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THREE ESSAYS ON MARKETING-FINANCE INTERFACE AND RETAILING

BY

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DISSERTATION

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Abstract

Seller-initiated consumer financing is a prevalent yet understudied phenomenon in marketing, especially in a distribution channel where a supplier offers trade credits to a retailer for selling the supplier's products and the retailer offers credits to consumers. In this dissertation, I study how the supplier prices its product and chooses the channel structure both financially and operationally with the default risk of both consumers and the retailer when consumers can purchase a product using seller-initiated financing. In addition, I also study ad platform and retail media's consumer data sharing strategy and suppliers bidding strategy with competition.

In Essay 1 "*Consumer Financing and Credit Pass-Through in Distribution-Financing Channels*", I study whether the retailer will pass through the trade credits from the supplier to consumers through consumer financing, and how firms make strategic decisions both financially and operationally with consumer default risks and the retailer bankruptcy risk. With consumer default risks, I find that if the product marginal cost is low, retailer-initiated financing can expand the market, and a retailer may offer credits to consumers even knowing consumers cannot pay off in the future. With the retailer bankruptcy risk, I show that surprisingly a financially distressed retailer may offer consumer financing whereas a non-distressed retailer does not, i.e., a financially distressed retailer has higher credit pass-through than a non-distressed retailer, which is due to the supplier's incentive to strategically lower its wholesale price to alleviate the retailer's bankruptcy risk (i.e., risk shifting effect). Interestingly, this risk shifting effect happens only if the retailer has the capability to offer consumer financing under certain conditions. Moreover, consumer financing by the retailer, which offers consumers the opportunity to buy products which they could not afford otherwise, can make consumers worse off.

The second essay "*Seller-Initiated Consumer Financing and Consumer Sales-Finance Conflicts*", I study the conflicts between sales divisions and consumer finance divisions in firms when firms both sell their products and provide financing to consumers, especially in a competitive market. I design a game-theoretical model to study the interdependence and conflicts between a sales division and a consumer finance division within a firm. The sales division decides the product price to maximize sales profits and relies on the consumer finance division to provide financing to consumers, while the consumer finance division decides whether to finance consumers' purchase to maximize interest profits and limit default loss which are affected by the sales price of the sales division. I model the competition of two competing firms with internal sales-finance conflicts

and study how competing firms' internal sales-finance conflicts affect the external interfirm competition on both pricing and consumer financing. While conventional wisdom suggests that a centralized firm where the sales and consumer finance divisions are integrated would benefit the firm, I show that in a competitive market, a decentralized firm where the sales and consumer finance divisions make price and financing decisions separately can benefit from the conflicts between the sales and consumer finance divisions and gain more profits than a centralized firm. Moreover, strikingly, competition can benefit a firm, i.e., a firm with the internal conflicts between its sales and consumer finance divisions can earn a higher profit with another competing firm in the market than without. I also expect to show that the conflicts between a sales division and a consumer finance division of a firm can affect consumer welfare through pricing and consumer financing, and the seemingly dysfunctional and uncoordinated conflicts between the sales and consumer financing divisions of a firm can actually benefit consumers.

In the third essay "*Online Retail Media, Data Sharing and Consumer Purchase Funnel*", I study ad platform and retail media's consumer data sharing strategy. I build a model consists of an ad platform, a retailer with or without ad network and two competing suppliers. Consumers are heterogeneous in their preference as well as their state in purchase funnel: consumers on ad platform are more likely to be in a browsing stage whereas the consumers on retail platform are more close to purchase in their purchase funnel. Considering consumers state and preference, I allow the suppliers/advertisers to choose their bidding strategies on ad platform (e.g. Google) and retail media (e.g. Amazon), if possible, to optimize their profits. Interestingly, I show that first, when the retailer does not have retail media, platform sharing data with suppliers is better than not sharing for suppliers and retailers. Second, when the retailer has the retail media, the ad platform, the retailer and suppliers are better off compared to benchmark where the retailer does not have retail media (win-win-win). Third, retailer advertising can be substitutes or complement to the platform advertising.

To my family and friends. So lucky to have you!

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Chapter 1

Introduction

Marketing must coexist with finance and operations (Shugan, 2004). Yet in current research, the marketing-finance interface is still an understudied area. In this dissertation, I mainly focus on firms' problems in marketing-finance interface and distribution channels, including default risks in distribution-financing channel, conflicts between consumer finance and sales divisions, bidding strategy of targeted advertising on ad platform and retail media.

Specifically, in Chapter 2, I resolve the puzzle why financially distressed firms offer consumer financing and how firms make strategic decisions both financially and operationally with consumers' default risks and the retailer's bankruptcy risk. With consumer default risks, I find that if the product marginal cost is low, retailer-initiated financing can expand the market, and a retailer may offer credits to consumers even knowing consumers cannot pay off in the future. With the retailer bankruptcy risk, I show that surprisingly a financially distressed retailer may offer consumer financing whereas a non-distressed retailer does not, i.e., a financially distressed retailer has higher credit pass-through than a non-distressed retailer, which is due to the supplier's incentive to strategically lower its wholesale price to alleviate the retailer's bankruptcy risk (i.e., risk shifting effect). Interestingly, this risk shifting effect happens only if the retailer has the capability to offer consumer financing under certain conditions. Moreover, consumer financing by the retailer, which offers consumers the opportunity to buy products that they could not afford otherwise, can make consumers worse off.

When firms offer consumer financing, it can potentially result in conflicts between sales and finance divisions. Essentially, sales and the finance divisions often have different goals, i.e., *sales-finance conflicts*. In many firms, the sales division focuses on attracting new consumers and increasing sales profit by selling the products or services and relies on the consumer finance division to provide financing to meet consumer demands. Thus, with the primary focus on increasing profits, a sales division may not fully or closely monitor consumer default loss to accomplish its tasks, which can create friction with the consumer finance division. In contrast, the consumer finance division often focuses on earning interest profits while limiting consumer default loss.

Therefore, in Chapter 2, I study how the potential conflicts between sales and finance divisions affects firms' financial and price decisions in a competitive market. I model two competing firms with internal sales-finance conflicts and study how intrafirm sales-finance conflicts affect the interfirm competition on both pricing and consumer financing. While conventional wisdom suggests that a centralized firm where the sales and consumer finance divisions are integrated would benefit the firm, I show that in a competitive market, a decentralized firm where the sales and consumer finance divisions make price and financing decisions separately can benefit from the conflicts between the sales and consumer finance divisions and gain more profits than a centralized firm. Moreover, strikingly, competition can benefit a firm, i.e., a firm with the internal conflicts between its sales and consumer finance divisions can earn a higher profit with another competing firm in the market than without. In addition, when competing firms can decide their organizational structure endogenously, I show that in contrast to the monopoly market where firms always choose a centralized structure without conflicts between the sales and consumer finance divisions, competing firms in a duopoly market, surprisingly, may choose a decentralized structure to strategically invoke the conflicts between sales and consumer finance divisions.

In Chapter 3, I investigate consumer purchase funnel, ad platform and retail media. The retail properties of retail media are critical to getting ads in front of audiences when they're showing intent to purchase. Compared to the traditional ad platform such as Google and Facebook, retail media are closer to the purchase point in consumer purchase funnel, which results in a higher traffic quality. Therefore, retail media ads are becoming strong competitors for traditional ad platforms. However, interestingly, there are many arguments for using both. As more retailers offer ads, more advertisers and/or suppliers are realizing that ads can provide them a positive return on investment. In addition, the rise of digital marketing during the COVID-19 pandemic has made digital sales more important to more brands. Therefore, fierce competition among advertisers raises the ad price in auction in turn. With fierce competition for ad slots, and with high ad loads, it can be hard (or impossible) for a brand to be seen without paying. To capture the relationship between advertising on ad platform and retail media, I build a game-theoretic model to study the first-party consumer data strategies of traditional ad platform and retail media and resolve the following questions. First, Why are some retail media more likely to share consumer data with advertisers through online advertising? Second, how should advertisers and consumers change their strategies in response to platform's data sharing policy? Third, is the retail advertising complement/ substitute to the sales revenue/ platform advertising? Interestingly, I show that first, when the retailer does not have retail media, platform sharing data with suppliers is better than not sharing for suppliers and retailers. Second, when the retailer has the retail media, the ad platform, the retailer and suppliers are better off compared to benchmark where the retailer does not have retail media (win-win-win). Third, retailer advertising can be substitutes or complement to the platform advertising.

The rest of this dissertation is organized as follows. In Chapter 2, I investigate why financially distressed firms offer consumer financing and how firms make strategic decisions both financially and operationally

with consumers' default risks and the retailer's bankruptcy risk. In Chapter 3, I study the conflicts between sales divisions and consumer finance divisions in firms when firms both sell their products and provide financing to consumers, in monopoly and duopoly markets. I design a game-theoretical model to study the interdependence and conflicts between a sales division and a consumer finance division within a firm. In Chapter 4, I build a game-theoretic model to study the first-party consumer data strategies of traditional ad platform and retail media.

Chapter 2

Consumer Financing and Credit Pass-Through in Distribution-Financing Channels

2.1 Introduction

Retailer-initiated consumer financing is a type of consumer financing initiated by retailers as a means of payment and recent innovations in consumer financing have created an opportunity for retailers to extend credit to a wider range of customers. For instance, many retailers offer store credit cards to their customers, such as Macy’s, Target, Best Buy, and Sears. At Macy’s, the profit from Macy’s branded credit cards accounted for 39 percent of the company’s total profit of \$1.9 billion in 2016, up from 26 percent in 2013, according to an analysis by Morgan Stanley (Corkery and Silver-Greenberg, 2017). At Kohl’s, the profit from plastic totaled 35 percent, up from 23 percent, over that same period. At Target, it made up 13 percent of total earnings, up from 11 percent in 2013. Retailer-initiated consumer financing often helps more consumers afford products sold by retailers. According to Jim Cadena, Lennox Industries Senior Merchandising Manager, “From a dealer’s perspective, offering financing to the consumer leads to a 65% increase in ticket size.” (Lennox, 2019). In this paper, I study the interactions between product financing and product sales when a retailer both sells products and offers consumer financing.

As with retailer-initiated consumer financing, suppliers often provide trade credits to and sell through retailers (Macy’s, Sears, etc.) who may in turn pass through the trade credits to consumers as consumer credits. In fact, trade credit from suppliers to retailers has become a regular component of market transactions and constitutes a major source of short-term financing. The volume of trade credit in the U.S. increases from 4.7 trillion in 2016 to 5.4 trillion in 2019 and the ratio of trade credit to bank loans is about 3:1

despite the improved affordability and accessibility of bank loans under FinTech (Federal Reserve 2019¹). Moreover, trade credit is used not only as a financing device (Burkart and Ellingsen 2004; Chod 2016; Biais and Gollier 1997; Kouvelis and Zhao 2012), but also as a strategic tool (Brennan et al. 1988; Babich and Tang 2012; Peura et al. 2017). Despite the widespread use of trade credit, offering this financing option exposes suppliers to retailer bankruptcy risks. For example, when the electronics retailer Circuit City filed for bankruptcy, 48 of its 50 largest unsecured creditors were trade creditors, and the three largest trade creditors (Hewlett-Packard, Samsung and Sony) had claims worth \$284 million (Yang and Birge, 2017). This could be especially true when retailers offer financing to their customers. The financial director of J&J Teixeira (a Portuguese timber company) talked of a “vicious spiral” such that “(payment delay from consumers) is leading to a big increase in bankruptcies... That leads us to delay payments to our suppliers too. It just goes down and down.”² This type of financing channel, where the supplier offers trade credits to a retailer and the retailer passes through credits to consumers, is also called two-level trade credit policy (Chen and Kang 2010, Wu et al. 2014). Yet the trade credit pass-through and potential “vicious spiral” along with the flow of product in a distribution channel is understudied in the marketing area. Previous literature on retail pass-through in marketplace (Tyagi 1999, Kumar et al. 2001, Nijs et al. 2010, Moorthy 2005, McShane et al. 2016) studies price or promotion pass-through problems and how retailers react to changes in the price and trade promotions. However, in this paper, with trade credits from the supplier, given a lower wholesale price, the retailer may choose to pass through the price or the credits. In contrast to previous literature on price pass-through, credit pass-through improves consumers’ affordability but introduces consumer default risks, which may benefit or backfire on the supplier. To sum up, on the one hand, the financing channel alleviates consumers’ and retailers’ financial constraints and stimulates sales; on the other hand, the credit pass-through policy may aggravate default risk even more, from both the retailer and consumers. Therefore, it is an intriguing problem why retailers use trade credits on one hand and offer consumer credits on the other hand, especially those financially distressed retailers.

More importantly, from the consumer perspective, consumer credit becomes a big concern to public policy makers on consumer welfare. According to the Survey of Consumer Finances 2016,³ 42 percent of families reported carrying a balance on credit cards, up from 36 percent in 2013 and 37 percent in 2010 (Bricker et al., 2017).⁴ One of the most well-known attributes of this unsecured credit market has been the large increase in personal bankruptcy rates (Athreya et al., 2012).⁵ Especially, retailer-initiated financing may provide credits for consumers with little credit-worthiness and beyond their ability to repay, which may be more likely to trigger consumer default. Besides, consumers may go unemployed or have an expense shock and fail to repay

¹Financial Accounts of United States, <https://www.federalreserve.gov/releases/z1/20190920/html/l225.htm>

²Financial Times 2010. See <https://www.ft.com/content/87509f7c-3762-11df-9176-00144feabdc0>

³Survey of Consumer Finances 2016, <https://www.federalreserve.gov/econres/scfindex.htm>.

⁴The Board of Governors of the Federal Reserve System constructs a measure of revolving consumer debt that excludes debt secured by real estate, as well as automobile loans, loans for mobile homes, trailers, or vacations. This measure is probably a subset of unsecured consumer debt which amounted to \$692 billion in 2001, or almost 7 percent of the \$10.2 trillion that constitutes U.S. GDP.

⁵In the U.S., the personal bankruptcy rate has increased more than three-fold in the last two decades of the last millennium (Livshits, 2015).

the loan from the retailer. In this case, borrowers can default on their loans by filing for bankruptcy under the rules laid down in Chapter 7 of the U.S. bankruptcy code⁶ and a large number of people who take out unsecured loans default each year (Chatterjee et al., 2007). However, default or bankruptcy is not without consequences. On the one hand, when consumers default and file bankruptcy, they may incur a reduction in earning capability (Livshits et al., 2007). On the other hand, consumers' default and bankruptcy also presents a challenge to retailers when retailers pass through credits to consumers, which in turn affects the retailers' trade credit solvency or the retailer's bankruptcy rate. Yet what is even more puzzling is that some financially distressed retailers, who face the bankruptcy risk, are still willing to offer credits to consumers, such as Sears and JC Penney. Therefore, in this paper, we study the interactions between consumer default risk and retailer default risk and how the interactions affect the decisions of suppliers and retailers on selling products and providing credits as well as consumer welfare.

To study the above issues, we set up a game-theoretical model of a supplier who sells to consumers through a retailer who needs trade credits from the supplier and may also provide financing to consumers. To capture consumer financial decisions, we assume consumers are heterogeneous in their income: high-income consumers can afford the product using their current period income while low-income consumers cannot and need to use retailer-initiated financing. When a low-income consumer obtains retailer-initiated consumer financing to make a purchase, he needs to pay his first period income as a down-payment and pay off the rest plus interest in the second period. If a low-income consumer defaults, part of the consumer's asset will be confiscated by the retailer. With consumer default risk, the retailer decides on the retail price and whether to provide financing to low-income consumers if the retailer has the capability to do so. Moreover, the retailer can be financially distressed and vulnerable to a random asset shock that may cause the retailer's bankruptcy. With the possibility of the retailer's bankruptcy, the supplier who offers trade credits to the retailer chooses a wholesale price to maximize its expected profit. To further study the effect of the retailer's consumer financing capability, we also study a special case where the financial distressed or non-distressed retailer does not have the capability of offering consumer financing.

2.1.1 Main Results

We analyze the model and obtain some intriguing results. First, we find that, counterintuitively, a financially distressed retailer may be more willing to pass through credits to consumers than a non-distressed retailer. A financial distressed retailer's bankruptcy risk depends on its profitability which is affected by the supplier's wholesale price and consumer default risk. Thus, a lower wholesale price induces the retailer to pass

⁶In terms of bankruptcy, there has been considerable public debate on the relative merits of alternative consumer bankruptcy rules. Livshits et al. (2007) investigate the effects of two alternative consumer bankruptcy provisions by using a heterogeneous agent life cycle model. One of these two bankruptcy arrangements captures key features of Chapter 7 of the U.S. bankruptcy code, and the other is motivated by the legislation of continental Europe. Chatterjee et al. (2007) analyze a general equilibrium model with unsecured consumer credit in which households smooth consumption by means of both a riskless asset and unsecured loans with the option of default. The default option captures the main features of U.S. consumer bankruptcy law which was mentioned as the "Fresh Start" system in Livshits et al. (2007). In this paper, the model mostly resembles Chapter 7 since it is more common than Chapter 11 and Chapter 13 in consumer bankruptcy.

through *credits* but not lower the retail *price* to consumers, improves the retailer's profit and reduces retailer bankruptcy risk. This is especially the case when the marginal production cost and the asset shock variance are moderate, and the product value is high. With a high product value and without consumer credits, even if the financial distressed retailer lowers the price to attract low-income consumers, consumers' ability to pay is constrained by their income so that the profit margin is relatively low for both the retailer and the supplier. Thus, the supplier is not willing to lower the wholesale price to further decrease profit margin. However, when a retailer passes through credits to consumers, low-income consumers' ability to pay increases so that the retailer and the supplier can charge higher prices. Thus, to secure a high profit margin, it is more profitable for the supplier to reduce the retailer's bankruptcy risk. Therefore, the supplier lowers its wholesale price and indirectly bears some bankruptcy risk for the financially distressed retailer (i.e., *risk shifting effect*), which is absent in the non-distressed retailer case. Therefore, a financially distressed retailer may be more willing to pass through credits to consumers than a non-distressed retailer.

Second, interestingly, we find that the *risk shifting effect*) where the supplier lowers its wholesale price and indirectly bears some bankruptcy risk for the financially distressed retailer is more likely to happen when the financially distressed retailer has the capability of offering consumer financing. This is because with the retailer's capability of offering consumer financing and credit pass through to consumers, low-income consumers' ability to pay increases so that the retailer and the supplier can charge higher prices. Thus, to secure a high profit margin, it is more profitable for the supplier to reduce the retailer's bankruptcy risk. This risk shifting effect improves the retailer's profit and reduces retailer bankruptcy risk especially when the retailer's asset shock is moderate, and the product value is high. Without the retailer's capability of offering consumer financing, even if the financial distressed retailer lowers its price to attract low-income consumers, consumers' ability to pay is constrained by their income so that the profit margin is relatively too low for both the retailer and the supplier. Thus, the supplier is less willing to lower the wholesale price to further decrease profit margin, resulting in less risk shifting effect.

Third, we show that interestingly, a retailer may offer financing to consumers even knowing the consumers cannot pay off in the future (i.e., *malicious consumer financing*). Specifically, the retailer may pass through the trade credits from the supplier with the risk of consumer bankruptcy, leading to financial risks for not only the retailer but also the supplier. This happens when the product marginal cost is low and the product value is high for consumers, and in this case, the retailer may charge a high price to consumers due to improved paying ability of low-income consumers through consumer financing. Although low-income consumers surely default, the retailer can strategically prey on the first period down-payment and confiscated asset from default consumers. Therefore, through *malicious consumer financing*, the retailer may pass through trade credits from the supplier to consumers even though low-income consumers will default in the future.

