0^{q_{SC}^{BR^*}} xf(x)dx}, \tag{4.17}$$

$$w^{BR^*} \leq (p - c_R) - \frac{K_R F\left(q_{SC}^{BR^*}\right)}{\int_0^{q_{SC}^{BR^*}} xf(x)dx}. \tag{4.18}$$

Proposition 4.4. *Under Scenario BR, to make the buyback contract* Ω^{BR*} *a Pareto improving coordination contract, we require* $\frac{(K_S+E)F\left(q_{SC}^{BR^*}\right)}{\int_0^{q_{SC}^{BR^*}} xf(x)dx} \leq w^{BR^*} \leq (p - c_R) -$

$\frac{K_R F\left(q_{SC}^{BR^*}\right)}{\int_0^{q_{SC}^{BR^*}} xf(x)dx}$, *and* $\frac{K_S - D}{\int_0^{q_{SC}^{BR^*}} xf(x)dx} \leq b^{BR^*} \leq p - \frac{K_R}{\int_0^{q_{SC}^{BR^*}} xf(x)dx}$.

Based on Proposition 4.4, it can be addressed that the minimal expected profit requirements of supplier and retailer are closely related to the optimal value of w^{BR^*} and b^{BR^*} under Scenario BS. The implications are similar to the ones under Scenario BS.

4.4.3 Pareto-improving Coordination under Initial Arrangement and Optimal Arrangement

In this sub-section, we further compare the different situations when the member implementing the final product assembly in the initial arrangement is different from that in the optimal arrangement. Under such circumstances, the channel member who initially conducts the final product assembly would incur a higher cost than that of the other channel member. With Pareto-improving coordination, the final product assembly should be transferred to the other channel member for implementation while the profit of the channel member who initially implements the final product assembly should not suffer a loss.

As an illustration, we discuss this issue under the situation that the supplier is the one implementing the final product assembly in the initial arrangement while the retailer should be the conductor for the final product assembly in the optimal arrangement. As we address above in Section 4.4, K_S and K_R respectively denote the minimal expected profit requirements of the supplier and the retailer under the optimal arrangement. Let $\widehat{K}_S$ and $\widehat{K}_R$ denote the achieved expected profits respectively for the supplier and the retailer under the initial arrangement. According to the derived result, an existing Ω^{2*} for the wholesale price and the buyback price can achieve the optimal profit for the retailer under the optimal arrangement that the final product assembly is implemented by the retailer, which also at least satisfy K_S, the minimal profit requirement of the supplier. As the supplier should not suffer a loss in the optimal arrangement compared to the profit generated in the initial arrangement, the minimal profit that the supplier obtains in the optimal arrangement should at least equal the profit that the supplier obtains in the initial arrangement. As such, we define $\widetilde{K}_S = \max\left(K_S, \widehat{K}_S\right)$. Based on Proposition 4.3 and Proposition 4.4, it can be concluded that the supplier is guaranteed not to suffer the loss in the optimal arrangement when $\widetilde{K}_S$ equal K_S. With the same approach, we define $\widetilde{K}_R = \max\left(K_R, \widehat{K}_R\right)$. It can also be

derived that the retailer is guaranteed not to suffer the loss in the optimal arrangement when $\widetilde{K}_R$ equals K_R.

4.5 Extended Models

In the above discussions, we have explored the case with one-product and the supply chain operates fully in the make-to-stock scenario. Here, for robustness checking, we study two extended cases.

4.5.1 Two-product Scenario

In the basic model, we explore the scenarios with only one product. From the perspective of industrial practice, the supplier, in general, offers more than one product (i.e. multi-products) to the retailer. In this section, we extend the analysis by considering the scenario of two products[6]. To be specific, the supplier offers two separate products with different final product assembly costs to the retailer. As for Product 1, we use c_{S1} and c_{R1} to denote the supplier's and retailer's costs for implementing final product assembly respectively. As for Product 2, we employ c_{S2} and c_{R2} to represent the supplier's and retailer's costs for implementing final product assembly respectively.

From the whole supply chain's perspective: For the cases when both c_{S1} and c_{S2} are larger than or smaller than c_{R1} and c_{R2}, the optimal choice of final product assembler is straightforward. For example, if both c_{S1} and c_{S2} are larger than c_{R1} and c_{R2}, respectively, then the retailer should take up the role as the final product assembler. If both c_{S1} and c_{S2} are respectively smaller than c_{R1} and c_{R2}, then the supplier should take up the role as the final product assembler. This is implied by Proposition 4.2.

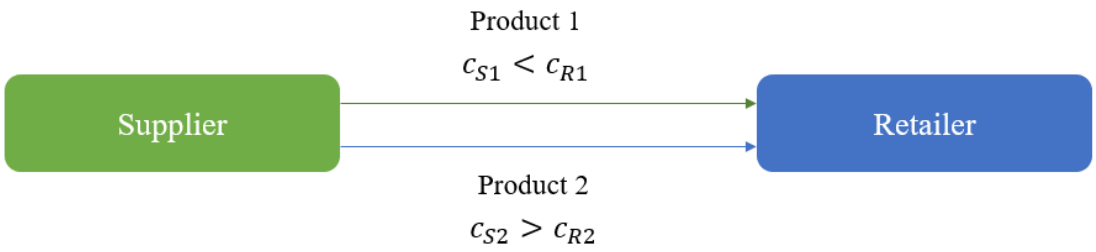

Figure 4.2. The channel structure with two products.

[6] As we will see later on, the two-product case can more clearly show the tradeoff and results, compared to the general *n* products case. The insights and findings in fact can be applicable to the *n* products case.

Now, we look at the less straightforward case in which we have the case as depicted in Figure 4.2. Note that without loss of generality, we set the specific case in which for Product 1, the final product assembly cost at the supplier is lower than that at the retailer and opposite for Product 2. We first consider the situation where the final product assemblies of Product 1 and Product 2 can be conducted by different channel members. According to Proposition 4.2, the channel member with less cost of final product assembly should be chosen as the optimal solution for the whole centralized supply chain, which implies that if the final assemblies of two products can be respectively implemented by different channel members. For Product 1, as $c_{S1} < c_{R1}$, it is optimal for the supplier to conduct the final product assembly. For Product 2, as $c_{S2} > c_{R2}$, it is optimal that the retailer conducts the final product assembly.

We next consider the situation where the final assemblies of Product 1 and Product 2 can only be conducted by one channel member, either the supplier or the retailer. In this case, we examine how to determine the optimal choice of final product assembler for the centralized supply chain system. Again, we explore the cases when the final assemblies of two products are solely conducted by either the supplier or the retailer. We consider the general case when all parameters of Product 1 and Product 2 can be different and add subscripts "1" and "2" to differentiate. We use the superscript TPS to denote the "two-product scenario".

Let $\pi_{SC}^{TPS,S}$ and $\pi_{SC}^{TPS,R}$ respectively denote the profits of the supply chain where the supplier conducts the final product assembly and the supply chain where the retailer conducts the final product assembly. Let $q_{SC,i}^{TPS,S}$ and $q_{SC,i}^{TPS,R}$ respectively denote the product quantities under both cases, $i \in (1,2)$ which presents Product 1 and Product 2.

For the case when the supplier implements the final assemblies for both products, we have

$$\pi_{SC}^{TPS,S} = \left[(p_1 - m_1 - c_{S,1})q_{SC,1}^{TPS,S} - (p_1 - v_1)\int_0^{q_{SC,1}^{TPS,S}} F_1(x_1)dx_1\right] + \left[(p_2 - m_2 - c_{S,2})q_{SC,2}^{TPS,S} - (p_2 - v_2)\int_0^{q_{SC,2}^{TPS,S}} F_2(x_2)dx_2\right].$$

For Product i: The optimal product quantity for the supply chain where the supplier conducts the final product assembly can be derived as follows: $q_{SC,i}^{TPS,S*} = F_i^{-1}\left(\frac{p_i - m_i - c_{S,i}}{p_i - v_i}\right), i \in (1,2)$. Then the optimal profit of the supply chain with two products when the supplier is the final product assembler is:

$$\pi_{SC}^{TPS,S*}\left(q_{SC,1}^{TPS,S*}, q_{SC,2}^{TPS,S*}\right) = \sum_{i=1}^{2}\left[\left(p_i - m_i - c_{S,i}\right)q_{SC,i}^{TPS,S*} - \left(p_i - v_i\right)\int_0^{q_{SC,i}^{TPS,S*}} F_i\left(x_i\right)dx_i\right].$$

For the case when the retailer implements the final assemblies for both two products. We have

$$\pi_{SC}^{TPS,R} = \left[\left(p_1 - m_1 - c_{R,1}\right)q_{SC,1}^{TPS,R} - \left(p_1 - v_1\right)\int_0^{q_{SC,1}^{TPS,R}} F_1\left(x_1\right)dx_1\right] + \left[\left(p_2 - m_2 - c_{R,2}\right)q_{SC,2}^{TPS,R} - \left(p_2 - v_2\right)\int_0^{q_{SC,2}^{TPS,R}} F_2\left(x_2\right)dx_2\right].$$

The optimal product quantity for the supply chain where the retailer conducts the final product assembly for the two-product case can be derived as follows: $q_{SC,i}^{TPS,R*} = F_i^{-1}\left(\frac{p_i - m_i - c_{R,i}}{p_i - v_i}\right), i \in (1,2)$. Then the optimal profit of the supply chain can be derived as follows:

$$\pi_{SC}^{TPS,R*}\left(q_{SC,1}^{TPS,R*}, q_{SC,2}^{TPS,R*}\right) = \sum_{i=1}^{2}\left[\left(p_i - m_i - c_{S,i}\right)q_{SC,i}^{TPS,R*} - \left(p_i - v_i\right)\int_0^{q_{SC,i}^{TPS,R*}} F_i\left(x_i\right)dx_i\right].$$

Let $\Delta q_{SC,i}^{TPS*} = q_{SC,i}^{TPS,S*} - q_{SC,i}^{TPS,R*}, \Delta\pi_{SC}^{TPS*} = \pi_{SC}^{TPS,S*} - \pi_{SC}^{TPS,R*}, \int_0^{q_{SC,i}^{TPS,S*}} F_i\left(x_i\right)dx_i = \xi_i\left(q_{SC,i}^{TPS,S*}\right), \int_0^{q_{SC,i}^{TPS,R*}} F_i\left(x_i\right)dx_i = \xi_i\left(q_{SC,i}^{TPS,R*}\right)$ and $\Delta\xi_i^{TPS*} = \xi_i\left(q_{SC,i}^{TPS,S*}\right) - \xi_i\left(q_{SC,i}^{TPS,R*}\right)$. We have

$$\Delta\pi_{SC}^{TPS*} = \sum_{i=1}^{2}\left[\left(p_i - m_i\right)\Delta q_{SC,i}^{TPS*} - c_{S,i}q_{SC,i}^{TPS,S*} + c_{R,i}q_{SC,i}^{TPS,R*} - \left(p_i - v_i\right)\Delta\xi_i^{TPS*}\right]. \quad (21)$$

By definition, when $\Delta\pi_{SC}^{TPS*} < 0$, the retailer should take up the task of implementing the final product assembly for both products whereas $\Delta\pi_{SC}^{TPS*} > 0$ implies that it is optimal for the supplier to take up the role as the final product assembler. We summarize the core findings derived above in Proposition 4.5.

Proposition 4.5. *In the centralized two-product supply chain system: (a) If the final product assemblies of Product 1 and Product 2 can be conducted by different channel members separately, for each product, the channel member with the lower cost of final product assembly should take the task of implementing the final product assembly for that specific profit. (b) For the situation where the final assemblies of both products have to be conducted by the same channel member: (i) if both* c_{S1} *and* c_{S2} *are*

respectively larger than c_{R1} and c_{R2}, then the retailer should take up the role as the final product assembler. If both c_{S1} and c_{S2} are respectively smaller than c_{R1} and c_{R2}, then the supplier should take up the role as the final product assembler. (ii) If one final product assembly cost is larger at the supplier while the other final product assembly cost is lower at the supplier, then we need to compute $\Delta\pi_{SC}^{TPS*}$; when $\Delta\pi_{SC}^{TPS*} < 0$, it is optimal for the retailer to take up the task of implementing the final product assembly for both products whereas $\Delta\pi_{SC}^{TPS*} > 0$ implies that it is optimal for the supplier to take up the role as the final product assembler.

Proposition 4.5 provides a clear decision rule for how to determine the optimal channel member to be the final product assembler under the two-product case.

As we consider the case in which $c_{S,1} < c_{R,1}$ while $c_{S,2} > c_{R,2}$ [Figure 4.2], suppose that we have the situation in which $\Delta\pi_{SC}^{TPS*} < 0$, which means it is optimal for the retailer to be the final product assembler. In this case, suppose that the supplier wants to improve its final product assembly efficiency by using additive manufacturing technologies so that it becomes optimal for it to be the final product assembler, what can it do? Define: $\hat{c}_{S,2} = \arg[\Delta\pi_{SC}^{TPS*} = 0]$. Proposition 4.6 shows the result.

Proposition 4.6. *When $c_{S,1} < c_{R,1}$ and $c_{S,2} > c_{R,2}$, suppose that $\Delta\pi_{SC}^{TPS*} < 0$. Then, there exists a unique threshold $\hat{c}_{S,2}$ with which if the supplier can reduce its final product assembly cost $c_{S,2}$ to be lower than it (i.e. $\hat{c}_{S,2} > c_{S,2}$), it will be optimal for the supplier to be the final product assembler.*

Proposition 4.6 shows an interesting result that it is, in fact, possible for one party, say the supplier, who is initially not the best party to take up the role as the final product assembler to become optimal by lowering the final product assembly cost through, e.g., the additive manufacturing technologies. This result is theoretically solid.

4.5.2 Make-To-Order (MTO) Scenario

In the basic model, when we consider the optimal choice of final product assembly, we only consider the case when both the supplier and the retailer operate in the same make-to-stock (MTS) operational mode. However, as the retailer is closer to the market, in many cases, the retailer can operate in the make-to-order (MTO) operational mode. This is especially true under the 3D technology era when AM technologies can facilitate the final product assembly in a speedy manner. In this extension, we explore this case. (See Figure 4.3)

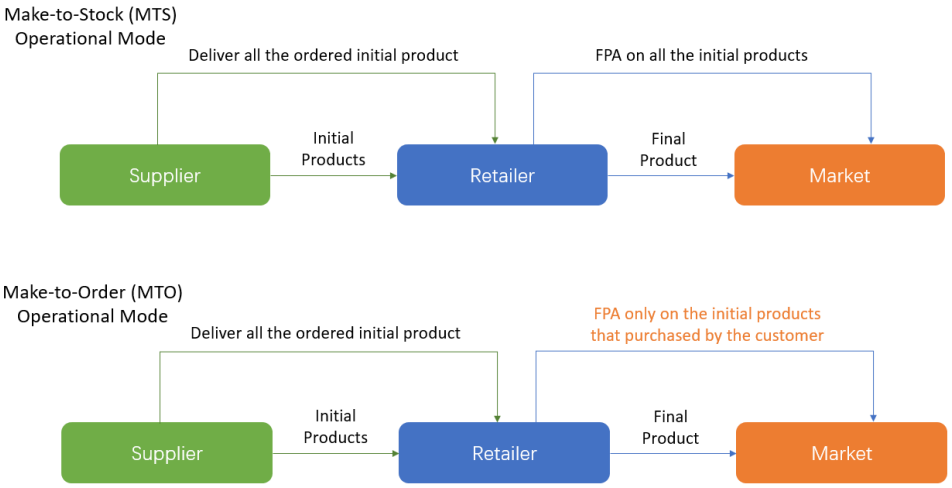

Figure 4.3. Make-to-Order (MTO) mode vs Make-to-Stock (MTS) mode.

Under the MTO operational mode, the final product assembly only occurs when the retailer actually sells the product to the customer, which means the retailer does not need to burden the cost of final assembly for the unsold product. Such operations are widely found in the customized sports jerseys in the fashion industry and the flower bundling in the decoration industry. The retailer purchases the initial products from the supplier before the selling season starts. During the selling season, once receives the order from the customer, the retailer implements the final assembly on the ordered product and delivers the final product to the customer. Let $\tilde{\boldsymbol{\pi}}_{\boldsymbol{R,MTO}}^{\boldsymbol{WR}}$ and $\boldsymbol{q}_{\boldsymbol{R,MTO}}^{\boldsymbol{WR}}$ respectively denote the profit and the ordering quantity of the retailer under the MTO operational mode. The profit function of the retailer under the MTO operational mode is as follows:

$$\tilde{\pi}_{R,MTO}^{WR} = (p - c_R)\min(q, x) + v\max(q - x, 0) - w^{WR}q.$$

The expected profit can be further derived as:

$$\pi_{R,MTO}^{WR} = (p - c_R - w^{WR})q \; - (p - c_R - v)\int_0^q F(x)dx. \qquad (4.19)$$

Following the newsvendor model, the expected profit-maximizing quantities for the retailer under the MTO operational mode is $q_{R,MTO}^{WR^*} = F^{-1}\left(\frac{p-c_R-w^{WR}}{p-c_R-v}\right)$.

Let $\Delta\pi_R^{WR} = \pi_{R,MTO}^{WR^*} - \pi_R^{WR^*}$. We have

$$\Delta\pi_R^{WR} = (p - w^{WR} - c_R)\left(q_{R,MTO}^{WR^*} - q_R^{WR^*}\right) + (p - v)\left(\int_0^{q_R^{WR^*}} F(x)dx - \int_0^{q_{R,MTO}^{WR^*}} F(x)dx\right) + c_R\int_0^{q_{R,MTO}^{WR^*}} F(x)dx.$$

$$\Delta\pi_R^{WR} = (p-v)\left[F\left(q_R^{WR^*}\right)\left(q_{R,MTO}^{WR^*} - q_R^{WR^*}\right) + \int_0^{q_{R,MTO}^{WR^*}} F\,(x)dx\right]$$

$$+ c_R \int_0^{q_{R,MTO}^{WR^*}} F\,(x)dx.$$

As $\frac{p-c_R-w^{WR}}{p-c_R-v} > \frac{p-w^{WR}-c_R}{p-v}$, we have $F^{-1}\left(\frac{p-c_R-w^{WR}}{p-c_R-v}\right) > F^{-1}\left(\frac{p-w^{WR}-c_R}{p-v}\right)$ and $q_{R,MTO}^{WR^*} > q_R^{WR^*}$. As a result, we can derive $\pi_{R,MTO}^{WR^*} > \pi_R^{WR^*}$. It can be concluded that the MTO operational mode is always better than the MTS operational mode for the retailer at the same cost of final product assembly.