Fourth, retailer-initiated consumer financing which offers consumers another option may make consumers worse off. Without consumer financing, the ability to pay of a low-income consumer is constrained by the affordability or income. With consumer financing, low-income consumers are able to pay more than

their income and in turn the retailer can set a higher price for the product which low-income consumers cannot afford without the retailer’s credits. Moreover, consumers’ income will be partially confiscated if they cannot repay. This will further decrease consumer surplus in the case with consumer financing. As for high-income consumers, consumer surplus decreases since the retailer can set a higher price. Therefore, although the retailer-initiated consumer financing offers consumers another option for advance consumption, under some conditions, consumer welfare is lower than in the scenario without consumer financing because the consumer may tend to spend beyond the affordability and he or she has to default on the debts. This result has significant implications for public policy makers to regulate retailer-initiated consumer financing since retailer-initiated consumer financing can be malicious and promote consumer over-spending and bankruptcy.

2.1.2 Literature and Contributions

This work contributes to the following four streams of literature: marketing-finance interface, retailer pass-through, trade credits and debt financing, and consumer financial decisions. Previous literature on marketing-finance interface (Edeling and Fischer 2016, Srinivasan and Hanssens 2018, Edeling et al. 2020) integrates research in marketing and finance into an overarching marketing-finance research framework and discusses new empirical methods and metrics. Building upon previous literature, this paper links finance and marketing by studying the interaction between product financing and product sales in a distribution-financing channel. Previous literature in distribution channels mainly focuses on pricing decisions in a channel, vertical integration, promotions and channel coordination (Jeuland and Shugan 1983, McGuire and Staelin 1983, Moorthy 1987, Gerstner and Hess 1995, Desai et al. 2004, Raju and Zhang 2005, Dukes and Liu 2010) and ignores the impact of financing decisions. Yet marketing must coexist with finance and operations (Shugan, 2004). This paper differs from this stream of literature in that we characterize the impact of consumer financing and both consumers’ purchasing and financial decisions in the model. In addition, several closely related papers in operations-finance interface examine how financial constraints or frictions influence supply chain performance (Gurnani and Shi 2006, Babich and Tang 2012 and Kouvelis and Zhao 2015). We enrich this research in operations-finance interface by showing how the prices, consumers’ decisions and the interaction between channel members change in the presence of consumer financing. Interestingly, we show that in equilibrium, the retailer with bankruptcy risk may strategically use consumer financing or credit pass-through as leverage for a better deal from the supplier.

This paper also contributes to retail pass-through literature in marketing and economics. Previous literature on retail pass-through in marketplace studies price pass-through (McShane et al. 2016), cross-brand pass-through (Moorthy (2005), Besanko et al. 2005, Dubé and Gupta 2008), tax pass-through Seiler et al. (2021), or trade promotion pass-through (Tyagi 1999, Kumar et al. 2001, Ailawadi and Harlam 2009, Nijs et al. 2010) theoretically or empirically. For instance, Moorthy (2005) analyzes the impact of category management and retail competition on pass-through, focusing on brand and retailer differences. Kumar et al. (2001) find when manufacturer offers trade promotions, a retailer may not have the incentive to pass a low wholesale

price onto consumers due to information asymmetry. This paper complements the previous literature by considering both price pass-through and credits pass-through and shows that the retailer may choose to use credit pass-through rather than price pass-through to attract consumers under some conditions.

This research is highly related to trade credit and debt financing literature which mainly focuses on one issue—why trade credit differs from bank financing or why trade credit coexists with bank financing.⁷ However, trade credits, capturing the financial interaction between channel members, does not provide a complete financial chain from retailers to consumers. Thus, in this paper, we complete the financial chain by studying the retailer’s credit pass-through decision after obtaining the trade credits from the supplier and show how the retailer makes the trade-off between the operational profitability and financial risks including both the retailer’s bankruptcy risk and consumers’ default risks. Some literature on debt financing suggests that there is an agency conflict between the creditor and the borrower, generally known as risk shifting. Due to limited liability, a firm maximizing the value of equity has an incentive to increase risk after issuing debt (Jensen and Meckling 1976; Chod 2016; Yang and Birge 2017). For example, Chod (2016) shows how trade credit can alleviate the agency costs of debts / distortion of inventory decisions from (other) debt financing. Although the present paper also discusses the risk shifting role of trade credit, this paper differs from previous work dramatically in the following aspects. First, we focus on the interesting strategic interactions of financing and price decisions between the supplier and the retailer rather than the inventory decisions. Second, since consumers’ ability to pay is as crucial as their willingness to pay in consumer finance, we consider consumers’ heterogeneity in income and characterize both consumers’ purchase and financial decisions. This setting allows us to identify interesting behavior in consumer finance, such as strategic default and rational default. Third, we show that with a random asset shock and trade credit, the risk shifting effect happens only when the retailer has the capability to offer consumer financing under some conditions. The supplier who offers trade credits to the retailer may actually lower the wholesale price to reduce the retailer bankruptcy risk. Due to this risk shifting effect, we resolve the puzzle why financially distressed retailers sometimes could be more likely to pass through credits to consumers compared to non-distressed retailers.

Previous literature argues consumer repayment, default and bankruptcy decisions are highly related to consumer risk attitude (Chatterjee et al., 2008), loan information disclosure (Navarro-Martinez et al., 2011), information costs (Sanchez, 2010), default costs (Gross and Souleles 2002, Narajabad 2012), expense and income shock (Domowitz and Sartain, 1999), strategic behavior (Fay et al., 2002), and other psychological factors (Amar et al., 2011). Some researchers discuss how the accessibility of credits affects spending decisions (Wilcox et al. 2011, Soman and Cheema 2002). However, these papers did not consider the downstream consequences of consumer financial decisions. In this paper, we further study how consumer financial decisions affect their purchase decisions, and in turn affect the retailer’s pricing, credit pass-through decisions, and

⁷Some classic rationales include information or monitoring advantage (Mian and Smith Jr 1992, Schwartz 1974, Burkart and Ellingsen 2004), transaction costs (Ferris, 1981), price discrimination (Brennan et al. 1988, Mian and Smith Jr 1992), internalized negative externality (Daripa and Nilsen, 2011), agency conflict (Chod, 2016), etc. Some researchers study the financial risks in trade credit, such as the bankruptcy risks of the retailer (Kouvelis and Zhao 2015, Yang and Birge 2017) and the credit rating of the retailer (Kouvelis and Zhao, 2017).

profits in a distribution-financing channel. Also, the above literature in finance focuses on the interactions between lenders and borrowers, and by contrast, this paper studies the interactions between the supplier and the retailer in the presence of consumer financial decision making or consumer default behavior. This paper also sheds light on optimal consumer financial decisions and consumer welfare. We show that consumer financing which offers consumers another financing method may make consumers worse off.

We present the research in the following sections. In Section 2, we set up the model. Then we analyze the model of a distribution channel with a retailer who might be financially constrained in Section 3. We study the effect of consumer financing capability and how consumer welfare changes with the provision of consumer financing in Section 4. Section 5 summarizes the main results and concludes the paper.

2.2 Model Setup

In this paper, we study a distribution channel where a supplier sells to consumers through a retailer who needs trade credits from the supplier. In turn, the retailer may pass through credits to consumers so that consumers who cannot afford the product can make a purchase. To further understand the role of consumer financing, we analyze the case where the supplier offers trade credits to the retailer and the retailer has the capability to offer consumer financing and choose whether to pass through the credits to consumers in Section 3 and compare it with the case where the supplier offers trade credits to the retailer, but the retailer does not have the capability to offer consumer financing in Section 4.

One novelty of this model is that consumers not only need to make purchase decisions but also choose whether to repay or not in the next period if they purchase with retailer-initiated consumer financing (i.e., consumer financial decisions). To model consumer financial decisions and capture consumer income heterogeneity of a market with the size normalized to 1, we assume half of the consumers receive a low-income I_L (i.e., the low segment) and half of the consumers receive a high-income I_H (i.e., the high segment) for two periods. When the product value d is higher than the product's price p and the price is higher than a consumer's income, the consumer may need consumer financing from the retailer to buy the product. To be consistent with the practice that low-income consumers are more likely to be capital constrained and default, we focus our study on an interesting case where it is possible that low-income consumers need financing to make a purchase and in turn are more likely to default, whereas high-income consumers do not need financing to make a purchase nor default ($I_L \leq d < I_H$).⁸ In other words, high-income consumers' willingness to pay is less than their ability to pay ($I_H > d$), while low-income consumers' willingness to pay is no less than their ability to pay ($I_L \leq d$). When low-income consumers obtain retailer-initiated consumer financing in the first period, they need to make a down-payment and pay off their debts plus interest with interest rate r in the second period. However, consumers may experience a random expense shock in the second period, where the expense shock equals 0 with probability $1 - \lambda$ and equals k with probability λ . This expense shock may

⁸On average, bankrupt households are 50%-70% poorer than the average household, with debt-to-income ratios well above average (Livshits et al., 2007).

result in consumers' insolvency and even default. If a consumer defaults on his debt, δ proportion of the consumer's net asset will be confiscated by the retailer.⁹

To manage the possibility of consumer defaults and limit the default risk, the retailer decides on the retail price and whether to pass through the credits to low-income consumers if the retailer has the capability to do so.¹⁰ In addition, the retailer needs trade credits from the supplier so that the retailer can purchase products without paying immediately. However, with a random asset shock, the retailer may go into bankruptcy and cannot pay off the debt to the supplier. Specifically, the retailer is vulnerable to a random asset shock α that may cause the retailer's bankruptcy. The random asset shock α follows a uniform distribution on $(-a, a)$ and captures the retailer's profit from other lines of business, uncertainties in fixed operational costs or random movement of the retailer's asset value. To capture the bankruptcy risk of the retailer, we further assume the random asset shock is realized after the selling begins.

The model sequence is as follows (Figure 1). At stage 1, the supplier decides the wholesale price w and offers trade credits so that the retailer can purchase products on account first and repay later. At stage 2, the retailer chooses the retail price p and credit pass-through strategy $G \in \{N, F\}$ for consumers where N denotes not offering and F denotes offering consumer financing. At stage 3, a consumer gets income I and decides whether to buy the product. If he decides to buy using consumer financing, he needs to make a down-payment of I and borrow the rest from the retailer. Then the random asset shock α is realized. At stage 4, the consumer gets income again and the expense shock is realized. If the consumer used retailer-initiated financing, he has to decide to repay or default, or formally $\Gamma \in \{R, D\}$. In order to capture the effect of the retailer's asset uncertainty and bankruptcy risks, we assume the retailer's asset shock is realized after consumers' purchases.

2.3 Model Analysis

We first start with the case where the retailer has the capability to offer consumer financing. Then we analyze a special case where the retailer does not have the capability to offer consumer financing in Section 4 to show the impact of consumer financing capability. In each case, we derive equilibrium for both the distressed retailer with bankruptcy risks and the non-distressed retailer without bankruptcy risks.

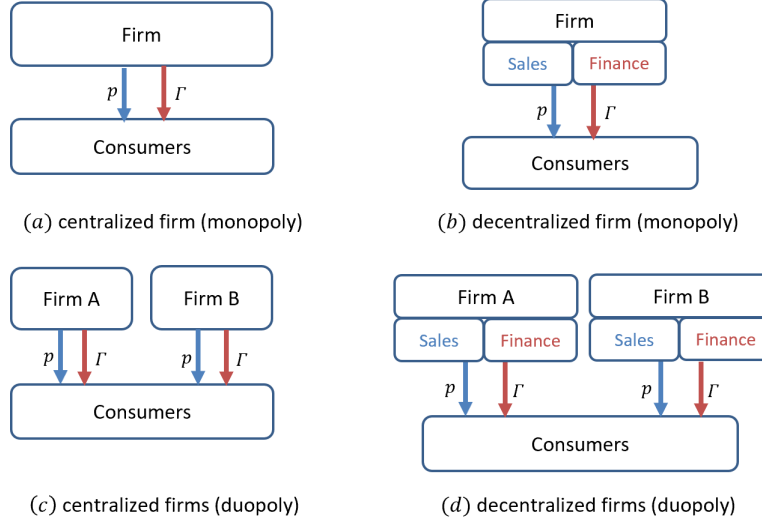
2.3.1 Consumer Decisions

Now we focus on the case where the retailer has the capability to offer consumer financing. As we mentioned before, low-income consumers are more likely in need of consumer financing, yet high-income consumers are

⁹Typically, the creditor/collector would likely be granted a judgment for the total amount due. With a judgment, the creditor can execute a bank levy or wage garnishment (depending on the laws in the consumer's state) or file a lien on the consumer's property in order to collect.

¹⁰In practice, banks typically use different measurements, such as the FICO score, to evaluate consumer credit history. Typically, the income level or the solvency is part of the FICO score. In this study, to simplify the problem, we consider the income as the surrogate solvency measurement.

Figure 2.1: The Sequence of the Game



less likely to buy with credits since the product value is lower than their income ($d < I_H$). Therefore, we focus our discussion on low-income consumers. If the low-income consumer makes a purchase using consumer financing, he has to make a down-payment I_L and borrow the rest $(p - I_L)$ from the retailer with an interest rate r .

Consumer Financial Decisions: At the last stage, for those consumers who used retailer credits to make a purchase, they decide to repay, or default given the price and realized expense shock. With a probability of λ , the consumer will have to spend k ($k < I$) on unavoidable, individually independent expense E and get a net income of $I - k$. With a probability of $1 - \lambda$, the consumer will not incur such expense and get an income of I . After the realization of the expense shock, if the consumer chooses to repay, he has to pay $p - I_L$ and the interest $r(p - I_L)$; if the consumer chooses to default, the retailer/ the creditor will confiscate a part of the consumer's net asset $\delta(I_L - k)$ or δI_L , where δ is the confiscated proportion of the bankrupt consumer's total net assets.

To sum up, if the consumer had an expense shock, the payoff is $U_R = d - I - (p - I)(1 + r)$ if he repays ($\Gamma = R$) and $U_D = d - I - (I - k)\delta$ if he defaults ($\Gamma = D$). Therefore, the consumer will default if $U_D > U_R$ and will repay if $U_D \leq U_R$. Consequently, the consumer financial decision with expense shock is

$$\Gamma(\cdot | p, w, G, E = k) = \begin{cases} R, & \text{if } p \leq I + \frac{\delta(I-k)}{1+r} \\ D, & \text{if } p > I + \frac{\delta(I-k)}{1+r}. \end{cases} \quad (2.1)$$

If the consumer does not experience the expense shock, the payoff is $U_R = d - I - (p - I)(1 + r)$ if he repays ($\Gamma = R$) and the payoff is $U_D = d - I - I\delta$ if he defaults ($\Gamma = D$). Therefore, the consumer financial

decision without expense shock is

$$\Gamma(\cdot|p, w, G, E = 0) = \begin{cases} R, & \text{if } p \leq I + \frac{I\delta}{1+r} \\ D, & \text{if } p > I + \frac{I\delta}{1+r}. \end{cases} \quad (2.2)$$

For the retailer, if the consumer defaults on the debt, the retailer cannot recover the cost (i.e., the wholesale price w) but may offset part of the default loss by confiscation of assets ($\delta(I_L - k)$ or δI_L). If the consumer repays, the retailer will get interest $r(p - I_L)$ along with the profit $p - w$.

As Equations (1) and (2) show, consumers' decisions on repay and default depend on the retail price. With the increase of price, low-income consumers are more likely to default. Specifically, if the price is lower than the income ($p \leq I_L$), low-income consumers can buy the product without using retailer credits. If the price is higher than the income but not too high ($p \in (I_L, I_L + \frac{\delta(I_L - k)}{1+r}]$), low-income consumers will always repay even with expense shock. When the price is moderate ($p \in (I_L + \frac{\delta(I_L - k)}{1+r}, I_L + \frac{\delta I_L}{1+r}]$), if a low-income consumer made a purchase, he will choose to default with expense shock and repay without expense shock. When the price is high ($p > (I_L + \frac{\delta I_L}{1+r})$), low-income consumers will always default regardless of expense shock.

Interestingly, despite the interest and confiscation of asset after default, we find that the retailer may charge a price beyond consumers' income $p > I_L$ due to consumer financing. We notice that when there is no expense shock and the price is high ($I_L + \frac{\delta I_L}{1+r} < p < I_L + \frac{I_L}{1+r}$), consumers are better off defaulting on the debt even though they have enough money to pay off the debt. The result is similar in the case with expense shock. The following lemma summarizes this interesting result:

Lemma 1 (Strategic Default). *For a low-income consumer who purchases with credit, if $I_L + \frac{I_L\delta}{1+r} < p \leq I_L + \frac{I_L}{1+r}$ without expense shock or $I_L + \frac{(I_L - k)\delta}{1+r} < p \leq I_L + \frac{I_L - k}{1+r}$ with expense shock, the consumer will strategically default.*

Lemma 1 shows that a consumer may default strategically, meaning that the consumer has the ability to repay the debt but he or she chooses not to since the asset confiscation is relatively small ($\delta I_L < (p - I_L)(1+r)$). This is consistent with Gerardi et al. (2013) and Trautmann and Vlahu (2013), who empirically and experimentally show the strategic default behavior in the mortgage loans and credit market. The reason is that when the price is relatively high ($p > I_L + \frac{I_L\delta}{1+r}$ or $p > I_L + \frac{(I_L - k)\delta}{1+r}$), low-income consumers pay less for default (i.e., $I_L + \frac{\delta(I_L - k)}{1+r}$ with an expense shock or $I_L + \frac{I_L\delta}{1+r}$ without the expense shock) than for repaying the debt p . This happens even when consumers are able to pay off the debt if the retail price is not too high (i.e., $p \leq I_L + \frac{I_L}{1+r}$ or $p \leq I_L + \frac{I_L - k}{1+r}$). Therefore, consumers will choose to default strategically even though they are able to pay off the debt.

Consumer Purchase Decisions: At stage 3, given the retailer's credit pass-through and pricing decisions, consumers decide whether to purchase the product. If the retailer chooses not to pass through credits to consumers, high-income consumers will make a purchase if $p \leq d$ whereas low-income consumers will make a purchase if $p \leq I_L$.

Now we focus on a more interesting case where the retailer chooses to pass through credits to consumers. If the price is no more than the product value ($p \leq d (< I_H)$), high-income consumers who do not need consumer financing from the retailer will make a purchase, and low-income consumers who need consumer financing make decisions as follows. When the price is extremely low ($p \in [0, I_L]$), low-income consumers do not need consumer financing and will buy the product since the product value is higher than their income $d > I_L$. When the price is low ($p \in (I_L, I_L + \frac{\delta(I_L - k)}{1+r}]$), low-income consumers need consumer financing since the product price is higher than their income $p > I_L$. If low-income consumers' utility of buying $U = d - I_L - (p - I_L)(1 + r) \geq 0$ (i.e., $p \leq p_L = \frac{d+rI_L}{1+r}$), they will make a purchase with credits and repay in the next period; if low-income consumers' utility of buying $U = d - I_L - (p - I_L)(1 + r) < 0$ (i.e., $p > p_L$), they will not make a purchase. When the price is moderate ($p \in (I_L + \frac{\delta(I_L - k)}{1+r}, I_L + \frac{\delta I_L}{1+r}]$), low-income consumers who buy with credits will get $U = d - I_L - \lambda\delta(I_L - k) - (p - I_L)(1 + r)(1 - \lambda)$. In this case, they will buy if $U \geq 0$ (i.e., $p \leq p_H = \frac{d+k\lambda\delta+I_L(r-\lambda(1+r+\delta))}{(1-\lambda)(1+r)}$), and repay without an expense shock and default with the expense shock; they will not buy otherwise. In the above two cases ($p \in (I_L, I_L + \frac{\delta(I_L - k)}{1+r}]$ and $p \in (I_L + \frac{\delta(I_L - k)}{1+r}, I_L + \frac{\delta I_L}{1+r}]$), we find that low-income consumers' ability to pay increases due to consumer financing so that the retailer can charge a higher price and the market expands under some conditions. When the price is high ($p > I_L + \frac{\delta I_L}{1+r}$), low-income consumers will buy with credits if $U = d - I_L - \delta(I_L - k\lambda) \geq 0$ (i.e., $d \geq I_L + \delta(I_L - k\lambda)$) and default later; they will not buy otherwise. In this case, we find if the retailer passes through credits to consumers and the product value is high enough (i.e., $d \geq I_L + \delta(I_L - k\lambda)$), low-income consumers will still make a purchase even when they cannot repay in the future. This result is summarized in Lemma 2.

Lemma 2 (Rational Default). *When $p > I_L + \frac{\delta I_L}{1+r}$ and $d \geq I_L + \delta(I_L - k\lambda)$, low-income consumers will make a purchase using consumer credits even when they cannot repay in the future.*

Lemma 2 depicts an interesting case where consumers rationally default on their debts. When the price is high enough ($p > I_L + \frac{\delta I_L}{1+r}$), low-income consumers realize they cannot pay off with or without expense shock in the future. However, as long as the product value is higher than the confiscated asset and default penalty, i.e., $U = d - I_L - \delta(I_L - k\lambda) \geq 0$, low-income consumers will make a purchase using consumer credits and default later on purpose. Both rational and strategic default happen when the price is relatively high, and consumers can benefit more from default than repay. However, rational default differs from strategic default in that rational default happens in the purchase decision stage (*ex ante*) and strategic default happens at the financial decision stage after the expense shock realizes (*ex post*). In the following sections, we further study when consumers' rational default will survive in the equilibrium and why.

We also notice that with the increase of the price, consumers are more likely to default on their debts, which brings more default risks to the retailer. The retailer needs to decide whether to pass through credits to consumers and choose their pricing strategy consistently. With a relatively high price, the retailer is better off not passing through credits to low-income consumers to control consumer default loss. With a relatively low price, the retailer may choose to pass through credits to sell to more consumers. If the retailer sets a low

price and does not pass through credits, selling to all consumers with a lower margin is not optimal because low-income consumers who are willing to make a purchase with credits cannot get consumer financing. In this case, there is no point setting a lower price. Moreover, if a low-price retailer, such as Walmart, intends to re-position itself as a high-price retailer by increasing the prices of its products, then consumer default risk will increase accordingly, which may offset the increased margin. On the other hand, if a high-end retailer, such as Nordstrom, intends to lower the price, then the retailer may need to consider offering consumer financing to low-income consumers.

2.3.2 The Retailer's Price and Credit Pass-Through Decisions

Now we study the retailer's decisions on price and credit pass-through. In practice, we notice an interesting phenomenon that some retailers are financially distressed yet still offer consumer financing, i.e., higher credit pass-through for a financially distressed retailer. To study the mechanism behind this, we consider a distribution channel where the supplier sells the product through a financially constrained retailer who needs trade credits from the supplier, has a bankruptcy risk, and may pass through the credits to consumers. Following the model setup, the retailer faces a random asset shock α that realizes after the retailer's decisions and may cause its bankruptcy. The random asset shock follows a uniform distribution on $(-a, a)$ with density function $f(\alpha) = \frac{1}{2a}$. Due to the random asset shock, the financially constrained retailer who relies on trade credits from the supplier may or may not pay back in the next period: the retailer will repay the supplier if current total asset is non-negative ($\alpha + \pi_R \geq 0$) and will file for bankruptcy if current total asset is negative ($\alpha + \pi_R < 0$) where π_R denotes the retailer's profit in general. Thus, the probability of retailer bankruptcy is $\Phi(-\pi_R) = \int_{-\pi_R}^0 f(\alpha) d\alpha = \frac{a - \pi_R}{2a}$ where π_R denotes the retailer's profit, and the asset shock variance is sufficiently high ($a > \pi_R$). Note that if the asset shock variance is low $a \leq \pi_R$, the retailer's profit is always positive, and the retailer never goes bankrupt. If a financially distressed retailer ($a > \pi_R$) files for bankruptcy, the retailer gets zero profit due to limited liability and the supplier or the creditor may not get repaid. Therefore, for a retailer without bankruptcy risk ($a \leq \pi_R$), the profit is simply π_R ; for a financially distressed retailer with bankruptcy risk ($a > \pi_R$), the retailer will go bankrupt with probability of $\Phi(-\pi_R)$ and get zero profit or the retailer will not go bankrupt with probability of $1 - \Phi(-\pi_R)$ and get π_R . Thus, the retailer's expected profit is

$$E[\Pi_D^R(p, G)] = (1 - \Phi(-\pi_R))\pi_R(p, G) = \frac{a + \pi_R(p, G)}{2a}\pi_R(p, G), \quad (2.3)$$

which is strictly increasing in $\pi_R(p, G)$. Therefore, the retailer only needs to maximize $\pi_R(p, G)$ regardless of bankruptcy risk.

At stage 2, expecting the random asset shock and consumers' decisions, the retailer chooses the retail price p and the credit pass-through strategy G to maximize the profit $\pi_R(p, G)$. We assume the probability of expense shock k equals $\frac{1}{2}$ (formally, $\lambda = \frac{1}{2}$) to simplify the problem. Our analysis shows when the interest

rate is not too low ($r > \hat{r}$),¹¹ the analytical expressions of the best response depend on three qualitatively different ranges of the product value d : (1) low product value: $I_L \leq d < \underline{d}$; (2) moderate product value: $\underline{d} \leq d < \bar{d}$; and (3) high product value $\bar{d} \leq d < I_H$. For simplicity, we use $i = 1, 2, 3$ to denote the three different ranges of the product value. Below we present the best response of the retailer $\{p^{BR}, G^{BR}\}$ for each of the above three cases. The detailed analysis using backward induction is given in the appendix.

Case 1: low product value $I_L \leq d < \underline{d}$. Our analysis shows that depending on the supplier's wholesale price, the retailer will choose different price and credit pass-through strategies to target different segments of consumers. When the wholesale price is low ($w \leq w_1 = \frac{d+rI_L}{1+r}$), the retailer is better off choosing a low price $p_L = \frac{d+rI_L}{1+r}$ and offering consumer financing to sell to all consumers. When the wholesale price is high ($w > w_1$), the retailer is better off choosing a high price $p = d$ and not offering consumer financing to sell only to high-income consumers.

Case 2: moderate product value $\underline{d} \leq d < \bar{d}$. With the increase of product value, when the wholesale price is low ($w \leq w_2 = \frac{2d+I_L(-1+r-\delta)+k\delta}{1+r}$), the retailer will choose a moderate price $p_H = \frac{2d-I_L(1-r+\delta)+k\delta}{1+r}$ and pass through credits to sell to all consumers. When the wholesale price is high ($w > w_2$), the retailer will choose a high price $p = d$ and does not pass through credits to consumers.

Case 3: high product value $\bar{d} \leq d < I_H$. When the wholesale price is low ($w \leq w_3 = I_L + I_L\delta - \frac{k\delta}{2}$), the retailer will choose a high price d and pass through credits to sell to all consumers. When the wholesale price is high ($w > w_3$), the retailer will choose a high price $p = d$ and does not pass through credits to consumers. Different from case 2, the retailer in case 3 can charge a high price and sell to both low- and high-income consumers since the product value is high. Therefore, when the wholesale price is low, the retailer will take advantage of consumers' high valuation of the product ($d \geq I_L + \delta(I_L - k\lambda)$), adopt high price strategy and pass through credits to consumers even though consumers do not repay¹², which will be further analyzed later.

2.3.3 Equilibrium and Malicious Consumer Financing

Now we study the case where the retailer has the capability to offer consumer financing and takes advantage of trade credits from the supplier in the meanwhile. The retailer may go bankrupt depending on the asset shock and profits. Moreover, consumer default risk may aggravate the retailer's bankruptcy risk and in turn negatively affect the supplier's profit. At stage 1, expecting the retailer's decisions and bankruptcy risks, the supplier decides the wholesale price to maximize the expected profit. When the random asset shock is high ($-\pi_i(p, G) < \alpha < a$, $i \in \{1, 2, 3, R\}$), the retailer does not go bankrupt and the supplier will be repaid w ; when the random asset shock is low ($-a < \alpha < -\pi_i(p, G)$), the retailer may go bankrupt and the supplier will

¹¹To be consistent with the practice, we study a case where the interest rate is not too low ($r > \hat{r}$) for the rest of this paper. When $r \leq \hat{r}$, main results still exist. We show that in the proof of Lemma 3 in the appendix.

¹²In the appendix, we show that when the product value is high and the wholesale price is low, the profit from high price strategy and offering consumer financing $\pi_3(d, F)$ is higher than that from medium price strategy and offering consumer financing $\pi_2(d, F)$. A high product value and a low wholesale price induce the retailer to charge a high retail price so that the profit margin from high-income consumers will be high and the confiscated asset from low-income consumers can offset part of the default loss.

not get repaid; in either case, the supplier will incur a production cost of cQ where Q denotes the demand. We will focus on the case where the retailer may have bankruptcy risk first and then summarize the special case of the non-distressed retailer later. Specifically, if the distressed retailer with bankruptcy risks has the capability to offer consumer financing,

(1) when the product value is low ($I_L \leq d < \underline{d}$),

$$E[\Pi^M(w)] = \begin{cases} \int_{-\pi_1(p_L, F)}^a wf(\alpha)d\alpha - c, & F, w \in [0, w_1] \\ \int_{-\pi_R(d, N)}^a \frac{w}{2}f(\alpha)d\alpha - \frac{c}{2}, & N, w \in (w_1, d]; \end{cases} \quad (2.4)$$

(2) when the product value is moderate ($\underline{d} \leq d < \bar{d}$),

$$E[\Pi^M(w)] = \begin{cases} \int_{-\pi_2(p_H, F)}^a wf(\alpha)d\alpha - c, & F, w \in [0, w_2] \\ \int_{-\pi_R(d, N)}^a \frac{w}{2}f(\alpha)d\alpha - \frac{c}{2}, & N, w \in (w_2, d]; \end{cases} \quad (2.5)$$

(3) when the product value is high ($\bar{d} \leq d < I_H$),

$$E[\Pi^M(w)] = \begin{cases} \int_{-\pi_3(d, F)}^a wf(\alpha)d\alpha - c, & F, w \in [0, w_3] \\ \int_{-\pi_R(d, N)}^a \frac{w}{2}f(\alpha)d\alpha - \frac{c}{2}, & N, w \in (w_3, d]. \end{cases} \quad (2.6)$$

The supplier chooses an optimal wholesale price to maximize its expected profit. The equilibrium results, similar to the retailer's best responds, depend on three qualitatively different ranges of the product value d : (1) low product value: $I_L \leq d < \underline{d}$; (2) moderate product value: $\underline{d} \leq d < \bar{d}$; and (3) high product value $\bar{d} \leq d < I_H$. For example, in Equation (5), when the wholesale price is low $w \leq w_1$, the retailer is better off selling to all consumers ($Q = 1$). The supplier will get repaid of w only when the retailer does not go bankrupt ($-\pi_R(p_L, F) \leq \alpha \leq a$) and incur a production cost c regardless whether the retailer goes bankrupt or not. The supplier chooses a wholesale price to maximize its expected profit $E[\Pi^M(w)]$ such that $w \leq w_1$ and $a \geq \pi_R(p_L, F)$. When the wholesale price is high $w > w_1$, the retailer is better off selling only to high-income consumers ($Q = \frac{1}{2}$). The supplier will only get repaid of $\frac{w}{2}$ when the retailer does not go bankrupt ($-\pi_R(d, N) \leq \alpha \leq a$) and incur a production cost $\frac{c}{2}$ regardless whether the retailer goes bankrupt or not. The supplier chooses a wholesale price to maximize its expected profit $E[\Pi_N^M(w)]$ such that $w \leq d$ and $a \geq \pi_R(d, N)$. Note that when the asset shock variance is low ($a \leq \pi_R(p, G)$), the retailer will not go bankrupt and the supplier will not suffer from the retailer's bankruptcy risk, so the supplier will just maximize $\pi^M(w)$ expecting the retailer's best response (See subsection 3.3). Below we present the equilibrium results $\{w^*, p^*, G^*\}$ for each of the above three cases. The detailed analysis using backward induction is given in the appendix.

Case 1: low product value $I_L \leq d < \underline{d}$. We find that depending on the marginal production cost and retailer asset shock variance, the supplier will choose an optimal wholesale price to induce the retailer

to make different retail price and credit pass-through decisions to sell to all consumers or only high-income consumers. Specifically, the supplier makes a trade-off between higher profit and lower retailer bankruptcy risk. When the marginal production cost is low ($c \leq c_1$) and the asset shock variance is moderate ($\underline{a}_1 = \frac{I_L r + d(2+r)}{6(1+r)} < a < \bar{a}_1 = \frac{3I_L r + d(2-r)}{2(1+r)}$), lowering retailer bankruptcy risk is more significant than increasing the profit margin of the supplier. Thus, the supplier will choose a relatively low price ($w^* = \tilde{w}_1 = \frac{I_L r + 2a(1+r) + d(2+r)}{4(1+r)}$) to reduce the retailer bankruptcy risk and incentivize the retailer to pass through credits to consumers. When the marginal production cost is low ($c \leq c_1$) and the asset shock variance is high ($a \geq \bar{a}_1$), for a low wholesale price ($w \leq d$), the supplier's profit increases with the wholesale price ($\frac{\partial E[\Pi^M(w)]}{\partial w} > 0$) so the supplier is less likely to suffer from the retailer's bankruptcy risk and in turn better off choosing a relatively high wholesale price ($w^* = w_1$) but still low enough to induce the retailer to pass through credits to consumers. When the marginal production cost is low ($c \leq c_1$) and the asset shock variance is low ($a \leq \underline{a}_1$), the retailer will not go bankrupt and the supplier will not suffer from the retailer's bankruptcy risk. Therefore, the supplier will choose a relatively low wholesale price ($w^* = w_1$) to induce the retailer to pass through credits to consumers. When the marginal production cost is high ($c > c_1$), the supplier will choose a relatively high wholesale price compared to the low marginal cost case, resulting in a high consumer default risk to the retailer. Thus, the retailer has less incentive to pass through credits to low-income consumers and will sell only to high-income consumers. For a high marginal cost, when the asset shock variance is moderate ($\underline{a} = \frac{d}{6} < a < \bar{a} = \frac{d}{2}$), the supplier will lower the price ($w^* = a + \frac{d}{2}$) compared to the low asset shock variance case to reduce the bankruptcy risk; when the asset shock variance is high $a \geq \bar{a}$, the supplier will choose a relatively high price ($w^* = d$) since the retailer bankruptcy risk is less significant than increased profit margin for the supplier. When the marginal production cost is high ($c \leq c_1$) and the asset shock variance is low ($a \leq \underline{a}$), the retailer will not go bankrupt, and the supplier will not suffer from the retailer's bankruptcy risk. Therefore, the supplier will choose a relatively high wholesale price ($w^* = d$) to induce the retailer not to pass through the credits to low-income consumer and sell only to high-income consumers.

Case 2: moderate product value $\underline{d} \leq d < \bar{d}$. For a low marginal production cost ($c \leq c_2$), when the retailer asset shock variance is moderate ($\underline{a}_2 = \frac{d(3+r) + I_L(-1+r-\delta) + k\delta}{6(1+r)} < a < \bar{a}_2 = \frac{d(5-r) + 3(I_L(-1+r-\delta) + k\delta)}{2(1+r)}$), the supplier will choose a relatively low price ($w^* = \tilde{w}_2 = \frac{I_L r + 2a(1+r) + d(3+r) - I_L \delta - I_L + k\delta}{4(1+r)}$); when the asset shock variance is high ($a \geq \bar{a}_2$), for $w \leq d$, $\frac{\partial E[\Pi^M(w)]}{\partial w} > 0$ so the supplier is less likely to suffer from the retailer's bankruptcy risk and in turn better off not lowering the wholesale price ($w^* = w_2$); when the asset shock variance is low ($a \leq \underline{a}_2$), the retailer will not go bankrupt and the supplier sets a low wholesale price ($w^* = w_2$) so that the retailer will pass through credits to low-income consumers and sell to all consumers. For a high marginal production cost ($c > c_2$), when the asset shock variance is moderate ($\underline{a} = \frac{d}{6} < a < \bar{a} = \frac{d}{2}$), the supplier will choose a relatively low price ($w^* = a + \frac{d}{2}$) to reduce the bankruptcy risk; when the asset shock variance is high $a \geq \bar{a}$, the supplier will choose a relatively high price ($w^* = d$) to incentivize the retailer not to pass through credits to consumers and sell only to high-income consumers; when the asset shock variance is low ($a \leq \underline{a}$), the retailer will not go bankrupt and the supplier will choose a relatively high

price ($w^* = d$) to incentivize the retailer not to pass through credits to low-income consumers and sell only to high-income consumers.

Case 3: high product value $\bar{d} \leq d < I_H$. As with case 1 and case 2, the supplier makes a trade-off between higher profit and lower retailer bankruptcy risk. For a low marginal production cost ($c \leq c_3$), when the retailer asset shock variance is moderate ($\underline{a}_3 = \frac{2d-k\delta+2I_L(1+t)}{12} < a < \bar{a}_3 = \frac{3(-k\delta+2I_L(1+\delta))-2d}{4}$), the supplier will choose a relatively low price ($w^* = \tilde{w}_3 = \frac{4a+2d+2I_L+2I_L\delta-k\delta}{8}$); when the asset shock variance is high ($a \geq \bar{a}_3$), the supplier is better off not lowering the wholesale price ($w^* = w_3$); when the asset shock variance is low ($a \leq \underline{a}_3$), the retailer will not go bankrupt and the supplier sets a low wholesale price ($w^* = w_3$). For a high marginal production cost ($c > c_3$), when the asset shock variance is moderate ($\underline{a} = \frac{d}{6} < a < \bar{a} = \frac{d}{2}$), the supplier will choose a relatively low price ($w^* = a + \frac{d}{2}$) to incentivize the retailer not to pass through credits to low-income consumers and sell only to high-income consumers; when the asset shock variance is high $a \geq \bar{a}$, the supplier will choose a relatively high price ($w^* = d$); when the asset shock variance is low ($a \leq \underline{a}$), the retailer will not go bankrupt and the supplier will choose a relatively high price ($w^* = d$) to incentivize the retailer not to pass through credits to consumers and sell only to high-income consumers.¹³

To sum up, in equilibrium: (1) for $I_L \leq d < \underline{d}$ and $c \leq c_1$, the optimal strategy is $\{\tilde{w}_1, p_L, F\}$ when $\underline{a}_1 < a < \bar{a}_1$; $\{w_1, p_L, F\}$ when $a \geq \bar{a}_1$ or $a \leq \underline{a}_1$. (2) for $\underline{d} \leq d < \bar{d}$ and $c \leq c_2$, the optimal strategy is $\{\tilde{w}_2, p_H, F\}$ when $\underline{a}_2 < a < \bar{a}_2$; $\{w_2, p_H, F\}$ when $a \geq \bar{a}_2$ or $a \leq \underline{a}_2$. (3) for $\bar{d} \leq d < I_H$ and $c \leq c_3$, the optimal strategy is $\{\tilde{w}_3, d, F\}$ when $\underline{a}_3 < a < \bar{a}_3$; $\{w_3, d, F\}$ when $a \geq \bar{a}_3$ or $a \leq \underline{a}_3$. (4) for $c > c_i, i \in \{1, 2, 3\}$ respectively, the optimal strategy is $\{\tilde{w}, d, N\}$ when $\underline{a} < a < \bar{a}$; $\{d, d, N\}$ when $a \geq \bar{a}$ or $a \leq \underline{a}$. We notice an interesting result that consumers' rational default behavior will survive in the equilibrium. When the product value is relatively high $\bar{d} \leq d < I_H$, the retailer will deliberately choose a high price strategy that indulges consumers' rational default behavior. This counterintuitive result is summarized in the following proposition.