Proposition 4.7. *In the scenario that the final product assembly is implemented by the retailer, compared to the MTS* operational mode*, if the final product assembly cost remains the same, the retailer benefits from the MTO* operational mode *with more profits.*

Proposition 4.7 shows that the MTO operational mode outperforms the MTS operational mode for the retailer. This is logical as the retailer assembles the product when there is a demand, i.e. MTO, instead of pre-assembling and wait. This finding is in accordance with many observed industrial practices. For example, in the fashion industry, the retailer for sports jersey adopts the MTO model for customizing the player's name and number, which better satisfies the customers' needs and reduces the burden of having some assembled products which are not sold (and hence wasted the assembly cost). The same operations can also be observed in the decoration industry.

As proved, it is more beneficial for the retailer to adopt the MTO operational mode (than the MTS operational mode), we further explore the impact of MTO operational mode on the whole supply chain compared to the case when the final product assembly is implemented by the supplier (under the MTS operational mode). Let $\pi_{SC,MTO}^{WR}$ and $q_{SC,MTO}^{WR}$ denote the expected profit and the production quantity of the whole supply chain under the MTO operational mode. The profit function of the whole supply chain can be derived as follows:

$$\pi_{SC,MTO}^{WR} = (p-m-c_R)q - (p-c_R-v)\int_0^q F\,(x)dx. \tag{4.20}$$

Following the newsvendor model, the expected profit-maximizing quantities for the supply chain under the MTO operational mode is $q_{SC,MTO}^{WR^*} = F^{-1}\left(\frac{p-m-c_R}{p-c_R-v}\right)$.

The expected profit of the supply chain under the MTS operational mode is derived as:

$\pi_{SC}^{WS} = (p - m - c_S)q - (p - v)\int_0^q F(x)dx.$

The expected profit-maximizing quantity for the supply chain under the MTS mode when the supplier is the final product assembler is $q_{SC}^{WS^*} = F^{-1}\left(\frac{p-m-c_S}{p-v}\right)$.

Let $\Delta\pi_{SC}^{WRS} = \pi_{SC,MTO}^{WR^*} - \pi_{SC}^{WS^*}$. We have

$\Delta\pi_{SC}^{WRS} = (p - m)\left(q_{SC,MTO}^{WR^*} - q_{SC}^{WS^*}\right) + (p - v)\left(\int_0^{q_{SC}^{WS^*}} F(x)dx - \int_0^{q_{SC,MTO}^{WR^*}} F(x)dx\right) + c_R\int_0^{q_{SC,MTO}^{WR^*}} F(x)dx + c_S q_{SC}^{WS^*} - c_R q_{SC,MTO}^{WR^*}.$

If $c_R = c_S$, we have $\frac{p-m-c_R}{p-c_R-v} > \frac{p-m-c_S}{p-v}$, then $q_{SC,MTO}^{WR^*} > q_{SC}^{WS^*}$.

$\Delta\pi_{SC}^{WRS} = (p - m - c_S)\left(q_{SC,MTO}^{WR^*} - q_{SC}^{WS^*}\right) + (p - v)\left(\int_0^{q_{SC}^{WS^*}} F(x)dx - \int_0^{q_{SC,MTO}^{WR^*}} F(x)dx\right) + c_R\int_0^{q_{SC,MTO}^{WR^*}} F(x)dx > 0$. We obtain $\pi_{SC,MTO}^{WR^*} > \pi_{SC}^{WS^*}$.

If $c_R < c_S$, we have $\frac{p-m-c_R}{p-c_R-v} > \frac{p-m-c_S}{p-v}$, then $q_{SC,MTO}^{WR^*} > q_{SC}^{WS^*} and\ c_R q_{SC,MTO}^{WR^*} < c_S q_{SC,MTO}^{WR^*}$. As $\Delta\pi_{SC}^{WRS} > 0$ when $c_R = c_S$ and $c_R q_{SC,MTO}^{WR^*} < c_S q_{SC,MTO}^{WR^*}$, we can derive $\Delta\pi_{SC}^{WRS} > 0$ when $c_R < c_S$.

To compare the performances influenced by the different final assembly costs of the channel members under the MTS operational mode where the supplier conducts the final assembly, and the MTO operational mode where the retailer conducts the final assembly, we have the following analysis.

Let $c_S = \hat{c}_R - \lambda$ ($\lambda > 0\ or\ \lambda < 0$). We define $\hat{c}_R = \arg[\Delta\pi_{SC}^{WRS*} = 0]$. Let $\Delta q_{SC}^{WRS*} = q_{SC,MTO}^{WR^*} - q_{SC}^{WS^*}$, $\xi_{SC}^{WR^*}\left(q_{SC,MTO}^{WR^*}\right) = \int_0^{q_{SC,MTO}^{WR^*}} F(x)dx$, $\xi_{SC}^{WS^*}\left(q_{SC}^{WS^*}\right) = \int_0^{q_{SC}^{WS^*}} F(x)dx\ and\ \Delta\xi_{SC}^{WRS*} = \xi_{SC}^{WR^*}\left(q_{SC,MTO}^{WR^*}\right) - \xi_{SC}^{WS^*}\left(q_{SC}^{WS^*}\right)$. We can derive that $\Delta\pi_{SC}^{WRS*} = (p - m)\Delta q_{SC}^{WRS*} - (p - v)\Delta\xi_{SC}^{WRS*} + c_R\xi_{SC}^{WR^*}\left(q_{SC,MTO}^{WR^*}\right) + c_S q_{SC}^{WS^*} - c_R q_{SC,MTO}^{WR^*}$. Solving $\hat{c}_R = \arg[\Delta\pi_{SC}^{WRS*} = 0]$ yields the threshold value $\hat{c}_R = \frac{\lambda q_{SC}^{WS^*} - (p-v)\left[\Delta\xi_{SC}^{WRS*} - F\left(q_{SC}^{WR^*}\right)\Delta q_{SC}^{WRS*}\right]}{\xi_{SC}^{WR^*}\left(q_{SC,MTO}^{WR^*}\right)}$. When the retailer's cost for the final assembly is lower than $\hat{c}_R$, the retailer should be the final assembler to achieve the optimal profit for the whole supply chain. Proposition 4.8 shows the results.

Proposition 4.8. *If the retailer implements the MTO operational mode for the final product assembly, and the supplier implements the MTS operational mode for the final product assembly: (a) It will be optimal for the retailer to be the final product assembler*

(from the supply chain system's perspective) if and only if the retailer's cost of final product assembly is lower than a unique threshold $\hat{c}_R$. (b) If the retailer's cost of final product assembly is no larger than the supplier's, it will be optimal for the retailer to take up the final product assembly task from the supply chain system's perspective.

Proposition 4.8(a) shows the necessary and sufficient condition to explain when it is optimal for the retailer to take up the final product assembly task. Observe that even if the final product assembly cost at the retailer is higher than the one at the supplier, it may still be optimal for the retailer to take up the role as the final product assembler if the retailer can operate in an MTO mode for the final product assembly. Proposition 4.8(b) specifies that even when the cost of the final product assembly on the retailer is equal to that on the supplier, the whole supply chain benefits when the final product assembly is implemented by the retailer if the retailer adopts the MTO operations strategy. Obviously, this is a sufficient condition while it also shows that similar to the basic model when we only consider the MTS assembly operational mode, the cost of final product assembly is still the critical factor governing whether the upstream supplier or downstream retailer should take up the final product assembly task in the supply chain. Thus, our findings from the basic model are robust.

4.6 Conclusion and Summary

Motivated by the popularity of additive manufacturing technologies and the widely observed involvement of different channel members in conducting final product assembly, we explore the factors that determine which channel member should conduct the final product assembly in the supply chain from a systems perspective. Focusing on the supply chain with one supplier and one retailer with the implementation of the final product assembly, we conduct an analytical study on the effects of the channel members' costs for the final product assembly and examine how such effects impact the profits of the channel members and the whole supply chain under wholesale price contracts and buyback contracts. Based on game theory, under the fixed wholesale price setting, we find that the double marginalization effect is more significant when the retailer implements the final product assembly, compared to the case when the supplier takes the role. From the perspective of the whole supply chain system, the respective costs on the final product assembly solely determine who the optimal member to implement the final product assembly is. Since the real supply chain system is operated in a decentralized manner, it is crucial to explore how to optimize (i.e. coordinate) it by

using an incentive alignment contract like buyback. With the analytical findings, we uncover the critical model parameters and the contract bounds of the proposed buyback contract for the achievability of the supply chain coordination. In addition, we extend the analysis to elucidate the case with two products and the make-to-order (MTO) operational mode and prove the robustness of the results with new findings. As a conclusion, we summarize the major insights and implications of our research as follows.

1) For the decentralized supply chain system in which a wholesale pricing contract is present, the double marginalization effect is larger under the scenario when the retailer implements the final product assembly. In such circumstances, the retailer must consider both the costs of sourcing the product from the supplier and conducting the final product assembly, which is regarded as an inherent shortage that hurts the performance of the whole supply chain. However, if a certain incentive alignment scheme can be integrated to dampen the double marginalization effect, e.g., using the buyback contract, the retailer can also be chosen to implement the final product assembly for the supply chain.
2) In the centralized supply chain with a single product, the optimal solution for the final product assembly only depends on the respective costs on the final product assembly of the channel members. The channel member with the lower cost should be optimal to take the task of implementing the final product assembly. The finding can be found identical to real-world industrial practices. Considering the total profit of the supply chain, the central-decision maker always allocates the final product assembly to the member with a lower cost for the implementation.
3) With the involvement of the buyback contract for the scenario where the supplier conducts the final product assembly, the contract bounds are mainly determined by the minimal expected profit requirements of both channel members. The increase of the supplier's minimal expected profit requirement and the decrease of the retailer's minimal expected profit requirement can push the wholesale price up. In addition, the increasing supplier's minimal expected profit requirement incurs a higher buyback price for better profit, which encourages the retailer to increase the ordering quantity.
4) Using the buyback contract for the scenario where the supplier conducts the final product assembly, similar findings can be observed that increasing the retailer's minimal expected profit requirements and the decreasing supplier's minimal

expected profit requirement can restrict the growth of the wholesale price.

5) Once the centralized supply chain system covers two-product operations, if the final assemblies of the two products can be individually conducted, the channel member with the lower cost should be chosen for the implementation of final product assembly for that specific product. If the final assemblies of both products can only be conducted by the same channel member while the final product assembly cost of one product is larger at the supplier while that of the other product is larger at the retailer, we need to check the total profit associated with two products in the supply chain in order to determine who should take up the final product assembly task. We interestingly show that in the situation when the supplier is inferior to the retailer to implement the final product assembly for both products, a specific threshold value of the supplier's final product assembly cost for the product with a higher final product assembly cost exists. Owing to the monotonic nature of the supplier's profit with respect to the final product assembly cost, if the supplier can decrease the final product assembly cost for such a product lower than that specific threshold value, the supplier is optimal to be the final product assembler. This result has good implications for industrial practice as nowadays, the supplier can adopt innovative production solutions such as those with additive manufacturing technologies to reduce the final product assembly cost. As a result, if the supplier wants to take up the final product assembly cost, using additive manufacturing to lower final product assembly costs with respect to our proposed threshold can help.

6) Compared to the MTS operational mode where the retailer implements the final product assembly, the retailer can enjoy a higher profit under the MTO operational mode if there is no change in the final product assembly cost. The findings are in line with a number of industrial practices, especially in the fashion industry where the retailer for sports jersey can better satisfy the customers' needs under the MTO operational mode for the final product assembly as it is easy to implement with a low cost. From the perspective of the whole supply chain, if the retailer operates under an MTO production mode, it is optimal for the retailer to take up the role as the final product assembler if the cost of final product assembly at the retailer is no larger than that at the supplier. Further notice that even if the final product assembly cost at the retailer is higher than the one at the supplier, it may still be optimal for the retailer to take up the role as the final product assembler if the

retailer can operate in an MTO mode for the final product assembly. The findings prove the insights that the cost of final product assembly is the crucial factor in determining whether the upstream supplier or downstream retailer should take up the final product assembly task in the supply chain system.

For future research, it will be interesting to examine the case with the involvement of the two-part tariff franchising contact and the target sales rebate contract for implementing the final product assembly to generate further insights on their ability in achieving supply chain coordination. Another extension is to consider the horizontal competitive case when, e.g., multiple supply chains compete, and see how the final product assembly task should be allocated. Besides, the risk references of the supplier and the retailer regarding the final product assembly can also be the dimension for future exploration.

Chapter 5. The Options of Contracts and Ordering Time within Online-offline Fashion Franchising Supply Chains without Channel Conflicts

5.1 Research Background

Online and offline operations of many fashion brands and international retailers are both well-developed but also induce channel conflicts if the same products are offered by them. Under many franchising arrangements in the fashion industry, to avoid channel conflicts and cannibalization between the franchisee and the brand owner, the brand owner will first supply the product for the franchisee to sell offline in the first period. In order to avoid channel conflicts and cannibalization between the franchisee and the franchisor (i.e. the fashion brand), some additional arrangements need to be made. For instance, one rather commonly seen measure is: During the same selling season, the fashion brand and the franchisee will not sell the same product at the same time. If we focus on one particular product item (e.g., a thick warm-keeping jacket), suppose that the fashion brand first supplies it to the franchisee and lets it sell offline in a market like Hong Kong during the winter (December). After the selling season in Hong Kong has ended, the fashion brand can sell its product online. Markets like Australia will have the winter in June and the fashion brand can sell to this market. In addition, some fashion brands apply O2O solutions to evade the problem of channel conflicts. This kind of offline and online operations can avoid having the channel conflicts between the franchisor and the franchisee. Plus, potentially, the franchisor can also consider postponing its ordering decision and employing the demand information from the franchisee's offline sales, to improve its demand forecast for the online market. However, under order postponement with a shortened lead time, the product cost is more expensive. So, a classic trade-off between ordering cost and the forecast accuracy exists (Choi et al., 2003). As a remark, the situation considered in our research is tricky and more challenging than Choi et al. (2003), because it involves two different sales channels and hence two different demands. Moreover, for franchising contracts, the simplest format includes the pure wholesale pricing contract in which the fashion brand offers the franchise right to the franchisee and makes a profit margin from the wholesale price. Another popular contract is the profit-sharing contract. Under the profit-sharing contract, we consider the case in which the fashion brand supplies the product at cost

and then shares the profit of the franchisee. Based on prior studies, the profit-sharing contract may be a more versatile contract compared to the wholesale pricing contract because it can dampen the double marginalization effect and improve the profits of the supply chain members.

5.2 Problem Description and Model Formulation

5.2.1 Supply Chain Structure

We consider a simple fashion supply chain with a fashion brand (B) which supplies and grants a franchise right to the franchisee (F). The fashion brand operates an online-offline system in which its products are sold online and offline. However, to avoid channel conflicts, the fashion brand sells the same product to the consumers either online itself or offline via the franchisee. Thus, the two channels do not sell the same product at the same time. This is a rather usual industrial practice under the franchising arrangement. The channel structure is demonstrated in Figure 5.1.

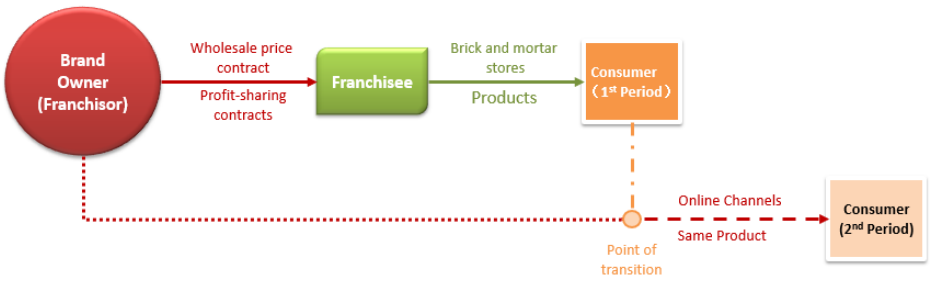

Figure 5.1. Channel structure.

Under this channel conflict avoidance strategy, we consider the case when the franchisee will get a fashionable product from the fashion brand at a time point called "Stage 0". Ordering at Stage 0 means the franchisee will definitely be able to get the ordered quantity when the season starts. The product's unit selling price in the market is p. By the end of the selling season, any leftover will be salvaged at a price v. Demand is uncertain and we will discuss its distribution later. For the franchising business, the fashion brand supplies the product to the franchisee and makes a profit. There are two different, mutually exclusive franchise contracts being considered in the study, namely the wholesale pricing contract and the profit-sharing contract. For the wholesale pricing contract, the fashion brand offers a constant wholesale price which is higher than the product cost for each item supplied to the franchisee. Thus, the wholesale pricing

contract is a simple one that guarantees that the fashion brand can make a certain profit margin (Shen et al., 2016). For the profit-sharing contract (Wei and Choi, 2010), the fashion brand supplies the product to the franchisee at cost (i.e. the wholesale price is the same as the product cost for the fashion brand). In order to make a profit, the fashion brand charges the franchisee a share of its profit generated by the product. Figure 5.2 presents the ordering cases. The notation as shown in Table 5.1.

- Case 1: The fashion brand follows the franchisee to order at Stage 0. Owing to the benefit of economy of scale, fashion brand can accumulate quantity (from franchisee and itself) when the order is placed.
- Case 2: The fashion brand postpones the ordering time and places the order at Stage 1 after observing the demand information in the market.