Proposition 1 (Malicious Consumer Financing). *If the retailer has the capability to pass through credits to consumers, when $\bar{d} \leq d < I_H$ and $c \leq c_3$, the retailer will adopt the high price strategy ($p = d$) and offers consumer financing even though low-income consumers do not repay in the future.*

Surprisingly, Proposition 1 shows that when the marginal production cost is low and the product value is high, even though low-income consumers cannot pay off their debt, the retailer may still offer consumer financing. In other words, retailer-initiated consumer financing may induce consumer bankruptcy and allow retailers to “prey” on low-income consumers. The intuition is as follows. First of all, the provision of consumer financing affects both consumers and channel members significantly. On the one hand, the option of consumer financing improves low-income consumers' ability to pay for the product, resulting in possible higher profit margin for the retailer and the supplier. For example, when the marginal production cost is low ($c \leq \hat{c}_0$) and the supplier intends to sell to the whole market by charging a low wholesale price. Without consumer

¹³Here c_1, c_2, c_3 solve $E[\Pi^M(w^*|p^{BR}, F)] = E[\Pi^M(w^*|p^{BR}, N)]$ when the product value is low, moderate and high, respectively, and denote the cutoff values that the supplier induces the retailer to offer consumer financing ($c \leq c_i, i \in \{1, 2, 3\}$) or not ($c > c_i$) for the sake of exposition. The specific value varies with different ranges of asset shock variance a . We will specify them in the following sections.

financing, the retailer can charge low-income consumers' income I_L at most; but with consumer financing, the retailer can charge a higher price $p^* = d > I_L$ when the product value is high ($\bar{d} \leq d < I_H$). The consumers' improved ability to pay with consumer financing can expand the retailer's and the supplier's market share when the marginal cost is moderate $\hat{c}_0 < c < c_i, i \in \{1, 2, 3\}$ (i.e., *market expansion effect*). On the other hand, when the marginal production cost is low ($c \leq c_3$) and the product value is high ($\bar{d} \leq d < I_H$), with consumer financing, low-income consumers surely default in the next period, resulting in consumer default loss to the retailer. However, the retailer can recover part of the default loss by confiscation of default consumers' income ($\delta(I_L - k\lambda)$). Therefore, the retailer chooses a retail price and a credit pass-through strategy to balance the increased profit margin, demand and net consumer default loss.

Specifically, with consumer financing capability, when the product value is high $\bar{d} \leq d < I_H$, the improved ability to pay for low-income consumers is so high that rational default is better than repaying the debt for the consumers. For high-income consumers, the increased price is no more than the product value ($p = d \leq d$) so they will buy and repay. Thus, the retailer will charge a high price due to the improved ability to pay such that rational default is better than repaying the debt for the low-income consumers. Even though low-income consumers surely default, the consumer default loss is less than the first period down-payment and confiscated asset from default consumers when the wholesale price is low $w \leq w_3$, i.e., the retailer gains more profit to offer consumer financing ($\pi_3 > \pi_N^L$). Expecting the retailer's decisions, the supplier chooses a low wholesale price $w \leq w_3$ when the marginal production cost is low $c \leq c_3$ and the product value is high $\bar{d} \leq d < I_H$ to induce the retailer to pass through credits to consumers (malicious consumer financing). However, Proposition 1 does not hold for a low product value ($I_L \leq d < \bar{d}$) or a high marginal production cost ($c > c_3$). When the product value is relatively low, consumers' default penalty will outweigh the purchase benefits so that consumers do not have enough incentive to rationally default. When the marginal production cost is relatively high, the loss from consumers' rational default is high such that the retailer chooses not to offer consumer financing.

Proposition 1 could partially explain the phenomenon that private label credit cards, as well as consumer payment delay and default, are becoming more and more prevalent. According to data compiled by Equifax Inc, nearly 300 million private-label credit card loans were outstanding from the previous year. About 1.8 percent were 30 days past due, a harbinger of future default, compared with 0.84 percent for general purpose credit cards (Surane, 2017). Proposition 1 may provide a possible reason why retailers are willing to take the risk of offering consumer financing is that the large consumer default loss can be offset by the increased price, down-payment and even income confiscation. Next, we focus on the case where the retailer does not go bankrupt and then show how a retailer's financial conditions affect consumer financing and pricing decisions.

Special Case: Supplier with a Non-Distressed Retailer If the supplier sells through a retailer without bankruptcy risk ($a \leq \underline{a}$) regardless of the marginal production cost, at stage 1, the supplier decides its wholesale price to maximize profit $\pi^M = Q(w - c)$ where Q denotes the demand. We denote the equilibrium results as $\{w^*, p^*, G^*\}$ and $\hat{c}_1 = \frac{d-dr+2I_L r}{1+r}$, $\hat{c}_2 = \frac{-d(-3+r)+2I_L(-1+r-\delta)+2k\delta}{1+r}$, $\hat{c}_3 = 2I_L(1 + \delta) - d - k\delta$. The

equilibrium is shown in the following Lemma 3.

Lemma 3. *If the supplier sells through a non-distressed retailer ($a \leq \underline{a}$) who has the capability to offer consumer financing, in equilibrium,*

- (1) *for $I_L \leq d < \underline{d}$, the optimal strategy is $\{w_1, p_L, F\}$ if $c \leq \hat{c}_1$ and $\{d, d, N\}$ otherwise.*
- (2) *for $\underline{d} \leq d < \bar{d}$, the optimal strategy is $\{w_2, p_H, F\}$ if $c \leq \hat{c}_2$ and $\{d, d, N\}$ otherwise.*
- (3) *for $\bar{d} \leq d < I_H$, the optimal strategy is $\{w_3, d, F\}$ if $c \leq \hat{c}_3$ and $\{d, d, N\}$ otherwise.*

Lemma 3 shows that the supplier chooses a low wholesale price ($w = w_i$, $i \in \{1, 2, 3\}$) to induce the retailer to pass through credits to consumers and sell to all consumers only when the marginal cost is low ($c \leq \hat{c}_i$ where $i \in \{1, 2, 3\}$). The rationale is as follows. With a low marginal cost, the supplier chooses a low wholesale price to sell to all consumers. Thus, even if the low-income consumer defaults in the second period, the default loss for the retailer is relatively low if the retailer offers consumer financing. Therefore, the increased profit margin from offering consumer financing is higher than the possible consumer default loss; the retailer is better off offering consumer financing and selling to all consumers. However, when the marginal cost is high, the supplier chooses a high wholesale price ($w > w_i$ where $i \in \{1, 2, 3\}$), the consumer default loss is higher so the retailer is prone to not offering consumer financing and will charge a high retail price ($p^* = d$) and sell only to high-income consumers to control the consumer default loss.

We now compare the cases of financially distressed retailer and non-distressed retailer and study the effect of the retailer's financial condition on both the retailer and the supplier. If the supplier sells through a financially distressed retailer ($a > \underline{a}_i$, $i \in \{1, 2, 3\}$) with bankruptcy risk, the supplier decides the wholesale price to maximize its expected profit. In equilibrium, we find that the supplier will lower the price compared to a distribution channel with a non-distressed retailer, i.e., $w_i > \tilde{w}_i$ and $d > \tilde{d}$ when $\underline{a}_i < a < \bar{a}$ ($i \in \{1, 2, 3\}$). Based on the equilibrium results, when $\underline{a}_i < a < \bar{a}$, we find that the supplier will lower the wholesale price regardless of the marginal production cost (we denote the cutoff values of marginal cost as $\tilde{c}_i$) and the retailer will pass through credits but not price to consumers. When the retailer asset shock variance is high $\bar{a} < a < \bar{a}_i$ ($i \in \{1, 2, 3\}$), the supplier will lower the wholesale price only when the marginal cost is low (we denote the cutoff values for marginal cost as $\bar{c}_i$).¹⁴ We formally summarize this risk shifting effect as the following proposition.

Proposition 2 (Risk Shifting Effect I). *If $a \in (\underline{a}_i, \bar{a})$ ($i \in \{1, 2, 3\}$), the supplier will charge a lower wholesale price ($w = \tilde{w}_i < w_i$, $i \in \{1, 2, 3\}$) if the supplier sells through a financially distressed than through a non-distressed retailer.*

Proposition 2 shows how the retailer can take advantage of its bankruptcy risk and consumer financing capability. In Proposition 2, compared to a non-distressed retailer ($a \leq \underline{a}_i$), a retailer with a higher random shock variance ($\underline{a}_i < a < \bar{a}$) may be able to get a lower wholesale price and passes through credits but not the lower price to consumers. The intuition behind Proposition 2 is as follows. For example, when the product

¹⁴See Proof of Proposition 1 in the appendix for specific values.

value is low ($I_L \leq d < \underline{d}$), compared to Lemma 3 where the retailer has a low asset shock variance ($a \leq \underline{a}_1$) and does not have bankruptcy risk, the supplier with a financially distressed retailer ($a > \underline{a}_1$) will suffer a loss from the retailer bankruptcy risk. Specifically, the supplier chooses an optimal wholesale price to balance between higher profit and lower retailer bankruptcy risk. When the marginal production cost is low ($c \leq c_1$) and the asset shock variance is moderate ($\underline{a}_1 < a < \bar{a}_1$), with the increase of wholesale price, the increased profit is less significant compared to the increased retailer bankruptcy risk ($\frac{\partial E[\Pi^M(w)]}{\partial w} < 0$ at $w^* = w_1$). Thus, the supplier will choose a relatively low price ($w^* = \tilde{w}_1 < w_1$) to induce the retailer's credit pass-through and lower the retailer bankruptcy risk. Therefore, the supplier indirectly bears some bankruptcy risks caused by asset volatility, consumer default loss and bankruptcy risk for the financially distressed retailer (i.e., *risk shifting effect*).¹⁵ Moreover, if we compare the distressed retailer with the non-distressed retailer, we find that the credit pass-through decision changes with the retailer's financial conditions, as shown in Proposition 3.

Proposition 3 (Credit Pass-through). *In equilibrium, for $\bar{d} \leq d < \frac{3}{4}(2I_L + (2I_L - k)\delta)$, if $c \in (\hat{c}_3, \bar{c}_3]$, the financially distressed retailer ($\bar{a} < a < \bar{a}_3$) will pass through credits to consumers whereas the non-distressed retailer ($0 < a \leq \underline{a}$) will not.*

One may intuit that retailers who are financially distressed are less willing to offer consumer financing. We find that, counterintuitively, under certain conditions the financially distressed retailer is more willing to offer consumer financing than the non-distressed retailer. The rationale behind Proposition 3 is as follows. When the retailer asset shock variance is moderate ($\bar{a} < a < \bar{a}_3$), the retailer may go bankrupt, in turn hurting the supplier. Therefore, the supplier makes a trade-off between the profit margin and the bankruptcy risk of the retailer. If the product value is high enough ($\bar{d} \leq d < I_H$), the supplier's profit margin is high and the loss from the retailer's bankruptcy increases more when the marginal cost is high ($c > \bar{c}_3$). Moreover, the supplier can lower the wholesale price to reduce the retailer bankruptcy risk when the asset shock variance and the marginal cost are moderate ($\bar{a} < a < \bar{a}_3$ and $\hat{c}_3 < c \leq \bar{c}_3$), which makes the retailer's low-price strategy with consumer financing more appealing for the supplier. Therefore, the supplier reduces the wholesale price, and in turn induces the financially distressed retailer to offer consumer financing, which is absent in the non-distressed retailer case.

However, when the supplier offers trade credits and sets a lower wholesale price for the financially distressed retailer, the financial distressed retailer will only pass through credits but not the price. This is because if the retailer passes through the price and reduces the price to attract low-income consumers, with a high product value, the loss in profit margin is too high. If the retailer passes through the credits to attract low-income consumers, low-income consumers' ability to pay increases, resulting in a higher profit margin. Therefore, the supplier who offers trade credits should be aware that a lower wholesale price may result in credit pass-through but not price pass-through.

¹⁵When the marginal production cost is low ($c \leq c_1$) and the asset shock variance is high ($a \geq \bar{a}_1$), for a low wholesale price $w \leq d$, the supplier's profit increases with the wholesale price ($\frac{\partial E[\Pi^M(w)]}{\partial w} > 0$) so the supplier is less likely to suffer from the retailer's bankruptcy risk compared to the moderate asset shock variance case ($\underline{a}_1 < a < \bar{a}$) and in turn better off not lowering the wholesale price ($w^* = w_1$).

This interesting result in Proposition 3 does not happen when the retailer asset shock variance is too high ($a \geq \bar{a}_3$) or too low ($a < \bar{a}$). When the retailer asset shock variance is too high ($a \geq \bar{a}_3$), the supplier will not lower the wholesale price regardless of the marginal cost because the asset shock variance is high so the supplier is less likely to suffer from the retailer's bankruptcy risk and in turn better off not lowering the wholesale price. Compared to the case without retailer bankruptcy risk, the supplier's profit is lower when the marginal production cost is low. When the asset shock variance is low ($\underline{a}_3 < a < \bar{a}$), the supplier will lower the wholesale price regardless of the marginal cost. Thus, compared to the case without retailer bankruptcy risk, the retailer with a high marginal cost will get a lower price as well and will have less incentive to pass through credits to consumers. When the asset shock variance is moderate ($\bar{a} < a < \bar{a}_3$), the supplier will lower the wholesale price to induce the financially distressed retailer to pass through credits to consumers if the marginal production cost is low ($c \leq \bar{c}_3$), but the supplier will not lower the wholesale price otherwise. Therefore, when the marginal cost is moderate ($\hat{c}_3 < c \leq \bar{c}_3$), a financially distressed retailer has more incentive to offer consumer financing compared to a non-distressed retailer, or a financially distressed retailer has higher credit pass-through compared to a non-distressed retailer. Proposition 3 resolves the puzzle why financially distressed retailers are still willing, if not more, to offer consumer financing: when the marginal production cost is low, the financially distressed retailers may leverage both bankruptcy risk and consumer default risk to induce the supplier to lower the wholesale price.

2.4 The Effect of Consumer Financing Capability

In this section, we first study a special case where the financial distressed or non-distressed retailer does not have the capability of offering consumer financing to further investigate the effect of consumer financing capability. To be consistent with the main model, the supplier still offers trade credits to the retailer, but the retailer does not have the capability to pass through credits. Then we investigate the implications for consumer welfare.

Non-Distressed Retailer without Consumer Financing Capability: If the non-distressed retailer does not have the capability to offer consumer financing, the retailer cannot charge more than consumers' income. Specifically, the retailer maximizes the profit $\pi_R^N = Q(p - w)$ by choosing the optimal retail price, where Q denotes the demand. If the retailer charges a low price $p = I_L$, all consumers can afford the product and $Q = 1$; if the retailer charges a high price $p = d > I_L$, only high-income consumers will buy and $Q = \frac{1}{2}$. Accordingly, the supplier will choose a wholesale price to maximize $\pi_M^N = Q(w - c)$ where c denotes the marginal production cost, expecting the retailer's best response price. Therefore, the supplier chooses $w = 2I_L - d$ when the product marginal cost is low $c \leq \hat{c}_0 = 4I_L - 3d$ and chooses $w = d$ when the product marginal cost is high $c > \hat{c}_0$.

Distressed Retailer without Consumer Financing Capability: If the distressed retailer does not have the capability to offer consumer financing, the retailer goes bankrupt when the retailer's total asset

(consists of operational revenue, operational cost / wholesale price, consumer default loss and asset shock) is negative. Specifically, the retailer may face bankruptcy risk when the retailer asset shock variance is high ($a \geq \underline{a}_0 = \frac{I_L}{3}$ when $c \leq \tilde{c}_0$ or $a \geq \underline{a} = \frac{d}{6}$ when $c > \tilde{c}_0$) and does not have bankruptcy risk otherwise. In a similar vein, when the retailer has the capability to offer consumer financing, the retailer may go bankrupt when the retailer asset shock variance is high ($a \geq \underline{a}_i$ when $c \leq c_i$ or $a \geq \frac{d}{6}$ when $c > c_i, i \in \{1, 2, 3\}$) and does not have bankruptcy risk otherwise. We find that, first, for a relatively high asset shock variance ($a \geq \underline{a}_0, \underline{a}, \underline{a}_i, i \in \{1, 2, 3\}$, respectively), when the supplier sets a high wholesale price, the retailer gains less operational profit and is more likely to go bankrupt. Formally, the probability of the retailer's bankruptcy is $\Phi(-\pi_R) = \int_{-a}^{-\pi_R} f(\alpha) d\alpha = \frac{a - \pi_R(p, G|w)}{2a}$ and $\frac{\partial \pi_R(p, G|w)}{\partial w} < 0$. Second, when the marginal cost is low ($c \leq \tilde{c}_0$), the retailer with consumer financing capability does not have bankruptcy risk when $\underline{a}_0 \leq a < \underline{a}_i$ whereas the retailer without consumer financing capability has. Lastly, if we compare the thresholds of asset shock variance, we find that $\underline{a} < \underline{a}_0 < \underline{a}_1 < \underline{a}_2 < \underline{a}_3$, i.e., the retailer is more likely to go bankrupt if the marginal production cost is high ($c > \tilde{c}_0, c_i, i \in \{1, 2, 3\}$) and the product value is relatively low. This interesting result is consistent with the practice that a lot of bankrupt retailers have unstable cash flow, high debts, high costs but provide low value products to consumers.

2.4.1 The Role of Consumer Financing Capability on Risk Shifting Effect

In Section 3.3, we compare the cases of financially distressed retailer and non-distressed retailer and show the risk shifting effect, i.e., If $a \in (a_i, \bar{a})$ ($i \in \{1, 2, 3\}$), the supplier will charge a lower wholesale price ($w = \tilde{w}_i < w_i, i \in \{1, 2, 3\}$) if the supplier sells through a financially distressed than through a non-distressed retailer (Proposition 2). If we compare the risk shifting effect with and without consumer financing capability, we find the following proposition.

Proposition 4 (Risk Shifting Effect II). *When the marginal cost is low $c \leq \tilde{c}_0$, $\underline{a}_i < a < \bar{a}$ ($i \in \{1, 2, 3\}$) and $4I_L < 3d$, compared to the case with a non-distressed retailer, the supplier will not lower the wholesale price ($w = w_i, i \in \{1, 2, 3\}$) if the financially distressed retailer does not have the capability to offer consumer financing; whereas the supplier will lower the wholesale price ($w = \tilde{w}_i < w_i, i \in \{1, 2, 3\}$) if the financially distressed retailer has the capability to offer consumer financing.*

As for Proposition 4, we notice that the risk shifting effect is more likely to happen if the financially distressed retailer has the capability to offer consumer financing when the marginal production cost is low ($c \leq \tilde{c}_0$). When the retailer has bankruptcy risk but is without consumer financing capability, the supplier needs to choose an optimal wholesale price to balance among the profit margin ($w - c$) and the retailer's bankruptcy probability $\Phi(-\pi_R)$. Regardless of asset shock variance, the optimal wholesale price does not change compared to the case without retailer bankruptcy risk when the marginal production cost is low ($c \leq \tilde{c}_0$). The reason is that when the retailer has bankruptcy risk, the supplier's revenue increases with the wholesale price but the probability of retailer not going bankrupt decreases with the wholesale price. Yet if

the retailer does not have the capability to offer consumer financing, the supplier is less likely to suffer from the retailer's bankruptcy risk and in turn better off not lowering the wholesale price ($w^* = w_i$). However, when the retailer who may go bankrupt has the capability to offer consumer financing, low-income consumers' ability to pay increases so that the retail price and the supplier's profit margin increase accordingly. Thus, it is more profitable for the supplier to lower the retailer's bankruptcy risk. Therefore, when the asset shock variance is moderate ($\underline{a} < a < \bar{a}$), the supplier is more likely to lower the wholesale price if the retailer has the capability to offer consumer financing than without.

Proposition 4 may partially explain why financially distressed retailers are still willing to offer consumer financing, such as JC Penney, Sears, Toys "R" Us, etc. When facing high variance of asset shock and bankruptcy risk, a retailer with the capability to offer consumer financing can expand the market by passing through the credits to consumers on one hand and may get a lower wholesale price and share some of the bankruptcy risk with the supplier on the other. In the next subsection, we study the implications for consumer welfare.