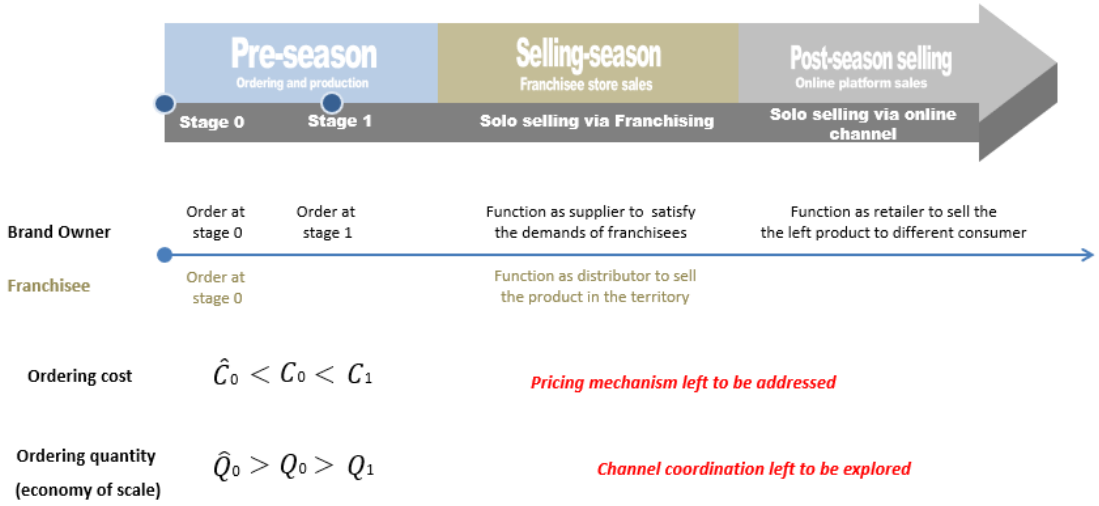

Figure 5.2. Ordering cases.

Table 5.1. Notation.

Category	Notation	Meaning
Distribution	$f_N(X,Y)$	The normal distribution with mean X and variance Y.
	$\varphi(\cdot)$	The standard normal density function.
	$\Phi(\cdot)$	The standard normal cumulative distribution function.
	$\Phi^{-1}(\cdot)$	The inverse function of $\Phi(\cdot)$.
	$\Psi(x)$	The right linear loss function of the standard normal:$\Psi(x) = \int_c^{\infty}(z-x)d\Psi(z)$
Supply Chain	B	The fashion brand

& its members	F	The franchisee
	SC	The supply chain
Contracts	WP	Wholesale pricing
	PS	Profit sharing
Time Point	0	Stage 0
	1	Stage 1
Ordering	OC1	Ordering Case 1
	OC2	Ordering Case 2
Quantity	q_F	Order quantity by the fashion brand
	q_B	Order quantity by the franchisee

5.2.2 Demand Distributions and Information Updating

Owing to the lead time requirement, the franchisee must order at Stage 0. However, since the fashion brand will sell the same product online after the selling season in the franchisee has finished, the fashion brand can consider the ordering time point. To be specific, the fashion brand can order at Stage 0, the same as what the franchisee does. At Stage 0, we model the demand distribution for the franchisee's market (which is offline) as follows:

$x_F \sim f_N(\theta, \delta)$,

where x_F represents the random seasonal demand of the product in the offline market faced by the franchisee, $f_N(\theta, \delta)$, is the distribution of x_F with mean θ and variance δ.

Following Iyer and Bergen (1997), Choi et al. (2006) and Choi (2007), we further model θ (the mean of x_F) as a random variable and it follows a normal distribution with mean μ0 and variance d0.

$$\theta \sim f_N(\mu_0, d_0). \quad (5.1)$$

Thus, at Stage 0, the marginal distribution of x_F is given to be:

$$x_F \sim f_N(\mu_0, \sigma_0^2), \quad (5.2)$$

$$\text{where } \sigma_0 = \sqrt{d_0 + \delta}. \quad (5.3)$$

For the fashion brand, since it will sell the same product online after the franchisee's offline season is over, it will improve its forecast if it decides to order later

and observe the market information from the sales of the franchisee. Following the linear demand relationship as proposed by Choi (2007), we consider the case when the demand faced by the fashion brand in the online market at Stage 0 $\left(x_{B,0}\right)$ to be related to x_F as follows:

$$x_{B,0} \sim f_N(a\theta + b, k\delta). \tag{5.4}$$

As θ is a random variable and its distribution is shown above in (3.1), we can derive the marginal demand distribution for $x_{B,0}$ as follows (see Choi, 2007):

$$x_{B,0} \sim f_N(m_0, s_0^2), \tag{5.5}$$

$$\text{where } m_0 = a\mu_0 + b, \text{ and } s_0 = \sqrt{a^2 d_0 + k\delta}. \tag{5.6}$$

For the fashion brand, if it decides to postpone its ordering decision to a time point Stage 1, market demand information from the franchisee's market will be observed. We denote the observation as $\tilde{x}_F$. Based on the Bayesian conjugate pair theory with the normal process with unknown mean and known variance (Pratt et al., 1995; Choi, 2007), we have the demand distribution for the fashion brand's online channel at Stage 1 as follows:

$$x_{B,1} \sim f_N(m_1, s_1^2), \tag{5.7}$$

$$\text{where } m_1 = a\left\{\left\{\left(\frac{d_0}{d_0+\delta)}\right)\tilde{x}_F + \left(\frac{\delta}{d_0+\delta)}\right)\mu_0\right\} + b,\ d_1$$

$$= \delta d_0/(d_0 + \delta), \text{ and } s_1 = \sqrt{a^2 d_1 + k\delta}. \tag{5.8}$$

Notice that in (5.8), m_1 represents the posterior demand mean which is a function of the prior mean μ_0 and market observation $\tilde{x}_F$; s_1 is the posterior demand standard deviation.

5.3 Construction of Different Scenarios

5.3.1 Two Ordering Cases

Under our model setting, the franchisee F always orders at Stage 0 with the prior demand information whereas the fashion brand B may order earlier at Stage 0 or later at Stage 1. Thus, there are two ordering cases.

Case 1 refers to the case when the fashion brand B follows the franchisee F to order at Stage 0. Owing to the benefit of the economy of scale, B can accumulate quantity (from F and itself) when the order is placed. Under this arrangement, the unit ordering cost for the product at Stage 0 is denoted by $\hat{c}_0$. Obviously, the benefit of adopting Case 1 ordering is to enjoy a lower unit ordering cost even though at the time

of ordering, both the fashion brand and the franchisee do not make use of market information.

Case 2 is the case when the fashion brand postpones the ordering time and places the order at Stage 1 after observing the demand information in the market. Under Case 2, the unit ordering cost for the franchisee at Stage 0 is c_0 and the unit ordering cost for the fashion brand at Stage 1 is c_1. Following the usual situation in the real world, the unit ordering cost is a decreasing function of lead time, and hence we have: $c_0 < c_1$. As $\hat{c}_0$ is smaller than c_0 owing to economy of scale, we have: $\hat{c}_0 < c_0 < c_1$. Table 5.2 summarizes the two ordering cases.

Table 5.2. The two ordering cases.

Case	Ordering Time Point	Product Cost	Demand Uncertainty
Ordering Case 1 (OC1)	Fashion Brand: Stage 0	$\hat{c}_0$	$s_0 = \sqrt{a^2 d_0 + k\delta}$
	Franchisee: Stage 0	$\hat{c}_0$	$\sigma_0 = \sqrt{d_0 + \delta}$
Ordering Case 2 (OC2)	Fashion Brand: Stage 1	c_1	$s_1 = \sqrt{a^2 d_1 + k\delta}$
	Franchisee: Stage 0	c_0	$\sigma_0 = \sqrt{d_0 + \delta}$

5.3.2 Two Contract Options

In this research analysis, we consider two franchise contracts, which are commonly seen under a franchise arrangement in the fashion supply chain. The first one is the wholesale pricing (WP) contract. The WP contract is the simplest franchise contract in which the franchisee *F* pays a unit wholesale price to the fashion brand B for each unit of supply. We denote this unit wholesale price by w. Undoubtedly, fashion brand *B* makes a profit margin by having w larger than the product ordering cost from the manufacturer.

The second franchise contract is the profit-sharing (PS) contract (Wei and Choi, 2010). Under the PS contract, we consider the situation that the fashion brand B supplies the product to the franchisee F at cost (i.e., B does not make a profit from the wholesale price). In order to make a reasonable profit, the fashion brand will receive a certain percentage of the franchisee's profit, and this percentage, denoted by λ, is well-written in the PS contract. Table 5.3 summarizes the details of the two franchise contracts.

Table 5.3. The two franchise contracts.

Contracts	Contract Parameters and Characteristics
Wholesale pricing (WP)	The unit wholesale price w, which is larger than the product cost. As this wholesale price is fixed, the fashion brand is guaranteed to make a profit.
Profit-sharing (PS)	The product is supplied at cost and the fashion brand receives a proportion λ of the franchisee's profit. As the profit of the

5.3.3 Four Scenarios

In the presence of the two ordering cases and the two franchise contracts, we have four probable scenarios, namely Scenario α, Scenario β, Scenario γ, and Scenario ξ, as shown in Table 5.4.

Table 5.4. The four scenarios.

		Contracts	
		WP	PS
Ordering	OC1	Scenario α	Scenario β
Cases	OC2	Scenario γ	Scenario ξ

We aim to analytically explore and develop insights on when to choose which scenario among the four different scenarios. Notice that we do not aim to optimize the supply chain by adjusting contract parameters under each scenario. Instead, we take the contract for each scenario as given and explore the situation under which one scenario is preferred to the other scenario. The perspectives from the fashion brand, the franchisee as well as the whole supply chain will be examined.

5.4 Scenario Analysis: When to Choose Which Scenario?

5.4.1 Analysis of The Individual Scenarios

5.4.1.1 Scenario α

For the scenario under Ordering Case 1 with the WP contract, noting that the problem can be formulated as the standard newsvendor model setting. We can find that

the expected profits for the franchisee and the fashion brand are given as follows:

$$\Pi_F^{\alpha}(q_F) = (p-v)\left[\mu_0 - \sigma_0 \Psi\left(\frac{q_F-\mu_0}{\sigma_0}\right)\right] - (w-v)q_F, \quad (5.9a)$$

$$\Pi_B^{\alpha}(q_B) = (p-v)\left[m_0 - s_0 \Psi\left(\frac{q_B-m_0}{s_0}\right)\right] - (\hat{c}_0 - v)q_B + (w-\hat{c}_0)q_F. \quad (5.9b)$$

Following the newsvendor model, it is straightforward to find that (5.9a) and (5.9b) are concave functions of q_F and q_B, respectively. Thus, the respective expected profit-maximizing quantities for the fashion brand and the franchisee are found by solving the first-order condition as follows:

$$q_{F*}^{\alpha} = \mu_0 + \sigma_0 \Phi^{-1}\left(\frac{p-w}{p-v}\right), \quad (5.10a)$$

$$q_{B*}^{\alpha} = m_0 + s_0 \Phi^{-1}\left(\frac{p-\hat{c}_0}{p-v}\right). \quad (5.10b)$$

As a remark, the terms $(p-w)/(p-v)$ in (5.10a) represents the inventory service level achieved by the ordering quantity q_{F*}^{α}. As the inventory service level in the real world should not be too low, we consider here the situation when the inventory service level is above 50%. In other words, we assume that

$(p-w)/(p-v) > 0.5$.

Putting (5.10a) and (5.10b) respectively into (5.9a) and (5.9b), it is easy to find that the optimal expected profit for the fashion brand and the franchisee under Scenario α are shown below:

$$\Pi_{B*}^{\alpha} = (p-\hat{c}_0)m_0 - s_0\left\{(\hat{c}_0 - v)\Phi^{-1}\left(\frac{p-\hat{c}_0}{p-v}\right) + (p-v)\Psi\left[\Phi^{-1}\left(\frac{p-\hat{c}_0}{p-v}\right)\right]\right\} + (w - \hat{c}_0)\left[\mu_0 + \sigma_0\Phi^{-1}\left(\frac{p-w}{p-v}\right)\right], \quad (5.11)$$

$$\Pi_{F*}^{\alpha} = (p-w)\mu_0 - \sigma_0\left\{(w-v)\Phi^{-1}\left(\frac{p-w}{p-v}\right) + (p-v)\Psi\left[\Phi^{-1}\left(\frac{p-w}{p-v}\right)\right]\right\}. \quad (5.12)$$

Notice that the expressions of (5.11) and (5.12) take a similar form as the ones derived in the literature (see, e.g., Iyer and Bergen (1997)). Define (5.13) and we have Lemma 5.1.

$$\Delta(x) = \left\{(x-v)\Phi^{-1}\left(\frac{p-x}{p-v}\right) + (p-v)\Psi\left[\Phi^{-1}\left(\frac{p-x}{p-v}\right)\right]\right\}. \quad (5.13)$$

Lemma 5.1. $\Delta(x) = (p-v)\phi\left[\Phi^{-1}\left(\frac{p-x}{p-v}\right)\right]$.

Proof of Lemma 5.1. All proofs are placed in the appendix.

Lemma 5.1 shows a compact form of an important term that will be used in many analytical derivations in subsequent parts. For the structural properties of $\Delta(x)$: First, it is positive. Second, since $\phi(z)$ is a decreasing function for any positive argument z,

$\Delta(x)$ is an increasing function of x in the range when $\Phi^{-1}\left(\frac{p-x}{p-v}\right)$ is positive

Using the result from Lemma 5.1, and the above analytical expressions, we have Corollary 5.1.

Corollary 5.1. *Under Scenario α, the optimal expected profits for the fashion brand and the franchisee are given as follows:*

$$\Pi_{B*}^{\alpha} = (p-\hat{c}_0)m_0 - s_0\Delta(\hat{c}_0) + (w-\hat{c}_0)\left[\mu_0 + \sigma_0\Phi^{-1}\left(\frac{p-w}{p-v}\right)\right], \quad (5.14)$$

$$\Pi_{F*}^{\alpha} = (p-w)\mu_0 - \sigma_0\Delta(w). \quad (5.15)$$

From Corollary 5.1, we can see that the optimal expected profits for the fashion brand and the franchisee under Scenario α can be expressed in terms of $\Delta(\cdot)$, which is a function defined in (5.13). Notice that under Scenario α, the fashion brand enjoys the benefit of having the lowest unit product cost $\hat{c}_0$ and hence $\hat{c}_0$ appears in (5.14).

5.4.1.2 Scenario *γ*

Under the scenario with Ordering Case 2 and the WP contract, we have Scenario *γ*. Similar to Scenario *α*, we can express the respective expected profits for the franchisee and the fashion brand in the following:

$$\Pi_F^{\gamma}(q_F) = (p-v)\left[\mu_0 - \sigma_0\Psi\left(\frac{q_F-\mu_0}{\sigma_0}\right)\right] - (w-v)q_F,$$

$$\Pi_B^{\gamma}(q_B) = (p-v)\left[m_1 - s_1\Psi\left(\frac{q_B-m_1}{s_1}\right)\right] - (c_1-v)q_B + (w-c_0)q_F.$$

The corresponding expected profit-maximizing quantities for the fashion brand and the franchisee under Scenario *γ* can be found to be the following:

$$q_{B*}^{\gamma} \mid m_1 = m_1 + s_1\Phi^{-1}\left(\frac{p-c_1}{p-v}\right). \quad (5.16)$$

$$q_{F*}^{\gamma} = \mu_0 + \sigma_0\Phi^{-1}\left(\frac{p-w}{p-v}\right), \quad (5.17)$$

With (5.16) and (5.17), we can find the optimal expected profit for the fashion brand and the franchisee under Scenario *γ* to be the following:

$$\Pi_{B*}^{\gamma} \mid m_1 = (p-c_1)m_1 - s_1\Delta(c_1) + (w-c_0)q_{F*}^{\gamma}, \quad (5.18)$$

$$\Pi_{F*}^{\gamma} = (p-w)\mu_0 - \sigma_0\Delta(w). \quad (5.19)$$

Un-conditioning (5.18) yields:

$$\Pi_{B*}^{\gamma} = (p-c_1)m_0 - s_1\Delta(c_1) + (w-c_0)\left[\mu_0 + \sigma_0\Phi^{-1}\left(\frac{p-w}{p-v}\right)\right]. \quad (5.20)$$

We summarize the findings in Corollary 5.2.

Corollary 5.2. *Under Scenario γ, the optimal expected profits for the fashion brand B and the franchisee F are:*

$$\Pi_{B*}^{\gamma} = (p - c_1)m_0 - s_1\Delta(c_1) + (w - c_0)\left[\mu_0 + \sigma_0\Phi^{-1}\left(\frac{p-w}{p-v}\right)\right],$$

$$\Pi_{F*}^{\gamma} = \Pi_{F*}^{\alpha}$$

From Corollary 5.2, we can see that the optimal expected profit for the franchisee under Scenario γ is the same as the one under Scenario α as its ordering is confirmed at Stage 0 and it pays the fashion brand a unit wholesale price w (which implies that the fashion brand makes a profit margin of $(w - c_0)$ for each unit ordered by the franchisee). However, for the fashion brand, it postpones the ordering decision so that it can observe market information and improve its forecast. However, in this case, the fashion brand has to pay a unit product cost c_1 which is also the highest one.