2.4.2 Consumer Welfare Analysis

In this subsection, we analyze the consumer welfare with and without the capability of providing consumer financing in a distribution channel. In the case where the retailer does not have the capability to provide consumer financing, if the marginal cost is low, the retailer chooses to sell to both segments and the consumer surplus is $CS_N^L = d - p^* = d - I_L$; if the marginal cost is high, the retailer chooses to sell only to the high-income consumers and consumer surplus is $CS_N^H = \frac{1}{2}(d - p^*) = \frac{1}{2}(d - d) = 0$.

When the retailer has the capability to offer consumer financing, we study three cases (low product value, moderate product value and high product value) based on the equilibrium results. When the product value is low ($I_L \leq d < \underline{d}$), the retailer sets the price at p_L and offers consumer financing to sell to both segments when the marginal production cost is low ($c \leq c_1$). Low-income consumers will buy, pay interest and repay, gaining a surplus of $d - I_L - (-I_L + p_L)(1 + r) = 0$; high-income consumers will buy directly and gain $d - p_L$. Thus, consumer surplus is $CS_1 = \frac{1}{2}(d - I_L - (-I_L + p_L)(1 + r)) + \frac{1}{2}(d - p_L) = \frac{1}{2}(d - p_L)$. When the product value is moderate ($\underline{d} \leq d < \bar{d}$), the retailer sets the price at p_H and offers consumer financing to sell to both segments when the marginal production cost is low ($c \leq c_2$). Low-income consumers will buy and may default, gaining a surplus of $d - I_L - (-I_L + p_H)(1 + r)$ if they repay or $d - I_L - (I_L - k)\delta$ if they default; high-income consumers will buy directly and gain $d - p_H$. Thus, consumer surplus is $CS_2 = \frac{1}{4}(d - I_L - (I_L - k)\delta) + \frac{1}{4}(d - I_L - (-I_L + p_H)(1 + r)) + \frac{1}{2}(d - p_H) = \frac{1}{2}(d - p_H)$. When the product value is high ($\bar{d} \leq d < I_H$), the retailer sets the price at d and offers consumer financing to sell to both segments when the marginal production cost is low ($c \leq c_3$). Low-income consumers will buy and default, gaining a surplus of $d - I_L - (I_L - k/2)\delta$; high-income consumers will buy directly and gain 0. Thus, consumer surplus is $CS_3 = \frac{1}{2}(d - I_L - (I_L - k/2)\delta)$. When the marginal production cost is high ($c > c_i, i \in \{1, 2, 3\}$) regardless of the product value, the retailer sets the price at d , does not pass through credits to consumers

and sells only to high-income consumers. Thus, consumer surplus is zero. We compare the consumer welfare cases with and without the retailer's capability to offer consumer financing. The result is summarized in the following proposition.

Proposition 5. *If the retailer has the capability to offer consumer financing and $c \leq \hat{c}_0 = 4I_L - 3d$ such that consumers are worse off in the case with retailer-initiated consumer financing than without.*

Surprisingly, we show that if the marginal production cost is low ($c \leq \hat{c}_0$), retailer-initiated consumer financing hurts consumer surplus. Without consumer financing, the ability to pay of a low-income consumer is constrained by the affordability (i.e., his income I_L). Accordingly, the retailer cannot choose a price that goes beyond all consumers' affordability. Thus, the retailer will set $p^* = I_L$ when the marginal production cost is low ($c \leq \hat{c}_0$) and only high-income consumers can get a positive surplus of $\frac{1}{2}(d - I_L)$ in total. However, with consumer financing, low-income consumers are able to pay more than their income, so the retailer can set a higher price ($p^* = p_L, p_H$ or d) for the product which low-income consumers cannot afford without credits. Moreover, consumers' income will be partially confiscated ($\delta(I - k)$ or $I\delta$) if they cannot repay. This confiscation of asset will decrease low-income consumers' surplus in the case with consumer financing. As for high-income consumers, consumer surplus decreases since the retailer can set a higher price ($p^* = p_L, p_H$ or d). Overall, when the product value is low or moderate ($I_L \leq d < \bar{d}$), only high-income consumers get positive consumer surplus but less than that in the case without the retailer's capability to offer consumer financing due to the increased retail price, so consumers are worse off. When the product value is high ($\bar{d} \leq d < I_H$), the retailer chooses a high retail price $p = d$ such that malicious consumer financing appears, and only low-income consumers get positive surplus but still less than that in the case without consumer financing capability, so consumers are worse off.

If the marginal production cost is moderate $\hat{c}_0 < c \leq c_i$ ($i \in \{1, 2, 3\}$), consumer surplus is zero without consumer financing capability but consumers will get positive surplus with consumer financing capability, i.e., consumer financing capability increases consumer surplus. If the marginal production cost is high ($c > c_i$), consumer surplus is zero, the same as in the case where the retailer does not have the capability to offer consumer financing. Therefore, although the retailer-initiated consumer financing offers consumers another option for advance consumption, under some conditions, the consumer welfare is lower than the scenario without consumer financing because the consumer may tend to spend beyond the affordability so that he or she has to default on the debts. This result provides implications for regulation as well. The regulators should caution that encouraging consumer consumption may hurt consumer welfare in the end.

2.5 Conclusion

In this paper, we study the effect of retailer-initiated consumer financing on distribution-financing channels. A retailer can introduce consumer financing to allow consumers to purchase a product that they cannot

afford. We also examine the effect of consumer financing on the retailer's and the supplier's price decisions, profits, consumers' default risk and consumer welfare.

We emphasize several interesting results of this research. First, under some conditions, the supplier will choose a lower wholesale price if he sells through a financially distressed retailer than through a non-distressed retailer (i.e., *risk shifting effect*). Moreover, compared to the case with a non-distressed retailer, a supplier will not lower the wholesale price if the financially distressed retailer does not have the capability to offer consumer financing; whereas a supplier will lower the wholesale price if the financially distressed retailer has the capability to offer consumer financing. This partially explains the puzzle of why financially distressed retailers are more likely to offer consumer financing despite their limited capital. Second, we find when the supplier offers trade credits and sets a lower wholesale price for the financially distressed retailer, the retailer will only pass through credits but not the price when the product value is high. Therefore, the supplier who offers trade credits to the retailer should be aware that a lower wholesale price may result in only credit pass-through but not price pass-through. Third, if the product marginal cost is low, retailer-initiated financing can expand the market and a retailer may offer credits to consumers even knowing consumers cannot pay off in the future (i.e., *malicious consumer financing*). Moreover, consumer welfare may be lower with consumer financing than without consumer financing. When the retailer offers consumer financing, it offers consumers another option for advance consumption. However, when the marginal production cost is low, the consumer welfare is lower than in the scenario without consumer financing because the consumer may tend to over-consume so that he or she has to default on the debts.

Many important questions about retailer-initiated consumer financing remain to be answered. For example, how do retailers make pass-through decisions when low-income high-risk consumers apply for consumer credits? Another question that remains is how the supplier chooses its financing channel. For example, in our paper, we discuss the cases where the financing channel is consistent with the distribution channel. However, in practice, we observe some examples where the supplier sells through his retailer but the supplier himself offers consumer financing to his consumers and bears the default risk. It will be interesting to study further the implications of inconsistency between financing channels and distribution channels. Finally, our study focuses on the monopoly case where the supplier sells directly or indirectly to consumers. However, it may be interesting to evaluate the effect of competition on financing channels.

Chapter 3

Seller-Initiated Consumer Financing and Consumer Sales-Finance Conflicts

*“Sometimes the sales team will see the finance department as the sales prevention team. The finance team will say that the sales staff aren’t selling the products, they are giving them away.”*¹

—Maria Pinelli, Global Vice-chair at Ernst & Young

3.1 Introduction

Seller-initiated consumer financing at point-of-sale is becoming increasingly popular, driven in part by younger consumers according to *The Economist*.² Consumers who might previously have financed purchases with a traditional credit card are now opting to borrow at the checkout from the sellers selling big-ticket consumer goods such as cars, furniture, electronics, or appliances.³ Filene Research Institute estimated the annual size of the point-of-sale consumer financing market at \$391 billion—approximately 3.5% of annual consumer spending—with healthcare, electronics, and home goods as the leading categories.⁴

This type of seller-initiated consumer financing could be beneficial for firms in many aspects. On the one hand, consumer financing may expand the market and/or increase consumer ticket size,⁵ and firms may provide financing to consumers at point-of-sale and use it as *a strategic tool*. According to a survey, 76% of consumers are more likely to make a purchase if a simple and seamless payment plan is offered.⁶ On the other hand, firms offering consumer financing may also benefit from substantial interest revenue. For instance, Ford

¹See Financial Times, <https://www.ft.com/content/a0836130-cb6e-11e1-916f-00144feabdc0>.

²See <https://www.economist.com/finance-and-economics/2018/08/04/tech-startups-are-reviving-point-of-sale-lending>

³See <https://hbr.org/2009/10/how-vulnerable-is-your-business-to-consumer-debt>.

⁴See <https://www.forbes.com/sites/forbestechcouncil/2020/09/11/options-for-retailers-considering-point-of-sale-financing-to-win-and-keep-customers/?sh=1c26723f1260>

⁵See <https://www.lennoxpros.com/news/why-consumer-financing-is-important>.

⁶<https://www.businesswire.com/news/home/20181108005056/en/76-Of-Consumers-Are-More-Likely-to-Make-a-Purchase-If-a-Simple-and-Seamless-Payment-Plan-is-Offered>.

Credit's total financing revenue increased to \$3.02 billion in 2019.⁷ Moreover, as for a firm in a competitive market, "providing retail finance to customers will give your sales a significant shot in the arm and enable you to steal a march on your competitors as a result."⁸

Despite the benefits of providing consumer financing, firms that directly finance their consumers' purchases may be left high and dry when consumers default on seller-initiated financing (Chatterjee et al. 2007, Athreya et al. 2012, Livshits 2015). For example, over 7% of personal loans are in some type of financial hardship program (defined as a deferred payment, forbearance program, frozen account or frozen past due payment) as of June 2021, according to TransUnion.⁹

Due to the high risk of consumer default, the marketing department in a firm needs to coordinate its sales division and the consumer finance division (Shugan, 2004) to make sure that the sales extended on credit are going to credit-worthy customers to reduce bad debt and increase timely payments by customers. Otherwise, with the high consumer default risk, the conflict between the sales division and the finance division may lead to serious problems for firms. Maria Pinelli, Global Vice-chair at Ernst & Young, says, "in 90 per cent of the cases I have dealt with there is an enormous struggle between finance and the sales team. Sometimes the sales team will see the finance department as the sales prevention team. The finance team will say that the sales staff aren't selling the products, they are giving them away."¹⁰ Essentially, in such a situation, the problem facing a firm is that the sales and the finance divisions often have different goals, i.e., *sales-finance conflicts*. In many firms, the sales division focuses on attracting new consumers and increasing sales profit by selling the products or services and relies on the consumer finance division to provide financing to meet consumer demands. Thus, with the primary focus on increasing profits, a sales division may not fully or closely monitor consumer default loss to accomplish its tasks, which can create friction with the consumer finance division. In contrast, the consumer finance division often focuses on earning interest profits while limiting consumer default loss.¹¹ Therefore, although providing financing to consumers can benefit the sales division and the firm as a whole, the consumer finance division must deal with the firm's receivable account and noncollectable debt which may result in cash flow problems for the firm.

Conventional wisdom in real-life experience and previous literature (Pinto et al. 1993, Fisher et al. 1997) suggest the centralized structure where divisions make integrated decisions may avoid such divisional conflicts, yet firms in practice thrive under different structures. For example, while the automaker Ford has been successful under a more centralized structure, former CEO of General Motors Alfred P. Sloan, Jr. believes that the system of financial controls and decentralized organizational structure where finance and sales divisions make decisions independently to achieve their goals are the two most important contributors to the company's achievements. In this case, GM somehow strategically took advantage of these divisional

⁷<https://www.autofinancenews.net/allposts/earnings/ford-credit-increases-cash-distribution/>.

⁸See <https://partner-support.lendingworks.co.uk/hc/en-us/articles/360007116072-How-and-why-retail-finance-will-boost-your-sales>.

⁹See <https://newsroom.transunion.com/performance-in-the-consumer-credit-market-holds-steady-as-number-of-borrowers-in-financial-hardship-status-stabilizes/>.

¹⁰See Financial Times, <https://www.ft.com/content/a0836130-cb6e-11e1-916f-00144feabdc0>.

¹¹See <https://www.levelset.com/blog/credit-department-what-does-a-credit-department-do/>.

conflicts.¹² Moreover, firms' internal structure of the sales and consumer finance divisions may have significant effects on consumers' purchase and financing decisions when firms compete for consumers in the same industry. In the previous example, Ford and GM, must take into consideration both the intrafirm conflicts between the sales and consumer finance divisions and also how the intrafirm conflicts affect their interfirm competition.

In this paper, we raise the following research questions. First, how do a sales division and a consumer finance division conflict/coordinate with each other in a monopoly market and a competitive market? Second, how do sales-finance conflicts affect firms' competition in terms of prices and credit granting rules? Third, why would some firms choose the seemingly dysfunctional decentralized structure with conflicts between the sales and consumer finance divisions? To solve the above questions, we model firms with internal sales-finance conflicts to study how the intrafirm sales-finance conflicts affect the interfirm competition on both pricing and consumer financing. To study the intrafirm conflicts, we design a model where each firm has distinct *sales* and *finance divisions* in charge of selling products and offering consumer financing. With consumer financing, a firm's profit comes from both finance and sales divisions. Specifically, the *sales division* decides the product price to maximize sales profits and relies on the consumer finance division to provide financing to consumers, while the *consumer finance division* decides whether to finance consumers' purchases to maximize financial profits, i.e., the interest revenue net consumer default loss which are affected by the price set by the sales division.

Consistent with the practice, a firm may have a *centralized organizational structure* where the firm makes sales and finance decisions jointly to maximize its profit; or a firm may have a *decentralized organizational structure* where the sales division decides the price and the consumer finance division chooses the credit granting strategy to optimize their objective functions respectively (Balasubramanian and Bhardwaj 2004, Toktay and Wei 2011, Shi et al. 2020). Regardless, these two divisions are interdependent on each other. On the one hand, the price decided by the sales division will affect the finance division's profits. With a higher price set by the sales division, the interest revenue will be higher for the consumer finance division, but consumers are more likely to default on the debt. On the other hand, the credit granting decision by the consumer finance division will affect the sales division's sales. While a loose credit granting rule allows more consumers to afford the product and generates more sales profit for the sales division, a strict credit granting rule hurts the sales profit for the sales division. In addition, the interaction between the two divisions may differ under different market structure. To capture the impact of market structure, we design models for a monopoly market and a duopoly market.

From the analysis of the model, we obtain several interesting results. In a competitive market, a decentralized firm where the sales and consumer finance divisions make price and credit granting decisions separately can actually benefit from the conflicts between the sales and consumer finance divisions and gain more profits than a centralized firm with its sales and consumer finance divisions integrated. The rationale is as follows. In a decentralized firm with sales-finance conflicts, the sales division takes profit margin and demand into account,

¹²See <https://hbr.org/1964/09/the-great-gm-mystery>.

not the total profit including interest revenue and default loss as in a centralized firm (i.e., *sales-finance conflict effect*). Such a conflict may lead to the situation where the sales division is more likely to charge consumers a high price which may cause consumer default, and consequently the consumer finance division may find providing financing too risky and choose not to do so. On the one hand, such a conflict with a high price and no consumer financing may lower the firm's demand especially from consumers who need consumer financing to make a purchase and also hurt the firm's interest revenue. However, on the other hand, a high price and lack of consumer financing ensured by the conflict between the sales and finance divisions in a decentralized firm may give the firm's competitor more incentive to provide financing to capture the budget-constrained consumers, and less incentive to compete on price. Therefore, under certain conditions (e.g., the marginal production cost is relatively high), the decentralized firm with conflicts between its sales and consumer finance divisions may benefit from softened competition on pricing and consumer financing with the competitor. In contrast, a centralized firm where the sales division also takes into consideration the firm's interest revenue and possible consumer default loss, is more likely to charge a low price and to provide consumer financing, which intensifies the competition with the competitor who also relies on low price and consumer financing to attract consumers. Consequently, a firm may benefit from the decentralized structure by strategically invoking the conflict between its sales and consumer finance divisions in a competitive market.

Moreover, we show that the external market structure can drive firms' internal organizational structure change when firms can decide on their organization structures endogenously. In a monopoly market, a firm benefits from avoiding sales-finance conflicts and chooses a centralized structure without sales-finance conflicts. In contrast, in a competitive market, firms may embrace such conflicts by choosing a decentralized structure with conflicts between the sales and finance divisions. As we discussed that a firm may benefit from internal conflicts between its sales and consumer finance divisions, competing firms can all benefit from softened competition on prices and consumer financing when firms choose a decentralized structure by invoking the conflicts between their sales and consumer finance divisions, respectively. Although the sales-finance conflicts can distort competing firms' internal coordination between the sales and consumer finance divisions, the softened interfirm competition on prices and consumer financing can indeed lead to a situation where all competing firms optimally embrace sales-finance conflicts. This result further strengthens the managerial implications that firms may want to strategically create intrafirm conflicts between the sales and consumer finance divisions in the presence of interfirm competition.

This work contributes to the following three streams of literature. First, our research is highly related to organizational conflicts and coordination in marketing. Previous research studies the conflicts between manufacturing and marketing (Balasubramanian and Bhardwaj 2004, Dockner and Fruchter 2014), manufacturing and remanufacturing (Toktay and Wei 2011, Shi et al. 2020), production and promotion (Sogomonian and Tang, 1993), advertising and IT (Tan and Mookerjee, 2005), and sales and marketing (Homburg and Jensen 2007, Perdikaki et al. 2017, Rubel et al. 2019). This paper contributes to the literature by being the first paper to study the unique interdependent and conflicting relationships between the sales and consumer

finance divisions in a firm. We capture the unique conflict between the sales and consumer finance divisions caused by the consumer default behavior and show how a firm can use the sales-finance conflicts as a strategic tool in a competitive market.

Second, this paper contributes to previous literature on consumer finance. There exists a fairly large literature that studies how the accessibility of credits affects spending decisions or how information disclosure affects consumer repayment decisions without the consideration of the competitive consequences of consumer financial decisions (Domowitz and Sartain 1999, Gross and Souleles 2002, Fay et al. 2002, Soman and Cheema 2002, Chatterjee et al. 2008, Wilcox et al. 2011, Navarro-Martinez et al. 2011, Amar et al. 2011). In this paper, we focus on how consumer financial decisions affect consumers' purchase decisions, and in turn firms' pricing, credit granting decisions, and profits. Also, the above literature in consumer finance focuses on the interactions between lenders and borrowers, and by contrast, this paper instead studies the interactions between firms' internal organizational structure of the sales and consumer finance divisions and the market structure.

Third, this paper is also related to marketing literature on price competition (Varian 1980, Narasimhan 1988, Chen et al. 2001a, Chen et al. 2001b, Villas-Boas 2004, Shugan 2005, Kuksov et al. 2017, Kuksov and Zia 2020). Varian (1980) and Narasimhan (1988) pave the path to study the nature of price competition among firms selling to both loyal and switching consumers. Building on Narasimhan (1988), marketing scholars have advanced the research on price competition in various settings such as promotion (Raju et al., 1990), price matching (Chen et al., 2001a), targeting (Chen et al., 2001b), or in-store advertising (Kuksov et al., 2017). In contrast to the previous literature which treats a firm as a unified entity, we instead open the black box of the firm and explicitly model the interdependence and conflicts between the sales and consumer finance divisions. We study how firms can compete both on prices and consumer financing and how firms may strategically create intrafirm conflicts between the firm's sales and consumer finance decisions to deal with interfirm competition.

We present the research in the following sections. In Section 2, we set up the model and summarize our main notation in Table 3.1. In Section 3, we analyze firms with and without sales-finance conflicts in a monopoly market. In Section 4, we extend the model to a duopoly market. In Section 5, we discuss the equilibrium of organizational structure. We summarize the main results and conclude the paper in Section 6.