5.4.1.3 Scenario β

Scenario β refers to the case with Ordering Case 1 and the PS contract. We can express the expected profits for the franchisee and the fashion brand in the following:

$$\Pi_F^{\beta}(q_F) = (1 - \lambda)\left\{(p - v)\left[\mu_0 - \sigma_0\Psi\left(\frac{q_F - \mu_0}{\sigma_0}\right)\right] - (w - v)q_F\right\},$$

$$\Pi_B^{\beta}(q_B) = (p - v)\left[m_0 - s_0\Psi\left(\frac{q_B - m_0}{s_0}\right)\right] - (\hat{c}_0 - v)q_B + \lambda\left\{(p - v)\left[\mu_0 - \sigma_0\Psi\left(\frac{q_F - \mu_0}{\sigma_0}\right)\right] - (w - v)q_F\right\}.$$

The expected profit-maximizing quantities for the franchisee and the fashion brand can be derived to be the following:

$$q_{F*}^{\beta} = \mu_0 + \sigma_0\Phi^{-1}\left(\frac{p-\hat{c}_0}{p-v}\right), \quad (5.21)$$

$$q_{B*}^{\beta} = m_0 + s_0\Phi^{-1}\left(\frac{p-\hat{c}_0}{p-v}\right). \quad (5.22)$$

With (5.21) and (5.22), we can easily derive the optimal expected profits for the fashion brand and the franchisee under Scenario β below:

$$\Pi_{B*}^{\beta} = (p - \hat{c}_0)m_0 - s_1\Delta(\hat{c}_0) + \lambda\overline{\Pi}_{F*}^{\beta}, \quad (5.23)$$

$$\overline{\Pi}_{F*}^{\beta} = (p - \hat{c}_0)\mu_0 - \sigma_0\Delta(\hat{c}_0). \quad (5.24)$$

$$\Pi_{F*}^{\beta} = (1 - \lambda)\overline{\Pi}_{F*}^{\beta}. \quad (5.25)$$

We have Corollary 5.3.

Corollary 5.3. *Under Scenario β, the optimal expected profits for the franchisee F and the fashion brand B are given as follows:*

$$\Pi_{F*}^{\beta} = (1 - \lambda)\{(p - \hat{c}_0)\mu_0 - \sigma_0\Delta(\hat{c}_0)\},$$

$$\Pi_{B*}^{\beta} = (p - \hat{c}_0)m_0 - s_0\Delta(\hat{c}_0) + \lambda[(p - \hat{c}_0)\mu_0 - \sigma_0\Delta(\hat{c}_0)].$$

Similar to Corollary 5.1, we can see that under Scenario β, the fashion brand

commits the ordering quantities (for itself and the franchisee) at Stage 0. Thus, the unit product cost is the lowest one (i.e. $\hat{c}_0$). As the fashion brand's supply business to the franchisee is based on the profit-sharing contract under Scenario β, it is interesting to note that the franchisee's expected profit also depends on $\hat{c}_0$, which means it enjoys the lowest product cost in getting the supply.

5.4.1.4 Scenario ξ

The last scenario refers to the case with Ordering Case 2 and the PS contract and we call it Scenario ξ. Similar to other scenarios, the expected profits for the franchisee and the fashion brand are listed in the following:

$$\Pi_F^{\xi}(q_F) = (1-\lambda)\left\{(p-v)\left[\mu_0 - \sigma_0 \Psi\left(\frac{q_F-\mu_0}{\sigma_0}\right)\right] - (c_0 - v)q_F\right\},$$

$$\Pi_B^{\xi}(q_B) = (p-v)\left[m_1 - s_1\Psi\left(\frac{q_B - m_1}{s_1}\right)\right] - (c_1 - v)q_B + \lambda\left\{(p-v)\left[\mu_0 - \sigma_0\Psi\left(\frac{q_F-\mu_0}{\sigma_0}\right)\right] - (c_0-v)q_F\right\}$$

The respective expected profit-maximizing quantities for the fashion brand and the franchisee under Scenario ξ can be found to be the following:

$$q_{B*}^{\xi} \mid m_1 = m_1 + s_1\Phi^{-1}\left(\frac{p-c_1}{p-v}\right), \tag{5.26}$$

$$q_{F*}^{\xi} = \mu_0 + \sigma_0\Phi^{-1}\left(\frac{p-c_0}{p-v}\right), \tag{5.27}$$

Define:

$$\overline{\Pi}_{F*}^{\xi} = (p-c_0)\mu_0 - \sigma_0\Delta(c_0). \tag{5.28}$$

With (5.26), (5.27) and (5.28), we can find the optimal expected profit for the franchisee and the fashion brand under Scenario ξ to be the following:

$$\Pi_{F*}^{\xi} = (1-\lambda)\overline{\Pi}_{F*}^{\xi},$$

$$\Pi_{B*}^{\xi} \mid m_1 = (p-c_1)m_1 - s_1\Delta(c_1) + \lambda\overline{\Pi}_{F*}^{\xi}. \tag{5.29}$$

Un-conditioning (5.29) yields:

$$\Pi_{B*}^{\xi} = (p-c_1)m_0 - s_1\Delta(\hat{c}_1) + \lambda\overline{\Pi}_{F*}^{\xi}. \tag{5.30}$$

We summarize the findings in Corollary 5.4.

Corollary 5.4. *Under Scenario ξ, the optimal expected profits for the fashion brand B and the franchisee F are:*

$$\Pi_{B*}^{\xi} = (p-c_1)m_0 - s_1\Delta(c_1) + \lambda[(p-c_0)\mu_0 - \sigma_0\Delta(c_0)].$$

$$\Pi_{F*}^{\xi} = (1-\lambda)\{(p-c_0)\mu_0 - \sigma_0\Delta(c_0)\},$$

In Corollary 5.4, observe that even though the franchisee places the order at Stage

0, as the fashion brand places its own order at Stage 1, the unit product cost for the franchisee is only c_0, but not the lowest one (i.e., $\hat{c}_0$). With the above analysis, it means compared to Scenario β, the franchisee enjoys a smaller "product cost advantage" under Scenario ξ.

5.4.2 Scenario Analysis – Fashion Brand's Perspective

5.4.2.1 Optimal Ordering Case

We have two ordering cases under two contracts. To compare choices on the ordering case, we first explore Scenario α versus Scenario γ, which are both using the WP contract. By directly comparing the expected profits for the fashion brand under these two scenarios, we have Proposition 5.1.

Proposition 5.1. *In the presence of the WP contract, in deciding the optimal ordering case, the fashion brand will prefer Scenario α (OC1) to Scenario γ (OC2) if and only if* $(c_1 - \hat{c}_0)m_0 + (c_1 - \hat{c}_0)\left\{\mu_0 + \sigma_0\Phi^{-1}\left(\frac{p-w}{p-v}\right)\right\} > s_0\Delta(\hat{c}_0) - s_1\Delta(c_1)$; *otherwise, the fashion brand will prefer Scenario γ (OC2) to Scenario α (OC1).*

Proposition 5.1 is intuitive, and the results are based on the trade-off between the product cost advantage and the demand uncertainty reduction advantage. To be specific, when the product cost savings (i.e., $(c_1 - \hat{c}_0)$, $(c_0 - \hat{c}_0)$) are sufficiently big compared to the demand uncertainty reduction (as reflected by $s_0\Delta(\hat{c}_0) - s_1\Delta(c_1)$), Scenario α is preferred to Scenario γ which means Ordering Case 1 (at Stage 0) is more beneficial. If the product cost savings are relatively small with respect to the demand uncertainty reduction, Scenario γ is the more preferred option.

For the cases with the PS contract, to reveal the optimal choice on the ordering case, we explore Scenario β versus Scenario ξ. By checking the corresponding expected profits for the fashion brand under these two scenarios, we obtain the following Proposition 5.2.

Proposition 5.2. *In the presence of the PS contract, in deciding the optimal ordering case, the fashion brand will prefer Scenario β(OC1) to Scenario ξ(OC2) if and only if* $(c_1 - \hat{c}_0)m_0 + \lambda(c_0 - \hat{c}_0)\mu_0 \geq (s_0 + \lambda\sigma_0)\Delta(\hat{c}_0) - (s_1 - \lambda\sigma_0)\Delta(c_1)$; *otherwise, the fashion brand will prefer Scenario ξ(OC2) to Scenario β (OC1).*

Similar to the findings in Proposition 5.1 (for the case with the WP contract), Proposition 5.2 shows the trade-off between the product cost advantage and the demand uncertainty reduction. As a remark, the profit-sharing rate λ also plays a critical role as shown in the analytical condition in Proposition 5.2.

5.4.2.2 Optimal Contract

Next, we consider the optimal choice for contracts. We have two contracts and two ordering cases. To compare choices on the franchise contract, we compare Scenario α (with the WP contract) versus Scenario β (with the PS contract), which are both under Ordering Case 1. To enhance presentation, we define the following: $J(x) = \frac{(w-x)Q(w)}{(p-x)\mu_0-\sigma_0\Delta(x)}$. By directly comparing the expected profits for the fashion brand under these two respective scenarios, we have Proposition 5.3.

As a remark, when we compare between the WP and PS contracts, as the fashion brand does not face any uncertainty (and hence has no risk) under the WP contract, whenever the expected profit it earns under the WP contract is equal to or larger than the expected profit it earns under the PS contract, the WP contract will be the more preferred choice.

Proposition 5.3. *Under Ordering Case 1, in deciding the optimal contract, the fashion brand will prefer Scenario α (WP contract) to Scenario β (PS contract) if and only if* $\lambda \leq J(\hat{c}_0)$*; otherwise, the fashion brand will prefer Scenario β (PS contract) to Scenario α (WP contract).*

Proposition 5.3 shows that if the profit-sharing rate λ is relatively small compared to the unit wholesale price, the WP contract is preferred. If the profit-sharing rate is sufficiently big, the PS contract will be the fashion brand's optimal choice. Under Ordering Case 2, to compare choices on the franchise contract, we compare Scenario γ (with the WP contract) versus Scenario ξ (with the PS contract), which are both under Ordering Case 1. By comparing the respective expected profits for the fashion brand under Scenario γ and Scenario ξ, we have Proposition 5.4.

Proposition 5.4. *Under Ordering Case 2, in deciding the optimal contract, the fashion brand will prefer Scenario γ (WP contract) to Scenario ξ (PS contract) if and only if* $\lambda \leq J(c_0)$*; otherwise, the fashion brand will prefer Scenario ξ (PS contract) to Scenario γ (WP contract).*

Proposition 5.4 indicates when it is optimal to choose the PS contract or the WP contract under Ordering Case 2. The result is consistent with our intuition and the findings in Proposition 5.3 depend on the value of profit-sharing rate λ, an optimal choice can be made. For the sake of notational simplicity, we define:

$$\Omega(w) = \Phi^{-1}\left(\frac{p-w}{p-v}\right) \text{ and} \tag{5.31}$$

$$Q(w) = \mu_0 + \sigma_0\Omega(w). \tag{5.32}$$

Table 5.5 summarizes the necessary and sufficient conditions, as revealed by Propositions 5.1 to 5.4, for the fashion brand to prefer one scenario to another one.

Table 5.5. Scenario preferences and optimal choices: From the perspective of the fashion brand.

Choices	Optimal Choices	Scenario Preferences	Necessary and Sufficient Conditions
Ordering Cases	OC1	$\alpha > \gamma$ (under WP)	$(c_1 - \hat{c}_0)m_0 + (c_0 - \hat{c}_0)Q(w) \geq s_0\Delta(\hat{c}_0) - s_1\Delta(c_1)$
	OC2	$\alpha < \gamma$ (under WP)	$(c_1 - \hat{c}_0)m_0 + (c_0 - \hat{c}_0)Q(w) < s_0\Delta(\hat{c}_0) - s_1\Delta(c_1)$
	OC1	$\beta > \xi$ (under PS)	$(c_1 - \hat{c}_0)m_0 + \lambda(c_0 - \hat{c}_0)\mu_0 \geq (s_0 + \lambda\sigma_0)\Delta(\hat{c}_0) - (s_1 - \lambda\sigma_0)\Delta(c_1)$
	OC2	$\beta < \xi$ (under PS)	$(c_1 - \hat{c}_0)m_0 + \lambda(c_0 - \hat{c}_0)\mu_0 < (s_0 + \lambda\sigma_0)\Delta(\hat{c}_0) - (s_1 - \lambda\sigma_0)\Delta(c_1)$
Contracts	WP	$\alpha > \beta$ (under OC1)	$\lambda \leq J(\hat{c}_0)$
	PS	$\alpha < \beta$ (under OC1)	$\lambda > J(\hat{c}_0)$
	WP	$\gamma > \xi$ (under OC2)	$\lambda \leq J(c_0)$
	PS	$\gamma < \xi$ (under OC2)	$\lambda > J(c_0)$

5.4.3 Scenario Analysis – Franchisee's Perspective

5.4.3.1 Optimal Ordering Case

As mentioned above, we have examined the scenarios from the fashion brand's perspective. We now proceed to examine the scenarios from the franchisee's perspective. Adopting a similar approach, to compare choices on the ordering case, we first investigate Scenario α versus Scenario γ, which are both using the WP contract. Comparing the franchisee's expected profits under these two scenarios, we have Proposition 5.5.

Proposition 5.5. *In the presence of the WP contract, for the optimal ordering case, the franchisee is indifferent between Scenario α (OC1) and Scenario γ (OC2).*

Proposition 5.5 is a direct result of the fact that the expected profits of the franchisee under Scenario α (OC1) and Scenario γ (OC2) are the same. Under the PS contract, we explore Scenario β versus Scenario ξ to reveal the optimal ordering case from the franchisee's perspective. By checking the respective franchisee's expected profits under these two scenarios, we yield Proposition 5.6.

Proposition 5.6. *In the presence of the PS contract, in deciding the optimal ordering case, the franchisee will always prefer Scenario β(OC1) to Scenario ξ(OC2).*

Proposition 5.6 is a strong and clear finding. For any given PS contract with a fixed profit-sharing rate, because the wholesale price under OC1 is lower than OC2, the franchisee's expected profit under OC1 is larger than the OC2 counterpart. Thus, OC1 is always preferred for any given PS contracts.

5.4.3.2 Optimal Contract

After considering the optimal ordering case for the franchisee, we now examine the optimal choice of contracts. To compare choices on the franchise contract, we compare Scenario α (WP contract) versus Scenario β (PS contract), which are both under OC1. For a notational purpose, we define the following:

$T(\hat{c}_0) = \{(w + \hat{c}_0)\mu_0 + \sigma_0[\Delta(w) - \Delta(\hat{c}_0)]\}/[(p - \hat{c}_0)\mu_0 - \sigma_0\Delta(\hat{c}_0)]$.

By directly comparing the franchisee's expected profits under these two scenarios, we have Proposition 5.7.

Proposition 5.7. *Under OC1, in deciding the optimal contract, the franchisee will prefer Scenario α (WP contract) to Scenario β (PS contract) if and only if* $\lambda > T(\hat{c}_0)$*; otherwise, the franchisee will prefer Scenario β (PS contract) to Scenario α (WP contract).*

Proposition 5.7 shows that if λ, the profit-sharing rate for the fashion brand, is sufficiently big, the WP contract is preferred from the perspective of the franchisee. If the fashion brand's profit-sharing rate is sufficiently small, the PS contract will be the franchisee's optimal choice. This finding is intuitive and reasonable. Under OC2, to find the optimal franchise contract, we compare Scenario γ (WP contract) versus Scenario ξ (PS contract). By comparing the respective expected profits for the franchisee under Scenario γ and Scenario ξ, we have Proposition 5.8.

Proposition 5.8. *Under OC 2, in deciding the optimal contract, the franchisee will prefer Scenario γ (WP contract) to Scenario ξ (PS contract) if and only if* $\lambda > T(c_0)$*; otherwise, the franchisee will prefer Scenario ξ (PS contract) to Scenario γ (WP contract).*

Proposition 5.8 is similar to Proposition 5.7, and the interpretation is similar. In short, if the profit-sharing rate (for the fashion brand) is sufficiently small, the PS contract is preferred by the franchisee; otherwise, the WP contract is preferred.

Table 5.6 summarizes the findings on scenario preferences and optimal choices from Propositions 5.5 to 5.8. It is interesting to observe that for the optimal decision on

"ordering case", the franchisee faces a very simple decision-making problem: (i) Under the WP contract, both OC1 and OC2 are equally good and hence the franchisee can choose either one of them without any trouble. (ii) Under the PS contract, OC1 is always preferred to OC2, which is a straightforward decision.

Table 5.6. Scenario preferences and optimal choices: From the perspective of the franchisee.

Choices	Optimal Choices	Scenario Preferences	Necessary and Sufficient Conditions
Ordering Cases	OC1	$\alpha > \gamma$ (under WP)	Never happens
	OC2	$\alpha < \gamma$ (under WP)	Never happens
	OC1 and OC2 are equally good	$\alpha = \gamma$ (under WP)	Always
	OC1	$\beta > \xi$ (under PS)	Always
	OC2	$\beta < \xi$ (under PS)	Never happens
Contracts	WP	$\alpha > \beta$ (under OC1)	$\lambda > T(\hat{c}_0)$
	PS	$\alpha < \beta$ (under OC1)	$\lambda < T(\hat{c}_0)$
	WP	$\gamma > \xi$ (under OC2)	$\lambda > T(c_0)$
	PS	$\gamma < \xi$ (under OC2)	$\lambda < T(c_0)$

5.5 Supply Chain Systems Analysis

5.5.1 Supply Chain Best Scenarios

In the scenario analysis, we have explored the four scenarios and derived the conditions under which one scenario is preferred to another one under the choice either on the ordering case or the franchise contract.

However, the perspective of decision making is only from the fashion brand's or the franchisee's perspective, but not considering the whole supply chain system. We then explore how the fashion brand's choices on the scenarios would affect the supply chain's performance.

By definition, under each scenario, the supply chain's expected profit is equal to the sum of the expected profits of the fashion brand and the franchisee. We thus have:

$$\Pi_{SC}^{i} = \Pi_{B*}^{i} + \Pi_{F*}^{i}, \text{ where } i = \{\alpha, \beta, \gamma, \xi\} \quad (5.33)$$

Following the definition as given by (5.33), Table 5.7 shows the analytical expressions of Π_{SC}^{i} for all scenarios.

Table 5.7. Supply chain expected profits under different scenarios.