3.2 Model Setup

In this paper, we model a monopoly firm or two competing firms, each of which has a sales division and a consumer finance division, selling products to consumers with possible financial constraint. To capture consumers' potential financial constraint and financial decisions, we assume that consumers are heterogeneous in their available income, $I_i \in \{I_L, I_H\}$ ($I_L < I_H$) with a market share of $\frac{1}{2}$ for low- and high-income consumers, and consumers receive income in two periods. Alternatively, we can interpret this available income as available

budget or available cash (Einav et al. 2012, Einav et al. 2013). Consumer i knows available income I_i for the first period but the income for the second period $\tilde{I}_i$ is uncertain. This uncertainty is captured by the probability of employment δ . With a probability of δ , she remains employed and gains an income of I_i in the second period; with a probability of $1 - \delta$, she experiences a risk of unemployment and receives zero income in the second period (Domowitz and Sartain 1999, Lopes 2008). We can also interpret the employment shock as other exogenous budget shock that may cause consumers' insolvency.

When buying the product from the firm(s), consumers may need financing to afford the product. This affordability is affected by consumers' available income. To simplify the model and focus on the most interesting results, we assume that high-income consumers' income is sufficiently high (higher than two periods' product value, i.e., $I_H > 2v$) such that high-income consumers do not need financing from the firm, yet low-income consumers' income is sufficiently low such that low-income consumers may need financing from the seller with an interest rate r to afford the purchase (i.e., $I_L < v < \frac{I_L}{1+r} + I_L$).¹³ If a low-income consumer buys the product at price p using consumer financing, she needs to make a down-payment I_L in the first period. After the income is realized in the second period, she decides whether to repay the interest as well as the rest of the debt $(1+r)(p - I_L)$ or default on the debt.¹⁴ If a consumer buys the product and repays the debt, she receives utility of v in each period; if a consumer buys and defaults in the second period, the product will be confiscated, and the consumer only receives value v in the first period (Li and Sarte 2006, Einav et al. 2013). If the consumer defaults and the firm confiscates the product, the confiscated product has a residual value v_s for the firm. In most industries that heavily rely on consumer finance, such as automobile, firms are differentiated in some degree such that some consumers are loyal to one product or brand while others are indifferent.¹⁵ To capture consumers' loyal and switching behavior, in a duopoly market, we consider two competing firms with two segments of consumers: the loyal and switcher segments.¹⁶ Each firm has a loyal segment of α who shops only at that firm and buys if the utility is non-negative. The remaining $1 - 2\alpha$ fraction of consumers are switchers who are indifferent to firms and always purchase from the firm who brings more utility (Narasimhan 1988, Raju et al. 1990, Chen et al. 2001a, Chen et al. 2001b, Kuksov et al. 2017, Kuksov and Zia 2020). Different from previous literature, when a switcher cannot afford the product and only one of the firms offers consumer financing, consumers will buy the product from the firm that offers consumer financing if the consumer utility is non-negative.

Firms have sales and consumer finance divisions in charge of selling products and providing consumer

¹³If $2v > I_H$, high-income consumers may also need consumer financing to make a purchase. If $v < I_L$, low-income consumers will not buy if they know they cannot pay off in the future. If $v > \frac{I_L}{1+r} + I_L$, the product value is too high such that the sales division will not sell to low-income consumers. To capture a more comprehensive and realistic situation, we assume $I_L < v < \frac{I_L}{1+r} + I_L, 2v < I_H$.

¹⁴ $\frac{1}{1+r} < \delta < 1$ such that on expectation offering financing to low-income consumers can be profitable for the finance division in the decentralized firm.

¹⁵According to an Automotive Brand Loyalty Study, Subaru holds the top spot in the mass market with 61.5% of buyers sticking around for another car, followed by Toyota with 59.5% (the resulting value represents the percentage of buyers who bought or leased a new vehicle from an automaker after trading in an existing car). See <https://www.cnet.com/roadshow/news/2019-jd-power-automotive-brand-loyalty-study-subaru-lexus/>.

¹⁶These consumers are similar to the loyal and switcher segments in Narasimhan (1988) or the uninformed and informed ones in Varian (1980).

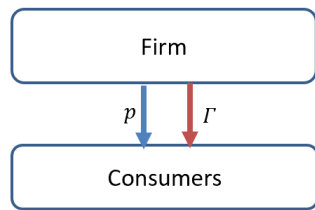
Table 3.1: Main Notation

Symbol	Description
I_i	Income or available budget for type i consumers
$\tilde{I}$	Second period income
$\hat{I}$	Realized second period income
$1 - \delta$	Employment shock or other exogenous budget shock
v	Consumer valuation for the product
r	Interest rate of consumer financing
v_s	Residual value of the confiscated product
α	Size of the loyal segment
p_j	Firm j 's product price, $j \in \{A, B\}$
$\Gamma_j \in \{F, N\}$	Firm j 's credit granting decision: offering F or not offering N
π_{DC}	Decentralized firm's profit in Case DC
π_{CD}	Centralized firm's profit in Case DC
F_j	Firm j 's price distribution
Superscript s	Sales division
Superscript f	Consumer finance division
Δ	Effective interest rate (interest rate discounted by consumer default rate)

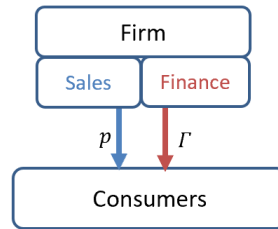
financing, respectively. We allow the sales and consumer finance divisions to have different objectives (similar to Balasubramanian and Bhardwaj 2004, Toktay and Wei 2011, Shi et al. 2020). A centralized firm where the sales and consumer finance divisions are integrated will maximize its sales and financial profits by choosing an optimal price p and a credit granting strategy $\Gamma \in \{N, F\}$ where N denotes not offering consumer financing and F denotes offering consumer financing (see Figure 3.1(a) and 3.1(c)). In contrast, for a decentralized firm where the sales and consumer finance divisions make decisions separately, the sales division chooses an optimal price p to maximize the sales profit and the consumer finance division chooses an optimal credit granting strategy $\Gamma \in \{N, F\}$ to maximize the financial profit (see Figure 3.1(b) and 3.1(d)). We also study the asymmetric case where one firm is a centralized firm without sales-finance conflicts, and the other is a decentralized firm with sales-finance conflicts (see Figure 3.1(e) and 3.1(f)).

As shown in Figure 3.1, we first model a monopoly market as a benchmark (Figure 3.1(a) and 3.1(b)) and extend the model to a duopoly market where two firms $j \in \{A, B\}$ with marginal cost c compete with each other on price p and credit granting decisions $\Gamma \in \{N, F\}$ (Figure 3.1(c) to 3.1(f)). To focus on the interesting interaction between firms and consumers, we assume $c > I_L + v_s$ where v_s is the product residual value of product confiscation following consumer default, such that default consumers cannot cover the marginal cost. We formalize the decision process as a three-stage game. In a monopoly market, at stage 1, a firm without sales-finance conflicts decides the price p and then makes the consumer credit granting decision $\Gamma \in \{N, F\}$. For a firm with sales-finance conflicts, the sales division decides price p and then the consumer finance division

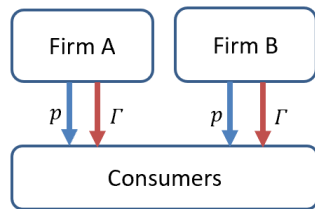
Figure 3.1: Organizational and Market Structures



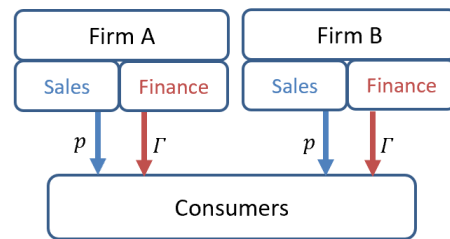
(a) centralized firm (monopoly)



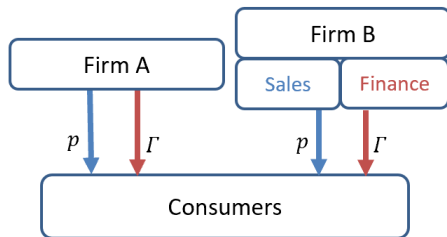
(b) decentralized firm (monopoly)



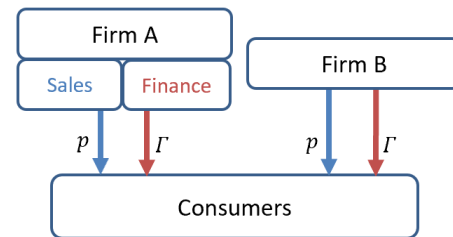
(c) centralized firms (duopoly)



(d) decentralized firms (duopoly)



(e) centralized and decentralized firms (duopoly)



(f) decentralized and centralized firms (duopoly)

makes credit granting decision $\Gamma \in \{N, F\}$. At stage 2, consumers decide whether to make a purchase with or without consumer financing provided by the finance division. At stage 3, consumers decide to repay or default on the debt if they use consumer financing. In a duopoly market, the sequence is similar except that two firms compete with each other and make decisions simultaneously in each stage, i.e., firms will decide on prices simultaneously first and then credit granting rules. This game sequence allows us to capture how firms react to both consumer purchasing and financing behavior, as well as the impact of interfirm and intrafirm conflicts.

3.3 Effects of Sales-Finance Conflicts in a Monopoly Market

We first analyze the case of a monopoly market, and solve the game backward starting with the last stage where consumers make financial decisions.

Consumer financial decision: In a monopoly market, at the last stage, for those consumers who used seller-initiated financing to make a purchase, they decide to repay or default given the price and the realized income shock. With a probability of $1 - \delta$, a consumer experiences a risk of unemployment and gets an income of 0; with a probability of δ , the consumer is still employed and gets an income of I_i (Domowitz and Sartain 1999, Lopes 2008). After the realization of the income shock, if a consumer chooses to repay, she has to pay the remaining loan plus interest $(1 + r)(p - I_i)$; if a consumer chooses to default, the seller will confiscate the product and the consumer repays 0. Note that high-income consumers' income is higher whereas low-income consumers' income is lower than two periods' value received by consumers (i.e., $I_L < v < \frac{I_L}{1+r} + I_L$, $2v < I_H$) so that only low-income consumers may need to use financing to make a purchase.

Therefore, for those who used consumer financing to make a purchase, in the first period, a consumer gains product value and income, and makes a down-payment $(v + I_i - I_i)$. In the second period (at the last stage), if she decides to repay, she gains product value and income, and repays the rest and interest. Her utility of repaying u_{ri} is given by

$$u_{ri} = v + \hat{I} - (1 + r)(p - I_i) \quad (3.1)$$

where $\hat{I}$ denotes the realized income in the second period and the income is higher than the remaining debt ($\hat{I} \geq (1 + r)(p - I_i)$). If she decides to buy with consumer financing and then defaults, she gains the second-period income. Her utility of defaulting u_{di} is given by

$$u_{di} = \hat{I}. \quad (3.2)$$

To sum up, if a consumer has an income shock or does not have enough income to pay off ($\hat{I} < (p - I_i)(1 + r)$), the consumer defaults and gains $v + \hat{I}$ in two periods; if a consumer does not experience an income shock and has enough income to pay off ($\hat{I} \geq (p - I_i)(1 + r)$), the consumer repays if the payoff of repaying is no less than the payoff of defaulting ($u_{ri} \geq u_{di}$, i.e., $v + \hat{I} - (1 + r)(p - I_i) \geq \hat{I}$) and defaults otherwise.

Therefore, consumers will only repay if they have enough income, and the product value is high enough for them. Formally, consumers' financial decision $\Omega \in \{R, D\}$ where R denotes repay and D denotes default is as follows.

$$\Omega(.|p, \Gamma = F, \hat{I}) = \begin{cases} R & \text{if } \min\{v, \hat{I}\} = \hat{I} \geq (p - I_i)(1 + r); \\ D & \text{if } \min\{v, \hat{I}\} = \hat{I} < (p - I_i)(1 + r). \end{cases} \quad (3.3)$$

Note that when $\hat{I} = 0$, low-income consumers cannot afford to repay and always default; when $\hat{I} = I_L$, given a low price $p \leq \frac{I_L}{1+r} + I_L$, low-income consumers repay, otherwise default. When the sales division chooses a higher price, the interest ($r(p - I_L)$) increases, which benefits the finance division. However, when the price further increases ($p > \frac{I_L}{1+r} + I_L$), consumers default, which hurts the finance division.

Consumer purchase decision: At the second stage, expecting the future financial decisions and given the product price p and the credit granting decision $\Gamma \in \{N, F\}$ where N denotes not offering consumer financing and F denotes offering consumer financing, consumers decide whether to purchase the product or not.

- High-income consumers: High-income consumers do not need consumer financing. The expected utility of not buying is $I_H + \delta I_H$; the expected utility of buying without consumer financing is $v + I_H - p + v + \delta I_H$. Therefore, they will buy when the price is relatively low ($p \leq 2v$) and will not buy otherwise.
- Low-income consumers: Without consumer financing ($\Gamma = N$), low-income consumers buy the product only if $p \leq I_L$. Next, we focus on the case with consumer financing ($\Gamma = F$). The expected utility functions of consumer i are as follows. If consumer i does not buy, she gains income for two periods. The expected utility of not buying $E[u_L]$ is given by

$$E[u_L] = I_L + \delta I_L. \quad (3.4)$$

With a low price $p \leq I_L$, low-income consumers can afford the product. The expected utility of buying without consumer financing $E[u_L]$ is given by

$$E[u_L] = v + I_L - p + v + \delta I_L. \quad (3.5)$$

With a moderate price $I_L < p \leq \frac{I_L}{1+r} + I_L$, low-income consumers who can only afford to buy with consumer financing expect to repay without employment shock and default with employment shock based on Equation (3). Therefore, the expected utility of low-income consumers is given by

$$E[u_L] = v + I_L - I_L + \delta(v + I_L - (p - I_L)(1 + r)). \quad (3.6)$$

With a high price $p > \frac{I_L}{1+r} + I_L$, the expected utility of low-income consumers is given by

$$E[u_L] = v + I_L - I_L + \delta I_L. \quad (3.7)$$

If we compare Equations (5)-(7) with Equation (4), with consumer financing, given a low price ($p \leq I_L$), low-income consumers will buy without consumer financing; given a high price, ($I_L < p \leq 2v$), low-income consumers will buy with consumer financing.

In the following subsections, we first derive the equilibrium of a firm with sales-finance conflicts in a monopoly market (Subsection 3.1). Then we derive the equilibrium of a firm without sales-finance conflicts in a monopoly market (Subsection 3.2).

3.3.1 Firm with Sales-Finance Conflicts in a Monopoly Market

For a firm where the sales and consumer finance divisions are independent (similar to Balasubramanian and Bhardwaj 2004, Toktay and Wei 2011, Shi et al. 2020), the sales division chooses the price p and the consumer finance division chooses the credit granting rule Γ . Consistent with the practice, we allow the sales division to maximize the sales profit and the consumer finance division to maximize the financial profit, i.e., the interest revenue net consumer default loss. In the first stage, the sales division decides the price first and then the consumer finance division decides its credit granting rule. We solve the model by backward induction by first solving the consumer finance division's optimal decision on providing consumer financing. Since the marginal production cost is high enough ($c > I_L$), firms will not set a price lower than I_L . Thus, the consumer finance division's payoffs are as follows. Given a low price, $\pi^f(\Gamma|p \leq I_L) = 0$ for any Γ . Given a moderate price, $\pi^f(\Gamma|I_L < p \leq \frac{I_L}{1+r} + I_L) =$

$$\begin{cases} 0 & \text{if } \Gamma = N; \\ \frac{1-\alpha}{2}(\delta(I_L + (1+r)(p - I_L) - p) + (1-\delta)(I_L + v_s - p)) & \text{if } \Gamma = F. \end{cases} \quad (3.8)$$

Given a high price, $\pi^f(\Gamma|\frac{I_L}{1+r} + I_L < p \leq 2v) =$

$$\begin{cases} 0 & \text{if } \Gamma = N; \\ (1-\delta)(I_L + v_s - p) & \text{if } \Gamma = F. \end{cases} \quad (3.9)$$

Here in a monopoly market, to be comparable to the duopoly case, the monopoly firm's demand consists of its loyal consumers (α) and the switcher segment ($1 - 2\alpha$). The consumer finance division decides whether to offer consumer financing by evaluating financial gain and loss given the price set by the sales division. For the low-income consumer segment who need consumer financing, given a low price ($p \leq \frac{I_L}{1+r} + I_L$), the consumer finance division has the financial gain of $\frac{1-\alpha}{2}\delta(I_L + (1+r)(p - I_L) - p)$ if consumers repay and financial loss of $\frac{1-\alpha}{2}(1-\delta)(I_L + v_s - p)$ if consumers default.¹⁷ If we compare the payoffs of offering and not offering

¹⁷Since $p > c > I_L + v_s$, we can show that $I_L + v_s - p < 0$.

consumer financing for the consumer finance division, the credit granting decision is given by $\Gamma^{BR}(\cdot|p) =$

$$\begin{cases} N & \text{if } p \leq \hat{p}, \bar{p} < p \leq 2v; \\ F & \text{if } \hat{p} < p \leq \bar{p}, \end{cases} \quad (3.10)$$

where $\hat{p} = I_L + \frac{v_s(-1+\delta)}{\delta(1+r)-1}$ ($< \bar{p} = \frac{I_L}{1+r} + I_L$). When the price set by the sales division is low ($p \leq \hat{p}$), the financial gain (interest revenue) is lower than the financial loss (default loss) so that the finance division will not offer consumer financing. When the price is moderate ($\hat{p} < p \leq \bar{p}$), financial gain (interest revenue) is higher than the financial loss (default loss), and the finance division will offer consumer financing. When the price is high $\bar{p} < p \leq 2v$, low-income consumers buy and will always default so that the finance division will not offer consumer financing.

As for the sales division, if the sales division charges a moderate price ($\hat{p} < p \leq \bar{p}$), the consumer finance division benefits from offering consumer financing with interest revenue. If the sales division charges a low price $p \leq \hat{p}$ or a high price $\bar{p} < p \leq 2v$, the consumer finance division cannot benefit from offering consumer financing. As we will show later in the equilibrium, the sales division may choose a price which leads to no interest revenue for the consumer finance division (i.e., *sales-finance conflicts*). Expecting the finance division's best response, the sales division's payoff is $\pi^s(p|\Gamma^{BR}) =$

$$\begin{cases} \frac{1-\alpha}{2}(p-c) & \text{if } p \leq \hat{p}, \bar{p} < p \leq 2v, \Gamma = N; \\ (1-\alpha)(p-c) & \text{if } \hat{p} < p \leq \bar{p}, \Gamma = F. \end{cases} \quad (3.11)$$

Here different from the consumer finance division, the sales division cares about sales profit it generates but not consumer default loss nor interest revenue. Therefore, the sales division will choose an optimal price strategically to affect the consumer finance division's decision on whether to offer consumer financing. Maximizing the sales division's profit, we solve the optimal price and consequent credit granting rule (p^*, Γ^*) of the consumer finance division, and report the equilibrium results in the following lemma.

Lemma 1. *In equilibrium, a firm with sales-finance conflicts will choose $(\frac{I_L}{1+r} + I_L, F)$ when the marginal cost is low (i.e., $c \leq \tilde{c}$) with a sales division profit of $\pi^s = (1-\alpha)(I_L + \frac{I_L}{1+r} - c)$, a finance division profit of $\pi^f = (1-\alpha)((I_L + v_s)(1-\delta) + 2I_L\delta - I_L - \frac{I_L}{1+r})$ and the firm profit of $\pi = \frac{1-\alpha}{2}((1-\delta)v_s + (\frac{1}{1+r} + 2 + \delta)I_L - 2c)$. A firm with sales-finance conflicts will choose $(2v, N)$ when the marginal cost is high (i.e., $c > \tilde{c}$) with a sales division profit of $\pi^s = \frac{1-\alpha}{2}(2v - c)$, a finance division profit of $\pi^f = 0$ and firm profit of $\pi = \frac{1-\alpha}{2}(2v - c)$.*

Here $\tilde{c} = 2(I_L + \frac{I_L}{1+r} - v)$ solves $\frac{1-\alpha}{2}(2v - c) = (1-\alpha)(\frac{I_L}{1+r} + I_L - c)$. Lemma 1 shows that with a higher marginal cost, the firm with sales-finance conflicts would choose a high price and not offer consumer financing; with a lower marginal cost, the firm with sales-finance conflicts would choose a low price and offer consumer financing. With a high marginal cost, the sales division would choose a higher price ($\bar{p} < p \leq 2v$) to increase profit margin even though the finance division will not offer consumer financing due to the high consumer

default risk associated with the high price. With a low marginal cost, the sales division would choose a relatively low price ($\hat{p} < p \leq \bar{p}$) to induce consumer financing and attract low-income consumers. In turn, the finance division would generate moderate interest revenue with moderate consumer default loss.

Lemma 1 implies that when $c \leq \tilde{c}$, we have $\frac{d\pi^s}{dr} < 0$ but $\frac{d\pi^f}{dr} > 0$ such that as the interest rate r increases, the sales division's profit decreases but the finance division's profit increases. Therefore, the conflict between the sales division and the finance division intensifies with interest rate r . This is because as r increases, consumers have to pay more interest when they obtain consumer financing, which makes it more likely for consumers to default, increases the financial risks for the finance division, and reduces the finance division's incentive to provide consumer financing. To counter this effect, the sales division has to lower its price to reduce the possibility for consumers to default on debt, and incentivize the finance division to provide consumer financing. Consequently, the sales division's profit decreases with the interest rate. In contrast, the finance division can benefit from the higher interest revenue from consumer financing, and the finance division's profit increases with r .

As interest rate r further increases such that $\tilde{c} = 2(I_L + \frac{I_L}{1+r} - v) < c$, the sales division finds that continuing to lower the price as r increases is no longer as profitable as charging a higher price to serve only high-income consumers and forgoing the opportunity to induce the consumer finance division to provide financing to low-income consumers. Consequently, as the interest rate r increases from $r < \frac{4I_L - 2v - c}{c - 2I_L + 2v}$ to $r > \frac{4I_L - 2v - c}{c - 2I_L + 2v}$, the increase of the interest rate will hurt the consumer finance division.

3.3.2 Firm without Sales-Finance Conflicts in a Monopoly Market

For a firm which has complete control over the sales and consumer finance divisions, each division makes the price and credit granting decisions, respectively, to maximize the profit including the sales and financial profits. In the first stage, the firm decides the price first and then its credit granting rule. The demand consists of its loyal consumers (α) and the switcher segment ($1 - 2\alpha$) if consumers can afford it in a monopoly market. If the firm chooses not to offer consumer financing, low-income consumers cannot afford the product so only high-income consumers or half of the consumers $\frac{1-\alpha}{2}$ will buy and generate a profit of $\frac{1-\alpha}{2}(p - c)$; if the firm chooses to offer consumer financing, all consumers can afford the product but low-income consumers may buy and default. With a probability of $1 - \delta$, low-income consumers default due to the risk of unemployment and firms will get first period down-payment I_L and residual value v_s , generating a profit of $\frac{1-\alpha}{2}(1 - \delta)(I_L + v_s - c)$; with a probability of δ , low-income consumers repay and firms will get first period down-payment I_L and the rest of the debt plus interest $(1 + r)(p - I_L)$, generating a profit of $\frac{1-\alpha}{2}\delta(I_L + (1 + r)(p - I_L) - c)$. High-income consumers behave similarly as in the case without consumer financing. Therefore, the firm's profit is as follows.

$\pi(\Gamma|p \leq I_L) = (1 - \alpha)(p - c)$ for any Γ .

$$\pi(\Gamma|I_L < p \leq \bar{p}) = \begin{cases} \frac{1-\alpha}{2}(p - c) & \text{if } \Gamma = N; \\ \frac{1-\alpha}{2}\delta(I_L + (1+r)(p - I_L) - c) + \frac{1-\alpha}{2}(1 - \delta)(I_L + v_s - c) + \frac{1-\alpha}{2}(p - c) & \text{if } \Gamma = F. \end{cases} \quad (3.12)$$

$$\pi(\Gamma|\bar{p} < p \leq 2v) = \begin{cases} \frac{1-\alpha}{2}(p - c) & \text{if } \Gamma = N; \\ \frac{1-\alpha}{2}(1 - \delta)(I_L + v_s - c) + \frac{1-\alpha}{2}(p - c) & \text{if } \Gamma = F. \end{cases} \quad (3.13)$$

We solve for the optimal price and credit granting rule (p^*, Γ^*) and summarize the equilibrium results in the following lemma.

Lemma 2. *In equilibrium, a firm without sales-finance conflicts will choose $(\frac{I_L}{1+r} + I_L, F)$ with a profit of $\pi = \frac{1-\alpha}{2}((1 - \delta)v_s + (\frac{1}{1+r} + 2 + \delta)I_L - 2c)$ when the marginal cost is low (i.e., $c \leq \hat{c}$) and choose $(2v, N)$ with a profit of $\pi = \frac{1-\alpha}{2}(2v - c)$ when the marginal cost is high (i.e., $c > \hat{c}$).*

Here $\hat{c} = (1 - \delta)v_s + (\frac{1}{1+r} + 2 + \delta)I_L - 2v$ solves $\frac{1-\alpha}{2}(2v - c) = \frac{1-\alpha}{2}\delta(2I_L - c) + \frac{1-\alpha}{2}(1 - \delta)(I_L + v_s - c) + \frac{1-\alpha}{2}(\frac{I_L}{1+r} + I_L - c)$. For the finance division in a firm without sales-finance conflicts, given a low price ($I_L < p \leq \hat{p}_C$, see Appendix B for details) by the sales division, the total gain (both financial and sales gains) is less than the total loss (both financial and sales losses) so that the finance division will not offer consumer financing. When the firm charges a moderate price ($\hat{p}_C < p \leq \bar{p}$), the total gain is higher than the total loss so that the firm can benefit from offering consumer financing. When the firm charges a high price ($\bar{p} < p \leq 2v$), low-income consumers will always default so the firm will not offer consumer financing. Accordingly, the sales division in a firm without sales-finance conflicts can coordinate its price with the consumer finance division's decision on offering financing. The firm can choose a relatively high price ($p = 2v$) and not to offer consumer financing if the marginal cost is high ($c > \hat{c}$), or a relatively low price ($p = \bar{p}$) and offer consumer financing if the marginal cost is low ($c \leq \hat{c}$). Lemma 2 further implies that $\frac{d\pi}{dr} < 0$ when $c < \hat{c}$. This is because as the interest rate r increases, the firm has to lower its price to reduce the possible default of consumers. As r increases such that $\hat{c} = (1 - \delta)v_s + (\frac{1}{1+r} + 2 + \delta)I_L - 2v < c$ (i.e., $r > \frac{v_s - v_s\delta + I_L(3+\delta) - c - 2v}{c + 2v - v_s(1-\delta) - I_L(2+\delta)}$), similar to Lemma 1, the firm will forgo the low-income consumers and instead charge a higher price $p = 2v$ and sell only to high-income consumers without providing consumer financing.

Table 3.2: Equilibrium Results in Centralized and Decentralized Firms

Costs	Centralized	Decentralized
$I_L < c \leq \tilde{c}$	$\{\bar{p}, F, \frac{1-\alpha}{2}((1 - \delta)v_s + (\frac{1}{1+r} + 2 + \delta)I_L - 2c)\}$	$\{\bar{p}, F, \frac{1-\alpha}{2}((1 - \delta)v_s + (\frac{1}{1+r} + 2 + \delta)I_L - 2c)\}$
$\tilde{c} < c \leq \hat{c}$	$\{\bar{p}, F, \frac{1-\alpha}{2}((1 - \delta)v_s + (\frac{1}{1+r} + 2 + \delta)I_L - 2c)\}$	$\{2v, N, \frac{1-\alpha}{2}(2v - c)\}$
$\hat{c} < c < I_L + \frac{I_L}{1+r}$	$\{2v, N, \frac{1-\alpha}{2}(2v - c)\}$	$\{2v, N, \frac{1-\alpha}{2}(2v - c)\}$

The equilibrium results $\{p^*, \Gamma^*, \pi^*\}$ in a monopoly market are summarized in Table 3.2. If we compare the

equilibrium results of firms with and without sales-finance conflicts, the firm without sales-finance conflicts takes financial profits into account, i.e., interest revenue and default loss, whereas the sales division of the firm with such conflicts does not. Essentially, if we compare the expected interest revenue $\delta(p - I_L)r$ and expected default loss $(1 - \delta)(p - I_L - v_s)$, this neglect of financial profits (i.e., *sales-finance conflict effect*) can result in under-provision of consumer financing since the interest revenue is higher than the default loss ($\delta(p - I_L)r > (1 - \delta)(p - I_L - v_s)$). We summarize this result in Proposition 1.

Proposition 1 (Effects of Sales-Finance Conflicts). *In a monopoly market, when $\tilde{c} < c \leq \hat{c}$, a firm without sales-finance conflicts will choose a low price $p^* = \bar{p}$ and offer consumer financing whereas a firm with sales-finance conflicts will choose a high price $p^* = 2v$ and not to offer. The size of the parameter space of $(\tilde{c}, \hat{c})$ increases as interest rate r increases ($\frac{d(\hat{c}-\tilde{c})}{dr} > 0$) or as δ increases ($\frac{d(\hat{c}-\tilde{c})}{d\delta} > 0$).*

Proposition 1 shows how sales-finance conflicts affect consumer financing and price decisions. Specifically, in a monopoly market, a firm without sales-finance conflicts is more likely to offer consumer financing than a firm with sales-finance conflicts when the marginal product cost is moderate ($\tilde{c} < c \leq \hat{c}$). According to Lemma 2, if the marginal cost is moderate ($\tilde{c} < c \leq \hat{c}$), the firm without sales-finance conflicts chooses a relatively low price ($p = \bar{p}$) and offers consumer financing to consumers. In this case, the firm coordinates its sales and consumer finance divisions by forgoing some sales profit in order to increase financial gain through interest revenue. Nevertheless, when the sales division in a *decentralized firm* chooses a price, due to the *sales-finance conflict*, it only takes profit margin and demand into account, not the financial profits including interest revenue and default loss as in a centralized firm (i.e., *sales-finance conflict effect*). Consequently, according to Lemma 1, the sales division in a decentralized firm with sales-finance conflicts will choose a relatively high price $p^* = 2v$ regardless of financial profits to maximize the sales profit, which results in under-provision of consumer financing compared to a centralized firm without sales-finance conflicts.

Proposition 1 also shows that the parameter space of the *sales-finance conflict* increases with interest rate r . As shown in Lemma 1, a higher interest rate r will increase the consumers' likelihood of default and reduce the consumer finance division's incentive to provide consumer financing. Consequently, the sales division in a firm with sales-finance conflicts has to further lower its price to reduce the consumers' default tendency and incentivize the finance division to provide consumer financing. Such a move by the sales division, however, is costly to the sales division since the sales division has to lower its margin from selling to consumers. Therefore, as interest rate r increases, the sales division in the firm with sales-finance conflicts is more likely to forgo the low-income consumers who need consumer financing from the finance division, and instead charge a higher price to focus only on high-income consumers. Therefore, as interest rate r increases, the parameter gap on providing consumer financing in a centralized firm and a decentralized firm increases ($\frac{d(\hat{c}-\tilde{c})}{dr} > 0$), resulting in intensified conflicts between the sales and finance divisions.

In addition, Proposition 1 shows that as the employment rate δ decreases or the unemployment rate $1 - \delta$ increases, the parameter gap on providing consumer financing in a centralized firm and a decentralized firm decreases ($\frac{d(\hat{c}-\tilde{c})}{d\delta} = I_L - v_s > 0$). This is because as employment shock increases, consumers are more likely

to default, resulting in higher risks for the consumer finance division if the finance division offers consumer financing. Therefore, even a centralized firm without sales-finance conflicts may have to forgo low-income consumers who need financing and focus on high-income consumers as a decentralized firm. Consequently, the conflict between the sales and consumer finance divisions is likely to decrease, and the equilibrium results on price and consumer financing for firms with and without conflicts are less likely to be different.

Proposition 1 has important implications on firms' decisions on managing their price and consumer financing, especially when market conditions change. Specifically, with the decrease of employment rate during depression such as the COVID-19 pandemic, firms may want to offer less consumer financing and sell to high-income consumers to decrease consumer default loss.

3.4 Sales-Finance Conflicts in a Duopoly Market

In the last section, we study a monopoly market as a benchmark and now we extend the benchmark to a duopoly market and further study how firms with and without sales-finance conflicts decide on both prices and credit granting rules. In a duopoly market, we consider two competing firms with two segments of consumers: the loyal and switcher segments (Narasimhan 1988, Kuksov et al. 2017, Kuksov and Zia 2020). Different from previous literature, when a switcher cannot afford the product and only one of the firms offers consumer financing, consumers will buy the product from the firm that offers consumer financing if the utility is non-negative. In a duopoly market, the sequence is similar except that two firms compete with each other and make decisions simultaneously, i.e., firms will decide on prices simultaneously first p_j, p_{-j} and then credit granting rules Γ_j, Γ_{-j} . Given the prices and credit granting rules, consumers decide whether to buy or not, then whether to repay or not.

We solve the model by backward induction. At the last stage, consumers follow the same financial decisions as in the monopoly market. At the second stage, for low-income consumers when firms do not offer consumer financing, switchers' buying decision is purely based on the prices charged by the competing firms. Switchers will buy from firm j if $p_j < \min\{p_{-j}, I_L\}$ and firm j 's loyal consumers buy if $p_j \leq I_L$. For low-income consumers when both firms offer consumer financing, switchers' decisions again will be based on the prices, and they will buy from firm j if $p_j < \min\{p_{-j}, 2v\}$ and firm j 's loyal consumers buy if $p_j \leq 2v$. For low-income consumers, when firm j offers consumer financing but firm $-j$ does not offer, switchers will buy from firm j if $p_j < \min\{p_{-j}, 2v\}$ and buy from firm $-j$ if $p_{-j} < \min\{p_j, I_L\}$. Firm j 's loyal consumers buy if $p_j \leq 2v$ and firm $-j$'s loyal consumers buy if $p_{-j} \leq I_L$. For high-income consumers, regardless of the credit granting decision, switchers will buy from firm j if $p_j < \min\{p_{-j}, 2v\}$ and firm j 's loyal consumers buy if $p_j \leq 2v$.

In a duopoly market, firms not only compete on prices but also compete on financing decisions. The conflicts of firms' pricing and financing decisions could lead to lower market share or lower profit margin, especially in a duopoly market. First of all, lack of consumer financing could hurt sales: if the sales division chooses a more competitive price, and the finance division chooses not to offer consumer financing, low-income

consumers (both loyal and switch segments) cannot afford the product. Second, a low price may prevent consumer financing: if the sales division chooses a competitive low price, the finance division loses the opportunity to make a profit from consumer financing. Third, a high price could also hurt the finance division if the sales division chooses a high price, and low-income consumers default such that the finance division suffers from consumer default loss. We are going to show the impact of sales-finance conflicts in the following subsections. In Subsection 4.1 to 4.3, we derive equilibrium for two competing decentralized firms (Case DD), one centralized firm and one decentralized firm (Case DC) and two centralized firms (Case CC). In Subsection 4.4, we show the effect of sales-finance conflicts.

3.4.1 Equilibrium for Firms with Sales-Finance Conflicts in a Duopoly Market (DD)

We first study the case of two symmetric decentralized firms with sales-finance conflicts competing with each other in a duopoly market. In the first stage, both firms' sales divisions will decide on their prices simultaneously. Given the prices of two competing firms, the consumer finance divisions of two firms decide simultaneously whether to offer consumer financing or not. Without loss of generality, we suppose one firm's price is lower than the other ($p_j < p_{-j}$). To find the subgame Nash equilibrium, given the prices, we analyze three subgames where consumer financing is offered by neither (NN), one (FN or NF) or both firms (FF). We compare profits in these subgames to see the incentive to offer consumer financing and yield the best responses of consumer finance divisions for firms with sales-finance conflicts given the prices set by the sales divisions of the firms.

If the prices are low ($p_j < p_{-j} < \hat{p}$)¹⁸, similar to the case in a monopoly market, the consumer finance divisions may find the interest revenue is not high enough to offset possible consumer default loss so neither offers consumer financing. If firm j chooses a low price and firm $-j$ chooses a moderate price ($p_j < \hat{p} < p_{-j} < \bar{p}$), only firm $-j$ offers consumer financing. If the prices are moderate ($\hat{p} < p_j \leq p_{-j} < \bar{p}$), low-income consumers may repay and the interest revenue is high enough to offset possible consumer default loss so that both firms offer consumer financing. If firm j chooses a moderate price and firm $-j$ chooses a high price ($\hat{p} < p_j < \bar{p} < p_{-j}$), only firm j offers consumer financing. In this case, low-income consumers can buy only from firm j and all switchers will buy from firm j . The best responses of financial divisions are summarized as follows (see Appendix B for detailed proof).

Lemma 3. *For firms with sales-finance conflicts, firm j offers consumer financing if $\hat{p} < p_j < \bar{p}$ where $j \in \{A, B\}$; otherwise, firm j does not offer consumer financing.*

Expecting the decisions of consumer finance divisions, the sales divisions in decentralized firms with sales-finance conflicts will choose prices to maximize sales profits rather than total net profits. In this case, there is no pure strategy equilibrium. Both firms' sales divisions use mixed price strategies, drawing their

¹⁸Here $\hat{p}$ solves $\pi_j^f(FN|p_j < p_{-j}) = \pi_j^f(NN|p_j < p_{-j})$. See Appendix B for more details.

prices from the price distribution $F_j^s(p_j)$ and $F_{-j}^s(p_{-j})$. Furthermore, there may be mass points and empty intervals in the interior range of the price distributions due to consumer financial decisions and organizational structure. For example, when the marginal cost is high, the firm without sales-finance conflicts may choose a high price above low-income consumers' maximum ability to pay so the financial division will not offer consumer financing. Therefore, similar to Gangwar et al. (2014), Kuksov et al. (2017), Kuksov and Zia (2020), there might be a hole in the price distribution above consumers' maximum ability to pay ($\bar{p}$) such that the sales division of the firm without sales-finance conflicts will not choose since the price needs to be high enough to offset the lost profit from low-income consumers.

In equilibrium, when the marginal cost is *low* ($I_L < c \leq \tilde{c}$), both firms' sales divisions will choose a price on the support of $p_A, p_B \in [p_D, \bar{p}]$ (See Appendix A for more details). However, the firm's profit includes both sales and financial profits. Therefore, both firms obtain expected profit of $E[\pi_D] = \int_{p_D}^{\bar{p}} \pi_F f^s(p) dp$ where $\pi_F(p_j) = (\frac{1-\alpha}{2}(1 - F_{-j}(p_j)) + \frac{\alpha}{2}F_{-j}(p_j))(\delta(I_L + (1+r)(p_j - I_L) - c) + (1 - \delta)(I_L + v_s - c) + p_j - c)$. When the marginal cost is *high* ($\tilde{c} < c < I_L + \frac{I_L}{1+r}$), both firms will choose a price on the support of $p_A, p_B \in [\underline{p}, \bar{p}] \cup [\underline{p}_1, 2v]$ (See Appendix A for more details). For both firms, if a firm's sales division chooses a low price on $[\underline{p}, \bar{p}]$, the financial division will offer consumer financing, otherwise the financial division will not. Both firms obtain an expected profit of $E[\pi_D] = \int_{\underline{p}}^{\bar{p}} \pi_F f^s(p) dp + \int_{\underline{p}_1}^{2v} \pi_N f^s(p) dp$ where $\pi_N(p_j) = (\frac{1-\alpha}{2}(1 - F_{-j}(p_j)) + \frac{\alpha}{2}F_{-j}(p_j))(p_j - c)$.