Scenarios	Supply Chain Expected Profits
α	$\Pi_{SC}^{\alpha} = (p - \hat{c}_0)m_0 - s_0\Delta(\hat{c}_0) + \sigma_0[(w - \hat{c}_0)\Omega(w) - \Delta(w)]$ $+ (p - w)\mu_0$
β	$\Pi_{SC}^{\beta} = (p - \hat{c}_0)(m_0 + \mu_0) - (s_0 + \sigma_0)\Delta(\hat{c}_0)$
γ	$\Pi_{SC}^{\gamma} = (p - c_1)m_0 - s_0\Delta(c_1) + \sigma_0[(w - c_0)\Omega(w) - \Delta(w)]$ $+ (p - c_0)\mu_0$
ξ	$\Pi_{SC}^{\xi} = (p - c_1)m_0 + (p - c_0)\mu_0 - s_1\Delta(c_1) - \sigma_0\Delta(c_0)$

From the supply chain's perspective, Table 5.8 shows the necessary and sufficient condition for the supply chain to prefer one scenario to another one. Combining Tables 8 and 11, we have the necessary and sufficient condition in which the optimal choice is the best for both the fashion brand and the supply chain system. The results are summarized in Table 5.9 and we have Proposition 5.9.

Table 5.8. Scenario preferences and optimal choices: From the perspective of the supply chain.

Choices	Optimal Choices	Scenario Preferences	Necessary and Sufficient Conditions
Ordering Cases	OC1	$\alpha > \gamma$ (under WP)	$(c_1 - \hat{c}_0)m_0 + (w - c_0)\mu_0 + s_1\Delta(c_1) - s_0\Delta(\hat{c}_0) + \sigma_0(c_0 - \hat{c}_0)\Omega(w) \geq 0$
	OC2	$\alpha < \gamma$ (under WP)	$(c_1 - \hat{c}_0)m_0 + (w - c_0)\mu_0 + s_1\Delta(c_1) - s_0\Delta(\hat{c}_0) + \sigma_0(c_0 - \hat{c}_0)\Omega(w) < 0$
	OC1	$\beta > \xi$ (under PS)	$(c_1 - \hat{c}_0)m_0 + (p - \hat{c}_0)\mu_0 + s_1\Delta(c_1) - s_0\Delta(\hat{c}_0) - \sigma_0(w - \hat{c}_0)\Omega(w) + \sigma_0[\Delta(w) - \Delta(\hat{c}_0)] \geq 0$
	OC2	$\beta < \xi$ (under PS)	$(c_1 - \hat{c}_0)m_0 + (p - \hat{c}_0)\mu_0 + s_1\Delta(c_1) - s_0\Delta(\hat{c}_0) - \sigma_0(w - \hat{c}_0)\Omega(w) + \sigma_0[\Delta(w) - \Delta(\hat{c}_0)] < 0$
Contracts	WP	$\alpha > \beta$ (under OC1)	$(w - \hat{c}_0)[\sigma_0\Omega(w) - \mu_0] - \sigma_0[\Delta(w) - \Delta(\hat{c}_0)] \geq 0$
	PS	$\alpha < \beta$ (under OC1)	$(w - \hat{c}_0)[\sigma_0\Omega(w) - \mu_0] - \sigma_0[\Delta(w) - \Delta(\hat{c}_0)] < 0$
	WP	$\gamma > \xi$ (under OC2)	$(w - c_0)\Omega(w) - [\Delta(w) - \Delta(c_0)] \geq 0$
	PS	$\gamma < \xi$ (under OC2)	$(w - c_0)\Omega(w) - [\Delta(w) - \Delta(c_0)] < 0$

Table 5.9. Scenario preferences and optimal choices which are the best for both the supply chain and the fashion brand.

Choices	Optimal Choices	Scenario Preferences	Necessary and Sufficient Conditions
Ordering Cases	OC1	$\alpha > \gamma$ (under WP)	$(c_1 - \hat{c}_0)m_0 + (c_0 - \hat{c}_0)Q(w) \geq s_0\Delta(\hat{c}_0) - s_1\Delta(c_1)$ (same as the one for the fashion brand).
	OC2	$\alpha < \gamma$ (under WP)	$(c_1 - \hat{c}_0)m_0 + (c_0 - \hat{c}_0)Q(w) < s_0\Delta(\hat{c}_0) - s_1\Delta(c_1)$ (same as the one for the fashion brand).
	OC1	$\beta > \xi$ (under PS)	$(c_1 - \hat{c}_0)m_0 + \lambda(c_0 - \hat{c}_0)\mu_0 \geq (s_0 + \lambda\sigma_0)\Delta(\hat{c}_0) - (s_1 - \lambda\sigma_0)\Delta(c_1)$ (same as the one for the fashion brand).
	OC2	$\beta < \xi$ (under PS)	$(c_1 - \hat{c}_0)m_0 + (p - \hat{c}_0)\mu_0 + s_1\Delta(c_1) - s_0\Delta(\hat{c}_0) - \sigma_0(w - \hat{c}_0)\Omega(w) + \sigma_0[\Delta(w) - \Delta(\hat{c}_0)] < 0$ and $(c_1 - \hat{c}_0)m_0 + \lambda(c_0 - \hat{c}_0)\mu_0 < (s_0 + \lambda\sigma_0)\Delta(\hat{c}_0) - (s_1 - \lambda\sigma_0)\Delta(c_1)$
Contracts	WP	$\alpha > \beta$ (under OC1)	$\lambda \leq \frac{(w - \hat{c}_0)Q(w)}{(p - \hat{c}_0)\mu_0 - \sigma_0\Delta(\hat{c}_0)}$ and $(w - \hat{c}_0)[\sigma_0\Omega(w) - \mu_0] - \sigma_0[\Delta(w) - \Delta(\hat{c}_0)] \geq 0$
	PS	$\alpha < \beta$ (under OC1)	$\lambda > \frac{(w - \hat{c}_0)Q(w)}{(p - \hat{c}_0)\mu_0 - \sigma_0\Delta(\hat{c}_0)}$ and $(w - \hat{c}_0)[\sigma_0\Omega(w) - \mu_0] - \sigma_0[\Delta(w) - \Delta(\hat{c}_0)] \geq 0$
	WP	$\gamma > \xi$ (under OC2)	$\lambda \leq \frac{(w - c_0)Q(w)}{(p - c_0)\mu_0 - \sigma_0\Delta(c_0)}$ and $(w - c_0)\Omega(w) - [\Delta(w) - \Delta(c_0)] \geq 0$
	PS	$\gamma < \xi$ (under OC2)	$\lambda > \frac{(w - c_0)Q(w)}{(p - c_0)\mu_0 - \sigma_0\Delta(c_0)}$ and $(w - c_0)\Omega(w) - [\Delta(w) - \Delta(c_0)] < 0$

Proposition 5.9. *In deciding the optimal ordering case under the WP contract: Comparing between Scenario α and Scenario γ, if it is optimal for the fashion brand to choose Scenario l, for* $l \in (\alpha, \gamma)$*, it will also be the optimal scenario for the supply chain. Under the PS contract, if it is optimal for the fashion brand to choose OC1, it will also be optimal for the supply chain.*

Proposition 5.9 shows that for the ordering case optimization problem in the presence of the WP contract, the fashion brand's optimal ordering case decision is consistent with the supply chain's optimal decision. This finding hence shows the beauty behind the WP contract: It is not only a simple contract easy to implement, in our model, we also achieve the consistency between the optimal ordering case decisions of the fashion brand and the supply chain. Under the PS contract, the "consistency" situation between the optimal ordering case choices of the fashion brand and the supply chain occurs only for the case when it is optimal for the fashion brand to choose OC1 but not OC2. This shows that a natural difference usually exists between the fashion brand's optimal choice and the supply chains' under the PS contract. For the other cases, the respective necessary and sufficient conditions need to be examined. Table 5.9 shows

the respective analytical conditions.

5.5.2 Pareto-improving Scenarios

In the above analysis, we look at the necessary and sufficient conditions for the optimal choices of the supply chain and find the common conditions with which the optimal choices of the fashion brand and the supply chain are the same. However, an optimal choice for the fashion brand and the supply chain need not always benefit the franchisee. Therefore, we examine the Pareto improving conditions for the choices (and scenario preferences). Here, we say that a choice is Pareto improving when after taking it, both the fashion brand and the franchisee are either both strictly benefited (i.e. win-win), or at least one of them is strictly benefited and the other is not worse off in expected profit.

To establish this result, we make use of the findings from Tables 5.5 and Table 5.6. The result is summarized in Table 5.10 and we have Proposition 5.10.

Table 5.10. Scenario preferences and choices which are Pareto improving.

Choices	Optimal Choices	Scenario Preferences	Necessary and Sufficient Conditions
Ordering Cases	OC1	$\alpha > \gamma$ (under WP)	$(c_1 - \hat{c}_0)m_0 + (c_0 - \hat{c}_0)Q(w) \geq s_0\Delta(\hat{c}_0) - s_1\Delta(c_1)$ (same as the one for the fashion brand).
	OC2	$\alpha < \gamma$ (under WP)	$(c_1 - \hat{c}_0)m_0 + (c_0 - \hat{c}_0)Q(w) < s_0\Delta(\hat{c}_0) - s_1\Delta(c_1)$ (same as the one for the fashion brand).
	OC1	$\beta > \xi$ (under PS)	$(c_1 - \hat{c}_0)m_0 + \lambda(c_0 - \hat{c}_0)\mu_0 \geq (s_0 + \lambda\sigma_0)\Delta(\hat{c}_0) - (s_1 - \lambda\sigma_0)\Delta(c_1)$ (same as the one for the fashion brand).
	OC2	$\beta < \xi$ (under PS)	Never happens.
Contracts	WP	$\alpha > \beta$ (under OC1)	$T(\hat{c}_0) < \lambda \leq J(\hat{c}_0)$
	PS	$\alpha < \beta$ (under OC1)	$J(\hat{c}_0) < \lambda < T(\hat{c}_0)$
	WP	$\gamma > \xi$ (under OC2)	$T(c_0) < \lambda \leq J(c_0)$
	PS	$\gamma < \xi$ (under OC2)	$J(c_0) < \lambda < T(c_0)$

Proposition 5.10. *(a) In deciding the optimal ordering case under the WP contract: Comparing between Scenario α and Scenario γ, if it is optimal for the fashion brand to choose Scenario l, for $l \in (\alpha, \gamma)$, it will be a Pareto improving scenario. (b) In deciding*

the optimal ordering case under the PS contract: Only OC1 can be a Pareto improving scenario and OC2 is never Pareto improving. (c) In deciding the optimal contract, the Pareto improving condition depends on the profit-sharing rate. Pareto improvement can be achieved only when the profit-sharing rate is neither too high nor too small.

Proposition 5.10 shows that for the ordering case selection problem in the presence of the WP contract, the fashion brand's optimal choice is also a Pareto improving choice. From Proposition 5.9, this is also an optimal choice for the decentralized supply chain. So, both propositions illustrate the nice feature of the WP contract in the optimal ordering case decision. However, for the case with the PS contract, this Pareto improving situation only appears for OC1, but not for OC2 because the franchisee always suffers under OC2. For the contract selection problem, when the profit-sharing rate (for the fashion brand) is bounded in the range as specified in the respective case in Table 5.9, Pareto improvement can be achieved. This result is intuitive because a big profit-sharing rate benefits the fashion brand but hurts the franchisee, whereas a very small profit-sharing rate hurts the fashion brand, however it benefits the franchisee. So, Pareto improvement appears only when the profit-sharing rate is neither too big nor too small.

5.6 Conclusion and Summary

Online-offline operations are known to induce channel conflicts if the same products are offered by them. Motivated by the importance of online-offline operations and the problems associated with channel conflicts within dual channels under franchising arrangement, we have examined a fashion franchising supply chain in which no channel conflicts exist, and the franchisor may make use of the franchisee's demand information to improve its own inventory planning. To be specific, we have studied the case in which the fashion brand (i.e. the franchisor) first supplies the product for the franchisee to sell offline in the first period. After that, the fashion brand will sell the same product online in the second period. The fashion brand can choose to order the product for its own online channel at the same time as the franchisee so that the unit ordering cost is lower (from an economy of scale). Alternatively, the fashion brand can choose to postpone its ordering decision to a later time point so that it can improve its demand forecast and reduce demand uncertainty. A trade-off hence exists between ordering cost and forecast accuracy.

For the optimization problems, we have focused on exploring the choice of

franchising contract and the ordering time. We have modeled the choices under four different scenarios and derived the analytical closed-form conditions in where one scenario is preferred to another with respect to contract type and ordering time option.

In the explorations, we have examined the scenario choices from the perspectives of the fashion brand owner, the franchisee and the supply chain. and identified the situations in which the optimal choices of the fashion brand and the supply chain are consistent. In particular, we have shown that under the WP contract, the optimal ordering case decisions among the fashion brand, the franchisee and the supply chain are consistent. However, this situation is not always true under the PS contract. This result is a bit counter-intuitive because it shows that the simple WP contract is, in fact, capable of achieving Pareto improvement for the optimal ordering case decisions.

We have further uncovered the conditions and cases in which Pareto improvement appears. All the conditions are derived in closed form and hence provide theoretically solid and practical guidance to decision-makers. Notice that various insights have been derived and reported in the proposed corollaries and propositions. The managerial implications and trade-offs have also been elaborated respectively.

Chapter 6. Franchising Contracts in Fashion Supply Chain Operations: Case Study with a Chinese Fashion Brand Company

6.1 Introduction

In this section, we proceed to the case study on a representative fashion company in franchising operations. Notice that, the case study is a proper and applicable research method for our study. Since with case study, we can deeply explore, in the fashion industry, why the franchisor and the franchisee establish the franchising cooperation and how the franchising contracts are implemented between different channel members. Besides, in our research, in-depth interviews are conducted. We also review a variety of relevant documents in practice as the supporting materials, which contribute to the rigor of the case study. During the process of the case study, we further validate the analytical findings derived in Chapter 3, Chapter 4 and Chapter 5 in the industrial franchising practice and consolidate the robustness of the analytical results with managerial insights.

To be specific, we follow the approach adopted by Choi et al. (2013a), which conducts a lot of semi-structured interviews and discussions with the internal staff of the fashion company to support their literature findings. Similar to Choi et al. (2013a), after addressing the literature review, we also conduct a case study to explore the franchising contracts in fashion industry operations. Various franchising contracts employed by the franchisor are analyzed within the dynamic fashion franchising channel in different evolving periods of the company. Furthermore, we integrate the insights with the findings generated from multiple sources including in-depth interviews and discussion with the franchisor and the franchisees, and the review of relevant documents, to achieve a better validity of the outcomes.

To enhance the reliability of the case study, we initially formulate the systematic procedure for each step. The formulated plan is tested as pilot projects with GJG and further improved according to the feedback and suggestions. Categorization for the target interviewees is also conducted. Four target groups are defined as the decision-makers of GJG, who are the President, the General Manager and the Vice General Manager; the senior management for the franchising business of GJG including Franchising Director, Retail Director, Finance Director, Inventory Director and the

regional managers of the Franchising Department; the crucial provincial agents and the key regional franchisees distinctive for the regional market status, sales volume, number of retail outlets and duration of cooperating with GJG. We adopt the 5-level questions portfolio depicted by Yin (2009) to develop the substantive interview questions for each group to extract the comprehensive qualitative evidence. The guideline of questions for the interviews is enclosed in the appendix. All the interviews are conducted by two experienced analysts to ensure validity. The evidence collected from individual interviews is cross-checked and cross-evaluated by both analysts to avoid any ambiguity and misunderstanding. If any biased information is detected, additional discussions are carried out to gain a better grasp of any misunderstanding inputs. Furthermore, the relevant documentation of GJG, including the standard format of franchising contracts and the regional franchising business reports, are reviewed as supporting materials after being checked for the facticity and validity. Based on the findings generated from the case study, the key facts upon the implementation of franchising contacts are discussed from the perspectives of the channel interaction, channel operations and channel coordination. Figure 6.1 demonstrates the research model.

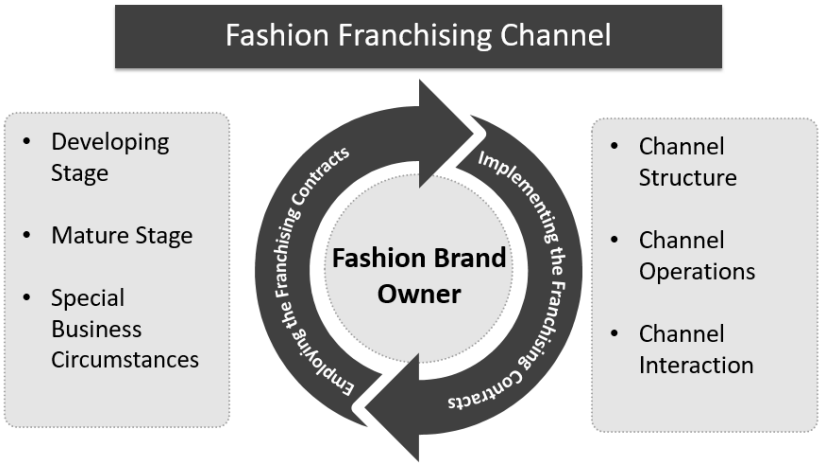

Figure 6.1. The research model.

6.2 Company Profile

6.2.1 Company Background

Founded in 1999, Guangzhou Jinyu Garments Co., Ltd (GJG) is a famous fashion company in China. Operated through the two well-reputed fashion brands names of

A.Yilian and A.Sgirl, the company is recognized as one of the biggest fashion brand owners covering nearly all the provinces in China with more than one thousand retail outlets. GJG distributes its products through multiple channels with the presence of direct retail shops (operated by GJG), franchised shops (operated by the franchisees) and the online sales channel (operated by GJG). Among all the channels, the franchising business is reported to provide the largest contribution to the total sales volume. In light of the complexity of the franchising business, GJG applies a series of franchising contracts for the cooperation with different channel members, e.g., provincial agents, franchised distributors and joint-retailing cooperators. The franchising contract portfolio greatly helps GJG to well develop from a small wholesale fashion company to the owner of the leading young lady fashion brand in China. Focusing our case study on GJG enables us to obtain a holistic understanding of franchising operations in the fashion industry together with a comprehensive knowledge of how the franchising contracts function in practice.

6.2.2 The Structure of The Franchising Distribution of The Company

Notice that above 80% of the total sales volume of GJG is obtained from the franchising business. Due to the unbalanced economic situation in different provinces and the varying capacity of the franchisees, GJG faces an intricate structure of channel members within the franchising system. (see Figure 6.2), which can be featured as multiple distribution channels. The combination of provincial agents and sub-regional franchisees is the most widely observed channel operations in GJG's franchising system. Under this hybrid system, GJG first supplies the products to the provincial agents. The products are then distributed to the sub-regional franchisees who operate retail shops, notated as Shop (F1). Nevertheless, some provincial agents also penetrate into the retail business via its own shops, notated as Shop (F2). Distributing the products through immediate regional franchisees is another emerging observation in GJG's franchising system. GJG can effectively shorten the franchising channel by skipping the provincial agents and directly supplying the products to the immediate regional franchisees. Then, the immediate regional franchisees sell GJG's products in the retail market via their shops, notated as Shop (F3), without the control and supervision exerted by any provincial agent. Under some circumstances, joint-retailing cooperators occur in GJG's distribution channel as special franchisees. For instance, seeing the difficulties of expanding business in some key cities in China or seeking the cooperation with strategic channel partners e.g. a famous department store, GJG tends to work with

the joint-retailing cooperator for opening the jointly owned retail shops, notated as Shop (F4), to make full use of the resources for better franchising operations.

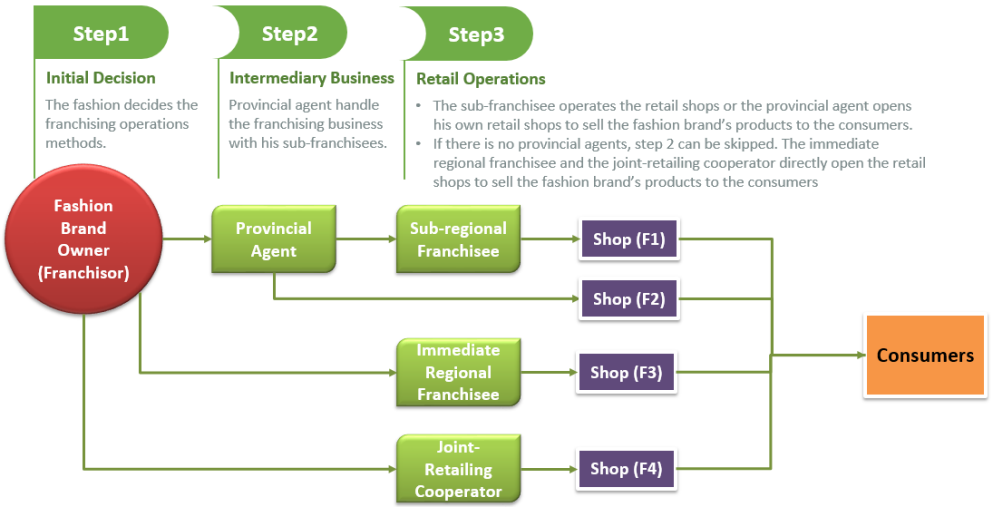

Figure 6.2. The franchising channel structure of GJG.

6.2.2.1 Provincial Agent

The provincial agent is the channel member handling the franchising business of the whole province. There are two types of provincial agents existing in GJG' franchising system. One is the single-provincial agent whose franchising business is restricted within only one province. The other is the cross-provincial agent who manages the franchising business in at least two provinces. Provincial agents are at the top of the pyramid of GJG's franchising distribution channels., the company has 18 single-provincial agents and 1 cross-provincial agent[7] in total. Permitted by GJG, nearly all the provincial agents have established the sub-franchising systems in their own regions in addition to their retail shops. Noticeably, the sub-franchising systems are regulated by the franchising contracts offered by GJG.

It is undoubted that the provincial agents play critical roles in the business expansion of GJG. On the other hand, however, the provincial agents also share certain portions of the revenue from GJG, which is considered negatively affecting the total profit of the company. Consequently, conflicting interests are detected between GJG and the provincial agents, which may hinder the optimization of the whole distribution channel. Therefore, GJG is motivated to tighten control over the provincial agents in

7 The only cross-provincial agent is based on Gansu province, which simultaneously handles GJG's franchising business in Qinghai province and Ningxia province.

recent years. From 2015 to 2016, GJG has even withdrawn the franchising rights of several provincial agents due to their poor performance.

6.2.2.2 Regional Franchisee

The regional franchisee is the franchisee directly operates one or several franchised shops in specified cities or areas with a relatively small scale and limited marketing resources. The regional franchisees consist of direct regional franchisees who are developed by GJG and sub-regional franchisees who are developed by the provincial agents. Both the two types of regional franchisees are granted under the franchising contracts issued by GJG. Compared to the sub-regional franchisees, the direct regional franchisees interact more closely with GJG in the marketing activities including the seasonal ordering, the marketing communication and the promotion. In addition, the direct regional franchisees also demonstrate a higher level of loyalty to the franchising system than the sub-regional franchisees.

It is notable that nearly two-thirds of the hundreds of regional franchisees are the sub-regional franchisees. GJG keeps putting efforts in recent years to increase the number of direct regional franchisees aiming to shorten the distribution distance and impose stricter control on the franchising system. The increasing number of direct regional franchisees also helps GJG to achieve the improvement in business capability and enhance the sense of belonging in the franchising channel.

6.2.2.3 Joint-retailing Cooperator

The joint-retailing cooperator refers to the franchisee involving in the channel operations but is not totally controlled by the franchising system. This kind of franchisees is particularly needed for some special business cooperation, e.g., sharing the costs and risks when opening a regional flagship shop in major cities. The joint-retailing cooperators include joint-operators and trustees. The joint-operators can negotiate the commercial terms such as the operations investment and the rate for sharing the revenue with the franchisor. For the case of GJG, the joint-operator must burden the cost for the store operations while GJG is responsible for the cost of the workforce, staff training and production. Specified by the franchising contract, the joint-operators can share a fixed percentage of the profit margins generated by the retailing operations, sometimes with the sales target. On the other hand, the trustees exist only when GJG lacks enough capacity of maintaining effective franchising management due to the remote location or short of sufficient resources. The trustee is thus authorized to handle the store operations without any proprietorship of the shops.

Under the franchising contract, GJG bears nearly all the operations costs and risks while the trustee can obtain a fixed service charge or a certain percentage of the sales revenue[8].

As emphasized by GJG decision-makers, although the number of joint-retailing co-operators is relatively small compared to the provincial agent and the regional franchisee, they do exert important effects in the franchising system. According to GJG senior managers, the channel resources, the operations team and the market reputation are the key indicators when they select the joint-retailing co-operators. Meanwhile, they also thoroughly evaluate the potential benefit, cost, and risk before further proceeding the cooperation with the joint-retailing co-operators. (Table 6.1 summarizes the members of the GJG franchising channel.)

Table 6.1. Members of the GJG franchising channel.

Franchisee Type	Franchisee Sub-category	Characteristic
Provincial Agent	Single-provincial agent	Handling the channel business of one province. Granted to develop the sub-franchising system.
	Cross-provincial agent	Handling the channel business of more than one province. Granted to develop the sub-franchising system.
Regional Franchisee	Direct regional franchisee	Interact closely with the franchisor in the marketing activities, e.g., seasonal ordering and promotion implementation.
	Sub-regional franchisees	Closely controlled by the provincial agents and less capable of negotiating the business activities for their own.
Joint-Retailing Co-operators	Joint-operator	Co-operates the shop with the franchisor, may negotiate for the marketing terms for more commercial benefits.
	Trustee	Handle the operations without owning the shop and burdening any cost. Obtain a fixed charge or a certain percentage of sales.

6.2.3 The Portfolio of Franchising Contracts in The Company

Due to the different characteristics of the channel members, a portfolio of franchising contracts is adopted by GJG to manage the franchising system. Noteworthily, as accentuated by GJG decision-makers and the senior management staff, the franchising contracts vary in different periods of development.

6.2.3.1 Developing Stage

Since GJG initiated the business from wholesaling, the wholesale price contract has been widely applied in GJG's franchising system from 1999 to 2000. As the business grows, GJG begins to incorporate the wholesale price contract with other

8 The trustee can attain her profit under the agreed Key Performance Indicator (KPI), e.g. monthly or annual sales revenue or net profit.

franchising contracts. Regarding the inventory holding cost and the market uncertainty, the buyback contract is employed to share the inventory risk with the franchisees, where 5% to 20% of the unsold products are allowable to be returned from the franchisees to GJG at discounted prices. Further driven by the increasing order, the wholesale price contract is extended to the quantity discount contract for the pre-season ordering to encourage the franchisees to purchase in larger quantities. Such discount is only available for the pre-season order excluding the replenishment order. Afterwards, GJG revises the quantity discount from all unit discount to partly quantity discount with minimum order quantity. The franchisee can only enjoy the quantity discount for the proportion above the basic order quantity standard.

6.2.3.2 Mature Stage

As the business further expands, GJG's franchising system becomes much more mature and stable. As a result, it leads to an emphasis on centralized control for improving channel efficiency. Therefore, since the winter of 2008, GJG starts to implement a two-stage ordering policy under the quantity commitment contract specifying the total seasonal order quantity. The franchisees can place the orders in two different time stages and GJG must satisfy any request of the franchisee within the contracted order quantity. The punishment is triggered by either party who fails to fulfill the terms specified in the contract. Furthermore, the franchise fee contract is utilized with the payment of the franchise fee for entering GJG's franchising system, which also guarantees the franchisee upon the unique franchising right in a specific region. The franchise fee serves not only as a criterion to select the qualified franchisees but also as a mechanism to balance the profit allocation within the franchising channel. As mentioned by some franchisees of GJG, the franchise fee can even push the franchisor to invest more on branding and encourage the franchisees to devote more efforts to marketing. Motivated by the request of profit management, GJG applies the retail price maintenance (RPM) contract to fix the retail price for all the distribution channels. It contributes to better controlling the profit and maintaining brand positioning. The franchisees of GJG address that they also feel comfortable with the RPM contact since it can effectively dampen the double marginalization problem and properly regulate the market competition.

6.2.3.3 Special Business Circumstances

Judged from the case study, GJG occasionally encounters the situations to deal with some special contractual interactions during the franchising operations, especially

for the cooperation with the joint-retailing cooperators. The royalty payment is commonly applied by the means of revenue-sharing contracts or profit-sharing contracts. Both the two-part tariff contracts contain the sharing-arrangement for the sales volume or profit in addition to the terms of the wholesale price and the franchise fee. When GJG employs the revenue-sharing contract or the profit-sharing contract, the company may reduce the wholesale price even lower than the production cost to strengthen the competitive capability. The potential loss shall be compensated by the joint-operator with the rebate from the sales value or the obtained profit. Another situation is the strategic promotion occurring in the seasonal marketing events that are activated by GJG as the response to the competition or to push the sales of specific products. GJG issues the tying contract bundling some promotional products with a special offer to the franchisees. Under the tying contract, the franchisees must compulsorily order the bundled promotional products and actively push the sales for such products. Meanwhile, GJG may reward the franchisees with additional rebates as the complementarity according to their sales performance. As for the cooperation with the trustees, GJG sometimes offers an incomplete contract to construct the equilibrium governance structure with negotiable space. The incomplete contract works as the tacit mechanism to facilitate both parties to strive for the optimality of the franchising system with joint-efforts.

Table 6.2 summarizes the franchising contract application of GJG in different stages of development. In the developing stage, the core objective of GJG is to rapidly expand the business and increase the sales revenue as well as the market share by boosting the order quantity in multiple distribution channels. Therefore, the major consideration for employing franchising contracts in the developing stage covers the wide acceptability for franchising partners, the easy handleability for the implementation and the prominence of channel competitiveness. As the franchisor steps into the mature stage, the core objective is transferred to maintain the market status, better control the channel operations and optimize the channel resources. As a result, the major consideration for employing franchising contracts in the mature stage turns to the promotion of overall channel superiority, dominance in the franchising system and the agglomeration of preponderant channel resources. While in rolling out special marketing plans, GJG can customize the franchising contracts to incorporate the mutual benefits for the individual franchising co-operator or the strategic advantages in the long term. In general, the company first identifies the periodical strategic goals before

selecting a contract, e.g., to enhance the market share or to optimize the resource. Then the company develops the channel strategy with the consideration of the channel position, channel structure and channel member portfolio, which constructs the framework to design the franchising contract with the key business variables. In the meantime, the company also assesses the features of each franchisee on the business characteristics, company capacity, duration of cooperation, business preference and focus, and even the personality of the decision-maker. Only after the entire systematical evaluation finishes, the franchising contracts are designed and offered to the franchisees. In some circumstances, the contract may be revised according to the feedback or counteroffer from the franchisees. Usually, GJG may not issue many different contracts at the same time, which maintains the stability and consistency of the franchising system.

Table 6.2. Summary of contract application of GJG in different stages.

Stage	Core Objectives	Major Considerations	Mainly Employed Contracts	Functions of the Contract
Developing Stage	Rapidly expand business; Increase sales revenue and market share by boosting the order quantity.	Wide acceptability; Easy handleability for the implementation; Prominence of channel competitiveness.	Wholesale price contract	Initiate the franchising business. The transactions are straightforwardly processed only by the wholesale price.
			Buyback contract	Reduce the inventory holding cost of the franchisee and share the franchisees' inventory risk.
			Quantity discount contract	Encourage the franchisees to raise the order quantity.
Mature Stage	Maintain market status. Better control the channel operations; Optimize the channel resources.	Promotion of overall channel superiority; Dominance in the franchising system; Agglomeration of preponderant channel resources.	Quantity commitment contract	The franchisees can place orders with better market information and more flexibility.
			Franchise fee contract	Guarantee the unique franchising right of the franchisee. Push the franchisor to invest more on branding.
			Retail price maintenance contract	Impose better control in pricing, profit management and market positioning
Special Circumstances	Cope with special marketing plans or business opportunities.	The mutual benefits for a particular franchising co-operator. The strategic advantages in a long-term	Revenue/Profit-sharing contract	Reduce the ordering cost of the franchisee and strengthen the competitive capability.
			Tying contract	Push the sales of specific products in the strategic promotion.
			Incomplete contract	Facilitate the channel members to strive for the optimality for the franchising system with joint-efforts.

6.2.4 The Implementation of The Franchising Contracts

It is clearly depicted in the GJG case study that the franchising contracts function significantly in the distribution channel in the fashion industry. In the following, the implementation of franchising contracts in GJG is discussed in the channel structure, channel operations and channel interaction.

6.2.4.1 Channel Structure

The implementation of franchising contracts can synthesize the information on the products and market knowledge and attract qualified franchisees. According to GJG's senior management, the franchising contract with the signal of lower start-up cost may greatly drive the potential franchisees to join in the system. Additionally, allocating the decision rights for critical terms such as pricing, franchise fees and royalties, is another important function of implementing the franchising contracts to maximize the channel benefit. Unlike some other franchisors that strictly restrict the multi-unit propensity of the franchisees, GJG holds an open attitude for multi-unit tendency and encourages the franchisee to expand the business by operating more shops. Concerning the channel conflict and the controversial activities among the channel members, the franchising contract can be utilized to control the disharmonies among the channel members and deploy the franchisor's preference as acquiring the franchised outlets and transferring them to be the company-owned ones.

6.2.4.2 Channel Operations

For the channel operations, considering the franchisees' risk preference and the demand uncertainty, GJG implements the franchising contracts to improve the channel performance through the variables such as the royalty, pricing, incentive scheme and service level. According to our case study, for instance, the royalty payment can keep the franchisees working in line with the best interest of the whole channel and encourage information sharing between the franchisor and the franchisee (Gallini and Lutz, 1992; Agrawal and Lal, 1995; Hempelmann, 2006; Yan and Wang, 2012). With the retail price maintenance (RPM) contract, GJG regulates the retail price that is simultaneously fixed in the ERP system for the entire franchising channel. Besides, GJG also applies the profit-sharing contract to encourage the franchisees to share demand information. On the other side, the franchisees' risk preference is also frequently addressed by the decision-makers and the senior management of GJG. For example, the franchisee's risk aversion is preferable for the franchisor and beneficial for the whole franchising system.

6.2.4.3 Channel Interaction

The franchising contracts can be utilized to interact with the channel members. In practice, GJG offers franchising contracts in three different approaches to distinguish the franchisee types and detect their private information. The three approaches include

the individual contract[9], the menu contract[10] and the pool contract[11]. As emphasized by the senior management of GJG, once the franchising business relationship is settled, the free-riding and the moral hazard problem unavoidably occur when the franchising contracts are implemented. With the dominance in the franchising system, GJG intensively imposes monitoring in the franchising channel, particularly for those new franchisees and the franchisees only operating one shop. Even at a high cost, the monitoring proves effective to supervise the franchisees and protect the brand reputation and equity. Besides, a certain amount of deposit must be paid by the franchisee to GJG as the guarantee before the franchising contract takes effect. If any franchisee is caught free-riding that seriously breaches the terms, GJG may terminate the contract immediately, withdraw the shops and confiscate the deposit. GJG imposes strict quality control standards to raise the threshold for free-riding of adding some low-quality products into GJG shops. As mentioned by GJG managers, when implementing the profit-sharing contract with the joint-operator, GJG increases the profit share percentage as the eventual incentive to reduce the motivation of moral hazard.

6.3 Key Factors: Implementing Franchising Contracts in Practice

Based on the detailed literature review in Section 2 and the case study in Section 3, a list of elements can be identified to influence the implementation of franchising contracts in various dimensions. The addressed factors can be summarized as information updating and information asymmetry, monitoring, free riding, moral hazard problem, royalty, incentive mechanism, service level, pricing, risk, power structure, franchise size, single-unit franchising and multi-unit franchising, dual distribution and signaling. Stimulated by these elements, we highlight the key factors for implementing franchising contracts in practice from the dimensions of the channel structure, channel operations and channel interaction (see Figure 6.3). The details are discussed as follows.

9 Designed for one franchisee type and does not consider the individual rationality constraint of the others.

10 A separating equilibrium contract where each franchisee selects the contract expressions designed strictly for her type.

11 The contract must satisfy the participation constraint for all the types of franchisees.

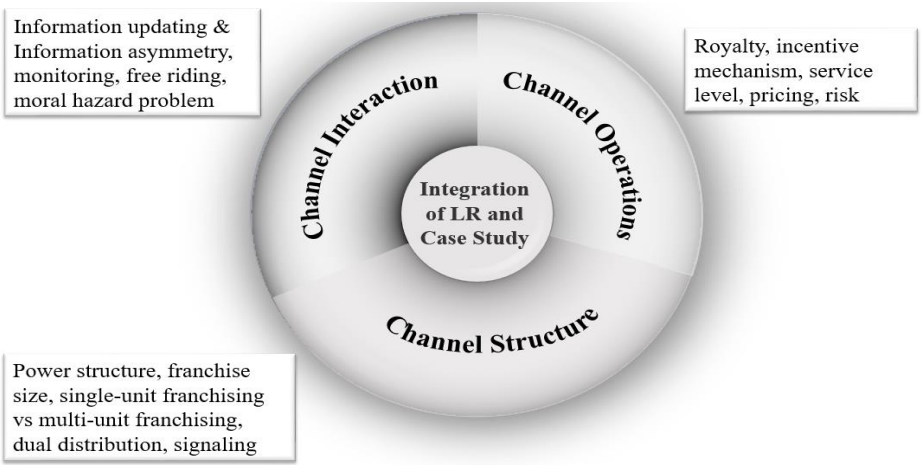

Figure 6.3. Key influencing factors.

6.3.1 The Factors within The Channel Structure

6.3.1.1 Power Structure

During the case study, GJG decision-makers emphasize that the power structure can influence the framework of franchising contracts. In particular, the bargaining power and decision rights are critical in constructing the framework of the franchising channel. The findings are supported by Dant et al. (2011) and Holmström (1999) mentioning that the asymmetrical power setting allows the franchisor to reign in the whole system but may slow down the growth of the franchising business. However, such power structure is overturning with the important role that franchisee plays, which can also be found in López-Fernández and López-Bayón (2017) discussing that the increase in franchisees' bargaining power may bring positive socialization effect towards the hold-up risk and the franchising contract termination. In some special cases, the involvement of a third party, such as a franchisee council, can also help to coordinate the allocation of power in the franchising system (Ehrmann and Spranger, 2007; Hendrikse and Jiang, 2011).

6.3.1.2 Franchise Size

Franchise size is the indicator reflecting the potential competitiveness of the franchising system and the franchisor's capacity. As reflected in the case study, both the GJG senior management and the franchisees admit that the franchise size is crucial in capturing the market share. In the literature, franchise size is featured as the measurement to prove the positive correlation between the royalty and the channel performance (Polo-Redondo and Lucia Palacios, 2011; Kacker et al., 2016). Franchise size is also the control variable to analyze the contract duration and the multi-unit

propensity (Vázquez, 2010). The royalty rate is found negatively influencing the franchise size and the negative impact grows stronger as the system matures (Shane et al., 2006). According to the experienced franchisees interviewed in the case study, the young franchisors usually pay more attention to the franchise size, which is supported by Shane (1996).

6.3.1.3 Preference of Multi-unit Franchising

As verified by the interviews and the discussions in our case study, multi-unit franchising becomes obvious as a striking trend, which is mentioned as well in Grünhagen and Mittelstaedt (2005). According to Kalnins and Lafontaine (2004) and Kaufmann and Dant (1996), 84% of the franchised restaurants are operated by multi-unit franchisees and 88% of the franchisors employ multi-unit franchising. Opposite to the findings of Vázquez (2010) that the franchisor holds a negative attitude towards multi-unit propensity due to the concern of greater free-riding threat, GJG decision-makers express a positive attitude towards the franchisee's multi-unit franchising propensity. Summarized in the literature, economies of scale, monitoring expenses, rapid system growth, system-wide adaptation, general reduction of system attrition rates, and strategic delegation of price or quantity choices to franchisees, are all considered as the key driving forces to push the expansion of multi-unit franchising (Azoulay and Shane, 2001; Kalnins and Lafontaine, 2004; Kalnins et al., 2006). From the franchisees' perspective, the franchisor's strategy and experience, and the financial benefits are regarded as the main factors for the decisions on single-unit franchising or multi-unit franchising (Dant et al., 2013).

6.3.1.4 Dual Distribution

The dual distribution channel is regarded as a widespread governance structure in the fashion industry. GJG has been implementing such a channel approach for a long time. Dual distribution combines the features of fully franchised and fully company-owned channels, where the franchised outlets coexist with the company-owned outlets. The advantage of dual distribution is supported by Hendrikse and Jiang (2011) verifying that dual distribution is an efficient approach to improve franchising operations depending on the benefits to the system related to the investment of the channel members. Concerning the moral hazard problem, the company-owned outlet is preferable to the franchised outlets as the franchisees are more incentive-based (Rubin, 1978), which can be identified as the general phenomenon in franchising operations in specific regional markets.

6.3.1.5 Signaling

As discovered in the case study, signaling is an important function of franchising contracts to link the individual demand of the channel members. In the literature, the above function is highlighted as the franchisor's signaling strategy for the high demand for a risk-neutral agent. Such a strategy substantially reduces the distortion in the franchising channel even at a high signaling cost as the service is unobservable (Agrawal and Lal, 1995). The Franchising Director and the Retail Director of GJG both emphasize that signaling is a useful tool to enhance the mutual understanding of business dimensions with the franchisees. The findings are supported by Shane et al. (2006) with the signaling theory demonstrating that the size of the franchise system is larger when the investment to initiate the franchising is lower. A similar application of the signaling theory can also be found in Combs et al. (2011) with the conclusion that the earning information should be released by the franchisor to the franchisee before it comes to a franchising contract.

6.3.2 The Factors within The Channel Operations

6.3.2.1 Royalty

As stressed by GJG and his franchisees, undeniably, the royalty is a core problem when a franchising contract is being negotiated. In the literature, the royalty is regarded as the most decisive issue that distinguishes the characteristic of a typical franchising contract (Lal, 1990; Blair and Lafontaine, 2005). Defined by Babich and Tang (2016), the royalty rate is a continuous payment for the franchisor as a portion of the revenues or profits generated by the franchisee. Mentioned in the case study, GJG management admits that the royalty also functions as the coordinating and signaling tool to entice the information sharing and the marketing activities, which is in line with the findings of Gallini and Lutz (1992), Agrawal and Lal (1995), Hempelmann (2006) and Yan and Wang (2012). According to Lanchimba et al. (2017), the royalty also works as the balancer to synthesize the risk and incentive to achieve the franchising channel coordination.

6.3.2.2 Incentive Mechanism

The incentive mechanism is an important element for the proper implementation of franchising contracts. Similar to the moral hazard, the incentive is also regarded as a two-sided mechanism by the franchisees of GJG. The incentive scheme is analyzed as the instrument in the literature to unify the respective interest of the franchising channel members (Hendrikse and Jiang, 2011). As examined in Hempelmann (2006), the

franchising contracts involve the incentives for the marketing activities of both the franchisor and the franchisee in the scenario of information symmetry and asymmetry. Besides, the application of royalty is proved to be sufficient for designing optimal franchising contracts considering risks. In Babich and Tang (2016), the authors explicate how the incentive can be positively related to the risk and propose a risk-incentive royalty that influences the performance of the franchising contracts.

6.3.2.3 Service Level

Though the fashion products seem not closely related to service, the fashion brand owners such as GJG do plan to incorporate the service level into the retail sector, not only to provide a better shopping experience but also to increase the customers' satisfaction and loyalty. The franchisor demands their franchisees to participate in such service involvement as well. In the literature, the service can be balanced with the royalty rate but negatively affected by the monitoring cost (Lal, 1990; Agrawal and Lal, 1995). As the franchising business grows, the franchisor can better observe the franchisees' service level via the monitoring systems (Shane et al., 2006). According to Desai and Srinivasan (1995), the observability of the service impacts the signaling of the high-demand franchisor. The service level can be enhanced by properly setting the variable income in the three-part franchising contract.

6.3.2.4 Pricing Mechanism

Pricing is the key component when issuing the franchising contract. As for GJG, the properly designed pricing mechanism with the franchise fee and the royalty enables the franchisor to share the positive information to attract the new franchisee or seize other brand's franchisees. In the literature, the main pricing-related determinants include the wholesale price, the royalty rate, the fixed franchise fee and the initial investment (Shane et al., 2006). The pricing mechanism constructs the links connecting all the channel members including the franchisor, the franchisee or even the manufacturer (Anderson and Weitz, 1992). In some special franchising contracts, e.g., the retail price maintenance (RPM) contract applied by GJG, the retail price is even specified in the clause and fixed in the ERP system. In addition, the pricing mechanism may affect the size of the franchising system and signal the information updating as well (Desai and Srinivasan, 1995). Opposite to the findings of Lafontaine and Shaw (1999) regarding the variation in the franchise fee and the royalty rate, Shane et al. (2006) discover that the franchisor in big scale prefers to revise the pricing mechanism by increasing the franchise fee and decreasing the royalty rate over time.

6.3.2.5 Risk

Concurred in the opinion of both the decision-makers and the senior management of GJG, risk-related variables are widely observed in applying the franchising contracts in the distribution channel. They all agree that the risk preferences of the channel members are among the most influential factors in franchising operations. In the literature, risk preference refers to the attitudes when the profit function is applied for the channel coordination, which can be categorized as risk-averse, risk-neutral and risk-seeking. According to Huang (1997), the franchisee's risk aversion plays a critical role in coordinating the franchising channel. The franchisee will cooperate with risk-averse and risk-neutral franchisors while the franchisor prefers to cooperate with risk-averse and risk-seeking franchisees. Whereas, under all the franchisee's risk preferences, cooperation creates the largest profit for the entire channel. Mentioned by some regional managers of GJG, the royalty rate may fluctuate with the different risk preferences of the channel members. As the royalty rate increases, the risk can be transferred from the retail outlet to the franchisor (Lafontaine, 1992). The positive relationship between the risk and the incentive motivation can be identified for designing the franchising contract (Prendergast, 2002; Shi, 2011; Fung, 2013; He et al., 2013 and Lanchimba et al., 2017). Based on the risk-cost effect and the information-induced effect-return effect, as the risk increases, the adjustment in royalty rate to provide more incentive can improve the channel performance (Lafontaine and Bhattacharyya, 1995; Lafontaine and Slade, 2014).

6.3.3 The Factors within The Channel Interaction

6.3.3.1 Information Updating & Information Asymmetry

Information updating and information asymmetry are crucial for implementing franchising contracts in fashion supply chains. Adequately addressed in the operations of GJG, information updating is critical for enhancing the demand forecasting. In the literature, Hammond (1990), Fisher and Raman (1996), Iyer and Bergen (1997), Eppen and Iyer (1997a, 1997b), Kim (2003), Tang et al. (2004), Choi (2007), and Cachon and Swinney (2011) all study the use of the market information regarding to postponing the ordering decision time point to improve the inventory planning in the fashion business. The optimal inventory policies are derived under the respective scenario and the insights are generated by emphasizing how information updating can improve the supply chain performance and coordinate the franchising channel. Further revealed by the case study, implementing the contractual quick response is quite popular in the

fashion industry. Quick response is widely explored with information updating from the perspectives of the strategic forward-looking consumers, the inventory service and the competitive market environment (Lin and Parlakturk, 2012; Yang et al., 2015; Choi, 2016). The interaction between the quick response and the demand forecast can be improved by market information updating with the franchising contracts in the online-offline operations of the fashion industry (Choi et al., 2017).

Extracted from the case study, both GJG and their franchisees at all levels are assumed to keep their own private information on the cost, profit or market demand. The franchising contracts work as a mutually beneficial mechanism to alleviate the negative effect of information asymmetry, for instance, the optimal franchising contract with the involvement of information asymmetry in the private marginal cost (Hempelmann, 2006). Besides, the inefficiency evoked by the asymmetric private information under the franchise contract and the franchise fee with service requirement contract is verified by Xie et al. (2016).

6.3.3.2 Monitoring

As shown in the GJG case, monitoring is widely imposed by both the franchisor and the provincial agents as a supervising tool to ensure the franchisees to behave in line with the best interest of the franchising channel. The findings are supported in the literature with the insights that the monitoring right is one of the focal elements in the franchising contract, which is crucial for the franchisors to handle the franchising relationships and keep the franchisee on the right track of obeying the contract terms (Lal, 1990; Bradach, 1998; Arruñada et al., 2001). Following the agency theory, franchising can be characterized as a balance of the monitoring cost and the risk of free-riding (Rubin, 1978; Lafontaine, 1992). The insights of monitoring theory are enriched by Gallini and Lutz (1992) with the comparison of monitoring both the company-owned outlets and the franchised outlets. The findings prove the conclusion of Brickley and Dark (1987) that the decision to franchise with the franchising contracts can be largely affected by the monitoring cost. The monitoring cost, accounting for a portion of the franchisor's total cost, can be reduced by transferring the compensation to up-front fees in the franchising contract (Shane, 1998). Posited by Hsieh et al. (2010) and Kacker et al. (2016), downstream ownership can improve the monitoring with lower variability and higher reliability. The franchisor in a better position, such as GJG, may devote the capacity to monitoring the franchisees to protect the brand equity, especially for the new-entrant single-shop franchisees.

6.3.3.3 Free Riding

Mentioned by the senior management staff of GJG, once the franchising system is established, free riding as a horizontal problem unavoidably occurs in the distribution channel. Consequently, strict regulations should be imposed when designing franchising contracts to cope with such a problem. The free-riding issue is widely addressed in the literature. Illustrated by Kalnins (2004), free riding is exampled by the franchisees' encroachment on franchisor's brand name and adding proximate products to the existing franchisor's ones. Due to the insufficient controlling mechanism, certain franchisees may reduce the quality maintenance but still obtain the full amount of sales revenue as the customers hold the assumption that the offered products are of the same quality like those of other outlets under the same brand (Rubin, 1978; Bork, 1978; Mathewson and Winter, 1984). Argued by Sadeh and Kacker (2017), the externality that the franchisee's efforts on the quality are not fully compensated induces the free-riding in the distribution channel. It also negatively affects the overall product quality of the brand. However, this phenomenon is not commonly observed among the franchisees of GJG, because GJG carries out harsh quality control by himself as the barrier for free-riding. Specified by Vázquez (2010), the franchisors with less contracting experience face higher potential free-riding risk. The problem is not applicable for GJG as a mature franchisor with adequate contracting experience for all kinds of franchisees. Studied from the theory of resource scarcity, the result of the game between the monitoring cost and the free-riding cost may decide whether to maintain the franchising or to carry out the ownership redirection (Combs et al., 2011). In fact, GJG does have withdrawn the franchising authorization of some franchisees caught free riding and acquired their outlets to be company-owned. To some extent, with the increasing cost brought by free riding, the franchising channel may shrink and decline (Michael, 1999; Combs and Ketchen, 2003; Combs et al., 2004).

6.3.3.4 Moral Hazard Problem

Similar to free riding, the moral hazard is also treated as a critical problem once the franchising contract comes into being. In the literature, the moral hazard problem arises from the inverse relationship of risks and incentives under the agency theory framework on the contract design and payment mechanism (Salanié, 2005; Bolton and Dewatripont, 2005; Macho-Stadler and Pérez-Castrillo, 2001; Blair and Lafontaine, 2005). Admitted by both the GJG decision-makers and the key franchisees, the two-sided moral hazard problem may be induced naturally during the business interaction.

The problem is explained by Brickley (2002) that the optimization of allocating risks and two-sided moral hazards can be achieved with the sharing contracts. The conclusion of Brickley (2002) explicates that the royalty rate should be increased to cover the cost brought by the two-sided moral hazard. Aiming to reduce the moral hazard problem, Babich and Tang (2016) suggest that increasing the profit share for the franchisee is a substantial incentive to reduce moral hazard problems. The suggestion is verified to be effective in GJG case study.

6.4 Industrial Validation for The Analytical Findings

6.4.1 Validation for The Influence of The Payment for The Fixed Royalty

GJG is the fashion brand owner that actively undertakes social responsibility for fashion sustainability. The company collects the unsold garments from the franchising network by the end of the selling season for product recycling and donation. Every year, the company donates the garments amounted to millions of RMB to the rural areas of China. As an experienced fashion franchisor, GJG employs the integrated royalty systems covering both the fixed royalty and the variable royalty in the franchising operations, not only as the threshold to filter the franchisees but also as the balancer to share the risks and profits with the franchisees. The amounts of fixed royalties can be different according to different franchising contracts with terms of upfront or later payments. Some crucial direct regional agents with long-term and healthy business cooperation with GJG can be granted the reduction in the fixed royalty and the later payment plan (LRP). While for those franchisees newly entered the franchising system, GJG employs the franchising policy of standard fixed royalty with upfront payment plan (UPR).

As addressed by the key provincial agents of GJG, who mainly are risk-averse and enjoy LRP with a relatively small amount of fixed royalties, compared to the later payment plan, they would rather make upfront payment for the fixed royalty for less anchoring effect, which they believe the risk can be lowered with just a small order quantity to cover the cost of the fixed royalty. As for the newly entered franchisees with risk-seeking preference, they feel comfortable with the URP as they prefer to place large order quantity, not only to cover the cost of fixed royalties due to the anchoring effect but also to support their business plan for rapid expansion in the region to generate more sales revenue and profits. Both the facts mentioned above can validate Proposition 3.2 specified in Chapter 3.

6.4.2 Validation for The Effect of Final Product Assembly (FPA) in The Franchising Supply Chain

GJG is the fashion brand owner with multiple product lines for young lady's wear. The operations of the final product assembly can be observed in the product line of lady's evening addresses which need to be decorated with customized accessories. Considering the lower cost and economies of scale, the final product assembly is commonly implemented by GJG before the final product is delivered to the franchisees, which, as introduced by the decision-makers of GJG, is effective to diminish the double marginalization effect. Such operations validate Proposition 4.1 and Proposition 4.2 derived in Chapter 4. In addition, the Commodity Director of GJG admits that though the final product assembly is mainly implemented by GJG with the additional cost that pushes up the wholesale price, GJG often offers a higher buyback price with the application of buyback contracts to encourage the franchisees to increase the order quantity, which proves the validation of Proposition 4.3.

6.4.3 Validation for The Options of Contracts and Ordering Time Considering The Operations of The Online-offline Franchising Supply Chain

Similar to other popular fashion brands in China market, GJG is an active player in online-offline operations with e-shops in mainstream e-commerce platforms such as Tmall and JD, which fully owned by the company. Unavoidably, channel conflicts are present in such operations. To deal with the channel conflicts and protect the profit of the franchisees, for most seasonal hot items, GJG first supplies to the offline channels and only puts such product for online sales after the major selling season has passed. As mentioned by the senior management of GJG, regarding the order quantity for the online sales, GJG has two options, to order at the same time as the franchisees or to order during the selling seasons, depending the valuation of production cost and demand uncertainty under different franchising contracts. Under the wholesale price contract, GJG tends to place the order for the online sales before the selling season together with the franchisees if the cost-saving is obvious due to economies of scale. Under a specific profit-sharing scheme, GJG tends to place the order for online sales during the selling season but employ a relatively high profit-sharing rate to guarantee the profit margin. Such operations validate Proposition 5.1 and Proposition 5.2 summarized in Chapter 5. However, from the perspective of the franchisees, under the profit-sharing scheme with the fixed sharing rate, if the wholesale price is lower before the selling season starts and higher during the selling season, most of the franchisees

choose the order with the lower wholesale price for better profit margin, which proves the validation of Proposition 5.6.

6.5 Conclusion and Summary

With the comprehensive literature review and the case study on GJG, we have identified different types of franchising contracts prevalently implemented in the distribution channel. In addition, we have explored how these franchising contracts function in the fashion industry and elaborated how the franchising contracts are analyzed with the relevant analytical approaches. We find that the franchisor tends to offer a series of franchising contracts to different types of franchisees to cater to their diverse characteristics within the complex franchising distribution channel. In the meantime, during the development process, the franchisor prefers to employ different franchising contracts with the respective objectives and considerations in different situations. Integrating the literature review and the findings of the case study on GJG, we have identified a list of key factors including information updating and information asymmetry, monitoring, free riding, moral hazard problem, royalty, incentive mechanism, service level, pricing, risk, power structure, franchise size, single-unit franchising and multi-unit franchising, dual distribution and signaling, which influence the implementation of franchising contracts in practice regarding the channel structure, channel operations and channel interaction. In addition, we also validate the findings derived from the analytical models constructed in Chapter 3, Chapter 4 and Chapter 5 with the empirical insights generated from the case study.

Chapter 7. Insights and Directions for The Future Research

To conclude, this thesis research contributes to both the literature and advancing industrial practices with multi-methodological approaches. Regarding the theoretical contributions, with the analytical findings derived from different models, our research advances the literature on royalty payments, final product assembly, and options on contracts and ordering times regarding the franchising operations in fashion supply chains. Regarding the practical contributions, with the case study and empirical findings, our research benefits the industry practice on the implementation of franchising contracts in the fashion industry with the managerial insights beneficial for the decision-makers and the whole industry.

7.1 Insights from The Analytical Models

7.1.1 Upfront or Later Fixed Royalty Payment in Sustainable Brand Franchising

With the analytical comparison between the URP plan and the LRP plan, we find that the social welfare performance under the URP scenario depends on the value of royalty payment, while the social welfare performance under the LRP scenario is not affected by the royalty payment. Moreover, the profit risks of the franchisee, the supply chain and the social welfare all increase with the order quantity. In the extended model, we uncover that when both the fixed royalty and the variable royalty co-exist, the franchisee will increase the optimal order quantity for maximizing the profit under the URP scenario. However, under the LRP scenario, the optimal order quantity of the franchisee will be reduced.

7.1.2 Final Product Assembly Operations in Franchising Supply Chain Systems

In our analysis of the influence of the different FPA costs, we find that under the wholesale pricing contract with the fixed wholesale price, letting the retailer does the FPA step will lead to a larger double marginalization effect. For the whole supply chain system's perspective, the optimal selection of member for FPA step is solely determined by the respective FPA cost. As for the supply chain coordination, we propose the use of a buyback contract and analytically derive the contract bounds. We find that the main findings under our basic model continue to hold in the extended models of the two-product and make-to-order scenarios, which proves the robustness of the results.

7.1.3 Online-offline Fashion Franchising Supply Chains without Channel Conflicts: Choices on Postponement and Contracts

The interaction between online and offline operations becomes common practice in the fashion industry. By modeling the choices under four different scenarios, we derive the analytical conditions in which one scenario is preferred to another scenario with respect to contract type and ordering time option. We examine the problem from the perspectives of the brand owner, the franchisee and the supply chain. We identify the situations in which the optimal choices of the brand owner and the supply chain are the same, as well as the conditions when Pareto improvement is achievable.

7.2 Insights from The Literature Review and The Case Study

7.2.1 Research Findings on Franchising Contracts for The Fashion Industry

Based on the literature, the main research findings on franchising contracts for the fashion industry can be specified as the application of contracts in fashion supply chains and the study on franchise contracting systems. As for applying contracts in fashion supply chains, due to the demand uncertainty and the flexibility in the fashion industry, the wholesale prices with quantity discounts and return or markdown money policies, revenue or profit-sharing mechanism, sales rebates and sales efforts, and risk preference of channel members are considered to be the vital factors for the application of contracts in fashion supply chains in the literature. As for franchise contracting systems, the research findings in the areas of contract design and contract optimization, contract offering and selection, coordination for the franchising channel, franchising contract evolution, duration and termination and governance structure and ownership of the franchising channel are further validated in the case study on the fashion franchisor. With the comprehensive investigation of the present research, we have found that inadequate research efforts are engaged in the research on franchising contracts, particularly in the fashion industry area. More research efforts, therefore, should be contributed to applying the franchising contracts in the fashion distribution channel.

7.2.2 Implementations of The Franchising Contracts

Based on the literature review, we observe the prevalent franchising contracts can be categorized as simple franchising contracts, two-part tariff franchising contracts, integrated franchising contracts and particular franchising contracts. Integrated with the findings of the case study on GJG, we notice that the wholesale price contract is seldom used alone. It is always employed together with the buyback contract and the quantity

discount contract to encourage the franchisee to boost the order quantity for the economy of scale. The quantity commitment contract is applied for flexible ordering with better market information. Due to the power dominance, the franchisor prefers to apply the retail price maintenance contract to fix the retail prices in all the distribution channels to maintain the brand image and optimize the market assets with considerable profit margins. Besides, the franchise fee contract and the revenue-sharing contract are both preferable to the franchisor for driving the franchisees to further devote to the franchising system with more marketing efforts. The incomplete contract is utilized by the franchisor upon some special channel members such as the joint-retailing co-operator to cope with the business relationship with subtle interactions. As for the regional promotion or themed products launching, the tying contract is imposed to bundle the specific products and motivate the franchisees to endeavor to deal with the market competition and penetration.

7.2.3 Functions of Franchising Contracts in The Fashion Industry

Reflected by the case study on GJG, the franchising contracts contribute greatly to enhancing the efficiency of the channel operations and optimizing the market resources in the fashion industry. Aiming at attracting new entrants to join in the franchising system, the franchising contracts can specify the competitive strengths of the franchisor to strive for better channel resources, e.g., the quality franchisees. The franchising contracts can also regulate all channel members to behave in line with the best interest of the whole distribution channel, especially in resisting the negative phenomenon in the channel operations including free riding and moral hazard problems. As mentioned in the case study, punishment or even contract termination is clearly stated in the franchising contracts as the game rule in the franchising system. In most circumstances, the franchising contracts manifest the dominance of the franchisor reining the entire distribution channel. However, the increasing bargaining power of the franchisee becomes more and more striking, reflected by the supplementary terms in the franchising contracts requested by the franchisee to demand more benefits, more incentives and more decision rights. The expanding power of the franchisee is regarded as the challenge to the traditional franchising governance as well. Facing the complex distribution structure, the franchisor is apt to offer the pool contract and the menu contract, not only to provide the flexible marketing solutions but also to detect the private information and business preference of the franchisee. Generally, the duration of the common franchising contracts is one year, which is renewable annually. Some

franchising contracts with the duration of three years also occur to tie up the cooperation with crucial franchisees, e.g., the provincial agents of the highly developed regions, the key direct regional franchisees with adequate market resources and the selected joint-retailing co-operators for some important regional markets. Both the franchisor and the franchisee are fond of the franchising contracts remaining consistent within a relatively long period, commonly three to five years, as it can stabilize the franchising system, maintain the brand image and accumulate the competitiveness and the sense of belonging among all the channel members, which is regarded as the core competitive strength of the whole franchising system.

7.2.4 Key Factors of Implementing Franchising Contracts in Fashion Supply Chains

As shown in the case study, the implementation of franchising contracts in the fashion industry can be influenced by some key factors in the channel structure, channel operations and channel interaction. Within the channel interaction, information updating and information asymmetry are the critical factors for implementing the franchising contracts in the fashion industry, especially in the quick response production and the market demand forecasting. The franchisor can detect the franchisee's private information through their selections on the franchising contracts. The free riding and the moral hazard problem are considered as another two major concerns. The franchisor may impose the harsh monitoring clauses in the franchising contract to better control the franchising system and decrease the potential threats. For channel operations, the royalty, the incentive and the pricing mechanism are the key issues involved in the implementation of franchising contracts in the fashion industry. Concluded from the GJG case, the royalty and the incentive can be co-applied in the franchising contracts to deal with the franchisees of different risk preferences and improve the channel performance. Many franchisors pay increasing attention to the service for the consumers in retail. It delineates the additional service involvement in the franchising contract, especially in VIP relationship management and the O2O channel interaction.

7.3 Future Research Directions

As indicated in Table 7.1, future research efforts can be concentrated in three main areas. For the research on the functional variables for franchising contracts, market demand uncertainty in cross-border competition can be examined to explore the impact

of franchising contracts on the sustainable supply chains. For the research on the implementation of franchising contracts, two-part tariff franchising contacts and target sales rebate contracts can be employed together to study franchising supply chains with horizontal competition and risk preferences. For the franchising operations in omni-channels, the O2O interactions with different products for different channels will also be an interesting topic to study in the future.

Table 7.1. Future research in three main areas.

Research Area	Current Work	Future Work	Solution Approach
Functional Variables for Franchising Contracts	Fixed royalties employed by sustainable fashion brand	Involve market demand uncertainty jointly investigated with economical sustainability.	To explore the impact of franchising contracts on sustainable supply chains
Implementation of Franchising Contracts	FPA with wholesale price contract and buyback contract.	FPA under two-part tariff franchising contacts and the target sales rebate contracts with horizontal competition and risk preferences.	To examine the optimization problems in the franchising supply chains
Franchising Operations in Omni-channels	Contracts and ordering times within online-offline channels	O2O Interaction with different products for each channel and multiple channel members of the mutualistic phenomenon.	To study the franchising contracts in the multiple channel context

In addition, several crucial gists for future research regarding franchising contracts in fashion operations are summarized as follows.

7.3.1 Multiple Channel Players

Most of the present research on the franchising contracts is conducted in the setting of one franchisor and one franchisee. However, derived from the GJG case, the franchisor usually operates the franchising system coping with many franchisees in multiple layers and may even allow the regional agents to develop their own sub-franchising systems. Referring to Chiu et al. (2015) and Choi (2015), one prospective direction for the future research is to study the impact of implementing franchising contracts with multiple channel players, where the single franchisor-franchisee interaction may be upgraded to include one franchisor with multiple franchisees or even multiple franchisors with multiple franchisees. Given the broadened coverage of the channel members, both the vertical and horizontal competitive markets can be more dynamic and diverse. More efforts should be devoted to the research from the perspectives of different channel members, especially for the mutualistic phenomenon such as inventory allocations, channel relationships and control patterns.

7.3.2 Multiple Products

Regarding the present research findings in the area, a single product setting still dominates the study on franchising contracts. Nevertheless, discovered in the practice of the fashion industry, the franchisor always offers the product portfolio to the franchisee within the franchising contract framework. To enrich the research insights in such domain, multiple products scenario should be one of the prospective avenues for future study. The academic concentration can be poured into the existence of heterogeneous products (Rezaei and Davoodi, 2008), and how the menu of products affects the business decision of the channel members (Munson and Hu, 2010), and how the multiple-product involvement may diversify the research findings if a franchisor provides different but related products for the different distribution channels (Hsieh and Hu, 2009).

7.3.3 Complex Franchise System

As can be observed in the case study, the fashion franchising channel operates in a complicated business environment with agile internal and external determinants. An example is the involvement of a bank in the franchising system addressed by Babich and Tang (2016) for franchising contracting. In such a sense, additional complexities should be worthy of further analysis regarding franchising contracts. As closely affecting the operations of the fashion franchising business, the law and legislation environment, the power or dominance transferred from the franchisor to the franchisee, and the risk management and sensitivity are the areas that scholars may further explore with priorities. Furthermore, as little literature is found related to the channel integration of the online and offline presence, the strategic commitment in the franchising system and the emergence or acquisition of the channel members, future research efforts should be supplemented in such fields as well. Despite the limited findings, the macro environment for implementing franchising contracts has not yet been fully explored. More investigation is needed to analyze the deterministic environmental factors such as the competitive intensity and the governance structures in the market together with the entry pressure and the screening on the quality channel applicants. In addition, future research can incorporate some supplementary entities involved in the franchising business for a more in-depth examination, e.g., the franchisee council and the external competitors.

7.3.4 More Variables

Owing to the nature of the franchising business, franchising contracts can be

affected by a list of variables within the distribution channel. A future research direction is to conduct a variables-orientated study with more specific parameters (Chiu et at., 2009). Derived from the literature review, some variables that are found influential but lack of adequate research attention, including the market demand uncertainty and variability (Yan and Wang, 2012), and the additional signaling mechanisms such as advertising and financial indicators (Babich and Tang, 2016; Sadeh & Kacker, 2017). Moreover, some single variable should be jointly investigated with others for further insights, e.g., the incorporation of the wholesale price and the value-added service process (Choi, 2016b; Xie et al., 2016;), a menu of products with dynamic quality (Du et al, 2016; Sadeh & Kacker, 2017), the marginal and fixed cost of the production and the sales performance, and the interrelated mechanism linking the pricing and the promotion (Chiu et al., 2012).

7.3.5 Information Updating

Though intensive efforts have been found devoted to the research on information sharing and information asymmetry in franchising, the information-related area is still worthy of being more fruitfully addressed for the future research. As explored in the GJG case study, both the franchisor and the franchisee strive to improve channel performance and efficiency by cultivating the data to enhance the accuracy of forecasting with joint-efforts. Referring to Zhu et al. (2011), Giovanni (2017), Xie et al. (2016) and Zhao et al. (2017), information updating and balancing are crucial in implementing the franchising contracts, particularly with the involvement of cost, timing, demand randomness, sales prediction and profit. Admittedly, the existence of asymmetric information in the franchising channel leads to the problem of two-sided moral hazard and the negative psychological effect among the channel members. It should be further scientifically investigated in future research as well.

7.3.6 Economical Sustainability in The Fashion Franchising Industry

With the increasing attention to sustainability in the fashion industry, the economical sustainability in fashion franchising operations is worthy of future research efforts (Calderonmonge et al., 2017). In addition, for the future research, sustainable fashion procurement and other possible payment schemes for sustainable fashion brand franchising can be further explored, such as considering multiple installments, trade credits, and interest rate (Peng et al., 2015; Shi et al., 2017; Niu et al., 2017).

7.3.7 Final Product Assembly (FPA) under Complicated Conditions

For the future research, it will be interesting to examine the case with the

involvement of the two-part tariff franchising contact and the target sales rebate contract for implementing the final product assembly to generate further insights on their ability in achieving supply chain coordination (Chiu et al., 2011; Chiu et al., 2012; Pfeiffer, 2016). Another extension is to consider the horizontal competitive case when, e.g., multiple supply chains compete, and see how the final product assembly task should be allocated (He et al., 2013; Kim, 2013; Yan and Pei, 2015; Li et al., 2018). Besides, the risk references of the supplier and the retailer regarding the final product assembly can also be the dimension for future exploration (Choi, 2015; Chiu and Choi, 2016; Choi, 2016a; Choi, 2016c).

7.3.8 Online-offline Interaction

For future research, other channel conflicts avoiding measures can be considered such as the case when the fashion brand offers multiple products and each channel is responsible for different related but not the same products (Winsor et al., 2012; Soysal and Krishnamurthi, 2015). Besides, other channel integration measures, such as ordering online and picking up in-store operations and the corresponding incentive alignment schemes, can also be considered (Gao and Xu, 2016).

As a remark, franchising has been developed into a critical business phenomenon related to many vigorous industries including the fashion industry as one of the most dynamic global business ecosystems. Franchising contracts are popularly implemented with different functions and features for coordinating the distribution channel and enhancing the business outcome in the fashion industry. We have discussed the implementation of different franchising contracts in the fashion franchising system from the perspective of the fashion brand owner. Our findings verify the significant functions carried by franchising contracts in the fashion industry. We also identify different crucial influencing factors related to implementing the franchising contracts under the diverse dimensions within the fashion franchising operations. The implementation of franchising contracts can be eventually improved for the fashion business with a better understanding of the addressed factors. It is beneficial not only for the franchisor and the franchisees but also for the whole industry. Note that even though this thesis research focuses on studying franchising operations in the fashion industry, many of the research findings can potentially be applied to other industries, e.g., the industries with perishable and seasonal products. Thus, the managerial insights generated by our research can potentially benefit the franchising operations in the

relevant industries such as the footwear industry, the accessories industry, and the automobile industry. For example, the issues of sustainability can also be widely observed in franchising operations of the footwear industry. Due to the anchoring effects, the franchisee tends to increase the order quantity to cover the fixed royalty cost with upfront payments. With the development of 3D printing, final product assembly becomes more popular in the automobile industry. Under the simple wholesale price contract, the automobile franchisor makes the decision on the implementation of final product assembly by evaluating the respective final product assembly costs of channel members. As online-offline operations are well established in the accessory industry, within a two-stage ordering policy, the preference of the brand owner depends on the trade-off between the product cost-saving and the reduction in the market demand uncertainty.

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