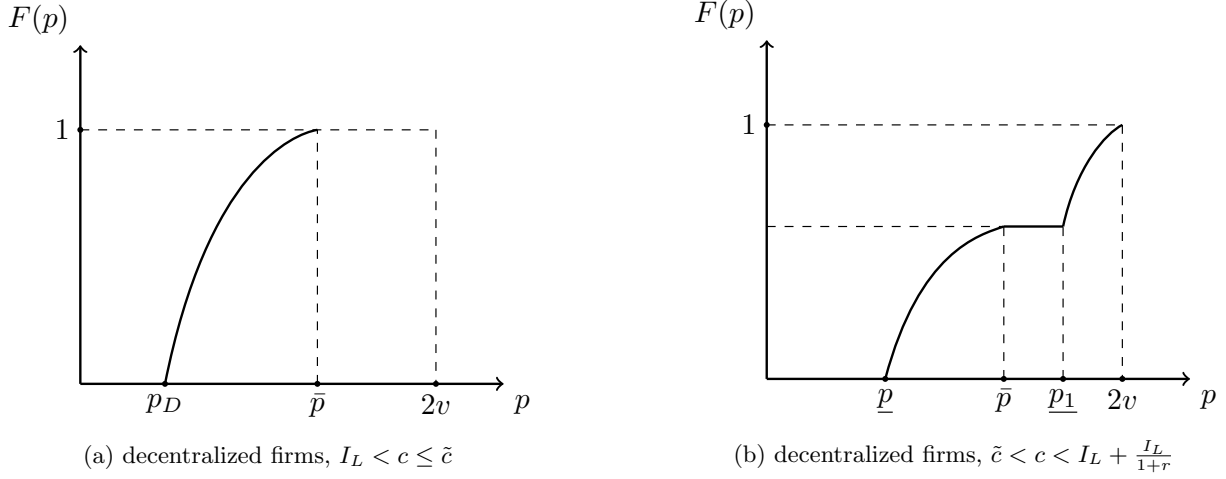
Recall that the sales division in a decentralized firm with sales-finance conflicts ignores the financial profit. In a duopoly market, with a low marginal cost ($I_L < c \leq \tilde{c}$), gaining market share is more profitable than increasing profit margin for the sales division. Therefore, the sales division randomizes on a low price range $[p_D, \bar{p}]$ and the consumer finance division offers consumer financing to compete for switchers. With a high marginal cost ($\tilde{c} < c < I_L + \frac{I_L}{1+r}$), increasing profit margin is more profitable than increasing market share for the sales division. Therefore, the sales division randomizes on a relatively high price range $[\underline{p}, \bar{p}] \cup [\underline{p}_1, 2v]$ such that the finance division offers consumer financing when the price is low ($p \in [\underline{p}, \bar{p}]$) and does not offer consumer financing when the price is high ($p \in [\underline{p}_1, 2v]$).¹⁹ Moreover, if we compare the case of duopoly decentralized firms with the decentralized monopoly case where the sales division chooses a high price $p = 2v$ and does not offer consumer financing, the sales division in a duopoly market randomizes on a relatively low price range $[\underline{p}, \bar{p}] \cup [\underline{p}_1, 2v]$, and induces consumer financing with some probability.

3.4.2 Equilibrium for Asymmetric Firms in a Duopoly Market (DC)

Next, rather than two symmetric firms with sales-finance conflicts, in this subsection we study the equilibrium for asymmetric firms competing with each other. Specifically, a centralized firm j without sales-finance conflicts competes with a decentralized firm $-j$ with sales-finance conflicts. Similar to the case of two symmetric firms with sales-finance conflicts, the finance divisions will decide on whether to provide consumer

¹⁹Similar to Gangwar et al. (2014), Kuksov et al. (2017), Kuksov and Zia (2020), we find mass points and empty space in the middle of price distributions. But different from previous literature, this empty space is due to firms' credit granting decisions in a competitive market.

Figure 3.2: Price Distributions in Case DD



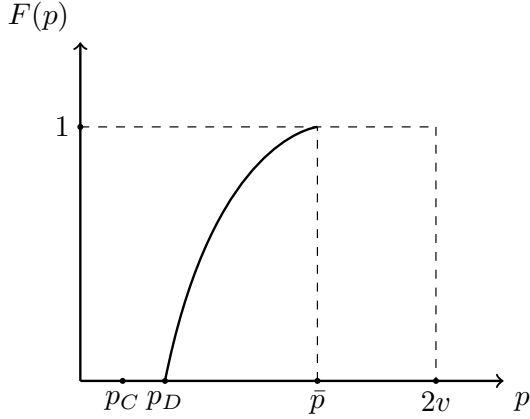
financing, given the prices decided by the sales divisions of both firms. Note that for firm j without sales-finance conflicts, both the sales division and the consumer finance division will maximize the firm's total profit with sales profit, finance revenue of interest, and possible consumer default loss. In contrast, the sales division and the consumer finance division of firm $-j$ with sales-finance conflicts still maximize the sales profit and financial profit, respectively. We have saved all the technical derivations for the appendices and the best responses of firms' financial divisions are summarized as the following lemma.

Lemma 4. *When firm j without sales-finance conflicts competes with firm $-j$ with sales-finance conflicts: For firm j , if $\hat{p}_C < p_j < \bar{p}$, firm j offers consumer financing; otherwise, firm j does not offer. For firm $-j$, if $\hat{p} < p_{-j} < \bar{p}$, firm $-j$ offers consumer financing; otherwise, firm $-j$ does not offer.*

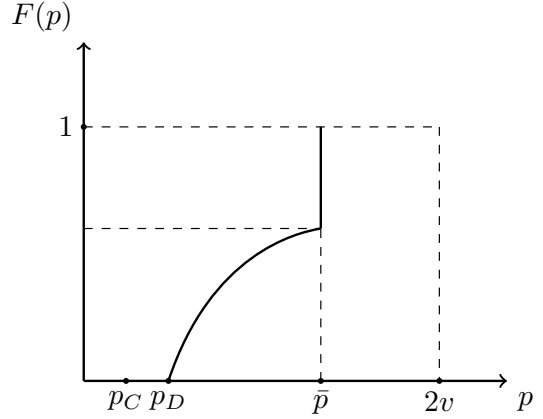
Expecting the decisions of consumer finance divisions, the sales divisions will choose optimal prices. A firm without sales-finance conflicts differs from a firm with sales-finance conflicts in that the sales division in a firm without sales-finance conflicts maximizes the total profit including the sales profit, interest revenue and possible consumer default loss whereas the sales division in a firm with sales-finance conflicts maximizes only the sales profit. Similar to the case of two symmetric firms with sales-finance conflicts, both firms in the asymmetric case use mixed price strategies, drawing their prices from the price distribution $F_j(p_j)$ and $F_{-j}^s(p_{-j})$. Since the game is asymmetric, the price distributions $F_j(p)$ could be asymmetric. Now we discuss the following cases.

Case 1: low marginal cost $I_L < c \leq \tilde{c}$. Both firms will choose a price on $[p_D, \bar{p}]$ and provide consumer financing (see Figure 3.3(a) and (b)). Although the sales division of firm j without sales-finance conflicts can further decrease the price below p_D , it will not because the sales division of firm $-j$ with sales-finance conflicts will not choose a price lower than p_D . Therefore, the sales division of centralized firm j is indifferent at $p_D, \bar{p}$: $\pi_j(p_D) = \pi_j(\bar{p})$; the sales division of decentralized firm $-j$ is indifferent at $p_D, \bar{p}$: $\pi_{-j}(p_D) = \pi_{-j}(\bar{p})$. If we solve the equations, we can get p_D, F_{-j}, F_j with a mass point $F_{-j}(\bar{p})$ (see Appendix A for more

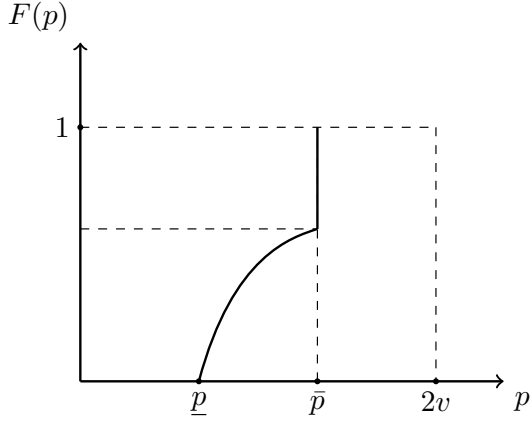
Figure 3.3: Price Distributions in Case DC



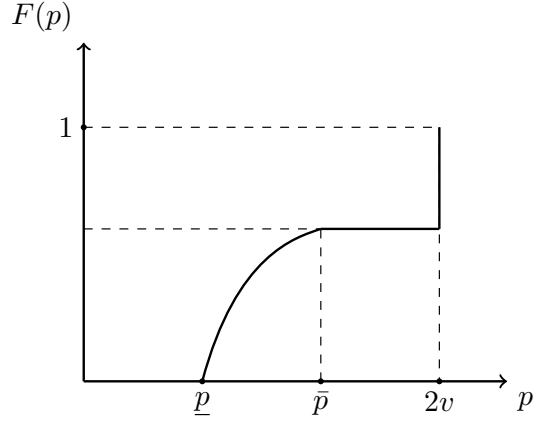
(a) centralized firms, $I_L < c \leq \tilde{c}$



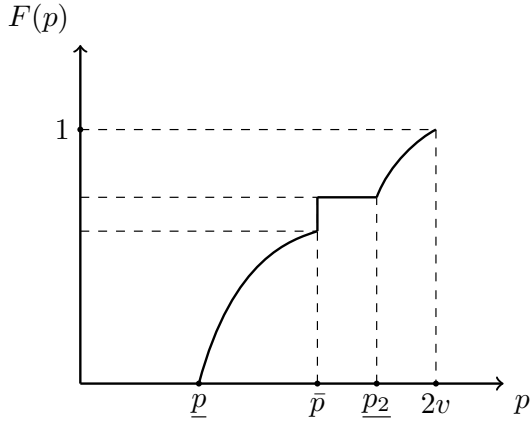
(b) decentralized firms, $I_L < c \leq \tilde{c}$



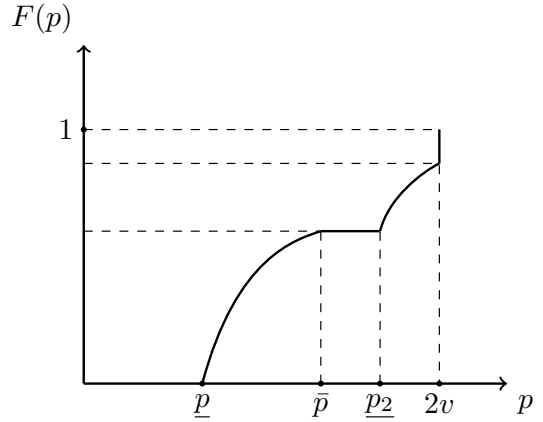
(c) centralized firms, $\tilde{c} < c \leq \hat{c}$



(d) decentralized firms, $\tilde{c} < c \leq \hat{c}$



(e) centralized firms, $\hat{c} < c < I_L + \frac{I_L}{1+r}$



(f) decentralized firms, $\hat{c} < c < I_L + \frac{I_L}{1+r}$

details). The expected profits for firms are $\pi_j = \frac{\alpha}{2}(\bar{p} - c + (1 - \delta)(I_L + v_s) + \delta(I_L + (1 + r)(\bar{p} - I_L)) - c)$ and $\pi_{-j} = \int_{p_D}^{\bar{p}} \pi_F(p_{-j})f_{-j}(p_{-j})dp$ respectively.

Case 2: moderate marginal cost $\tilde{c} < c \leq \hat{c}$. The centralized firm without sales-finance conflicts chooses a price on $[p_D, \bar{p}]$ and offers consumer financing since it takes financial profits into account and is more likely to

offer consumer financing than a decentralized firm with sales-finance conflicts which ignores financial profits (see Figure 3.3(c) and (d)). Yet the marginal cost is not low enough to induce firm $-j$ with sales-finance conflicts to always offer consumer financing. Therefore, the sales division of the firm with sales-finance conflicts chooses a price on $[\underline{p}, \bar{p}] \cup \{2v\}$, and the firm without sales-finance conflicts will choose a price from $(\underline{p}, \bar{p})$. Firm j is indifferent at $\underline{p}, \bar{p}$: $\pi_j(\underline{p}) = \pi_j(\bar{p})$; firm $-j$ is indifferent at $\underline{p}, \bar{p}, 2v$: $\pi_{-j}(\underline{p}) = \pi_{-j}(\bar{p}) = \pi_{-j}(2v)$. If we solve the equations, we can get $\underline{p}, F_j, F_{-j}$ with mass points $F_j(\bar{p}), F_{-j}(2v)$. The expected profits for firms are $\pi_j = \frac{\alpha}{2}(\bar{p} - c + (1 - \delta)(I_L + v_s) + \delta(I_L + (1 + r)(\bar{p} - I_L)) - c)$ and $\pi_{-j} = \int_{\underline{p}}^{\bar{p}} \pi_F f^s(p) dp + F_{-j}(2v) \frac{\alpha}{2}(2v - c)$ respectively.

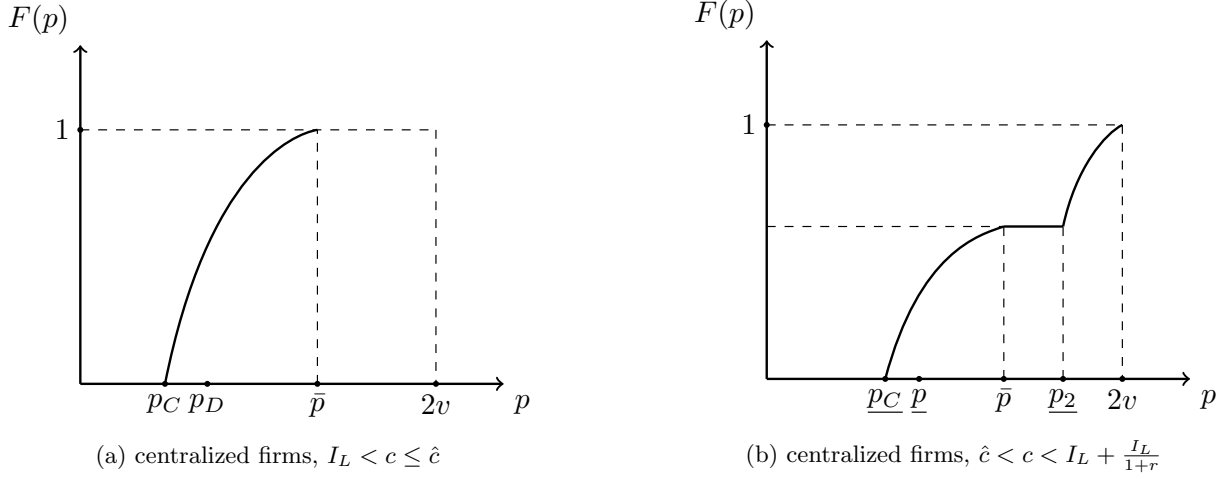
Case 3: high marginal cost $\hat{c} < c < I_L + \frac{I_L}{1+r}$. In this case, the cost is so high that the sales divisions may choose a high price regardless of sales-finance conflicts (see Figure 3.3(e) and (f)). The decentralized firm's sales division ignores the financial gain and will have less incentive to charge a price as low as a centralized firm to induce the consumer finance division to provide consumer financing. Although the sales division of the firm without sales-finance conflicts can further decrease the price below $\underline{p}$ (or $\underline{p}_2$), it will not because the sales division of the firm with sales-finance conflicts will not choose a price lower than $\underline{p}$ (or $\underline{p}_2$). Therefore, both firms' sales divisions choose a price on $[\underline{p}, \bar{p}] \cup [\underline{p}_2, 2v]$. Yet the centralized firm without sales-finance conflicts has a mass at $\bar{p}$ whereas the decentralized firm with such conflicts has a mass at $2v$ such that the decentralized firm is more likely to choose a higher price and not to offer consumer financing than a centralized one. For either firm's sales division, it is indifferent at $\underline{p}, \bar{p}, \pi_j(\underline{p}_2), \pi_j(2v)$: $\pi_j(\underline{p}) = \pi_j(\bar{p}) = \pi_j(\underline{p}_2) = \pi_j(2v)$. If we solve the equations, we can get $\underline{p}, \underline{p}_2, F_{-j}, F_j$ with mass points $F_{-j}(\bar{p}), F_j(2v)$. Note that the distribution function F_j has a mass point at $\bar{p}$ and $\underline{p}_1 < \underline{p}_2$ (see Appendix A for more details). The expected profits for firms are $\pi_j = \frac{\alpha}{2}(2v - c)$ and $\pi_{-j} = \int_{\underline{p}}^{\bar{p}} \pi_F f^s(p) dp$ respectively.

3.4.3 Firms without Sales-Finance Conflicts in a Duopoly Market (CC)

In this subsection, we study the equilibrium for two centralized firms without sales-finance conflicts competing with each other. According to Lemma 4, if we compare the objective functions for finance divisions, we find best responses. For firms without sales-finance conflicts, if the prices are moderate ($\hat{p}_C < p_j \leq p_{-j} < \bar{p}$), both firms offer consumer financing. If firm j chooses a moderate price and firm $-j$ chooses a high price ($\hat{p}_C < p_j < \bar{p} < p_{-j}$), only firm j offers consumer financing. If firm j chooses a low price and firm $-j$ chooses a moderate price ($p_j < \hat{p}_C < p_{-j} < \bar{p}$), only firm $-j$ offers consumer financing.

Expecting the decisions of consumer finance divisions, the sales divisions will choose optimal prices to maximize profits. Similar to previous cases, there is no pure strategy equilibrium. Both firms use mixed price strategies, drawing their prices from the price distribution $F_j(p_j)$ and $F_{-j}(p_{-j})$ (see Figure 3.4). If the marginal cost is low ($c < \hat{c}$), in equilibrium, both firms will adopt mixed strategies on the support of $p_j, p_{-j} \in [p_C, \bar{p}]$. The expected profit for firm j is $\pi_{CC} = \frac{\alpha}{2}((1 - \delta)v_s + (2 + \delta^2 + \frac{\delta}{1+r})I_L - 2c)$. If the marginal cost is high ($c > \hat{c}$), both firms will adopt mixed strategies on the support of $p_j, p_{-j} \in [\underline{p}_C, \bar{p}] \cup [\underline{p}_2, 2v]$ and the expected profit for firm j is $\frac{\alpha}{2}(2v - c)$.

Figure 3.4: Price Distributions in Case CC



3.4.4 Effect of Sales-Finance Conflicts

We compare the case of two competing centralized firms without sales-finance conflicts in Section 4.3 and the case of a centralized firm and a decentralized firm with sales-finance conflicts in Section 4.2. Conventional wisdom usually suggests a centralized firm is more profitable than a decentralized firm by making integrated decisions and avoiding divisional conflicts in a firm. Counter to that, we find the firm with sales-finance conflicts in the asymmetric case may gain more profit than the firm without sales-finance conflicts in the symmetric case. This result is summarized in the following proposition.

Proposition 2 (Benefit of Sales-Finance Conflicts). *If $\hat{c} < c < I_L + \frac{I_L}{1+r}$, the profit of a decentralized firm competing with a centralized firm is higher than that of a centralized firm competing with another centralized firm.*

Proposition 2 shows, surprisingly, that a seemingly dysfunctional decentralized firm with conflicts between its sales and finance divisions may gain more profits than a centralized firm without such conflicts, which happens when the marginal cost of the product is high ($\hat{c} < c < I_L + \frac{I_L}{1+r}$). In this case, when two centralized firms without sales-finance conflicts compete with each other (Case CC), both firms choose a price on $[p_C, \bar{p}] \cup [p_2, 2v]$ and offer consumer financing on $[p_C, \bar{p}]$ to compete for switchers (see Figure 3.4(b)). However, when a decentralized firm with sales-finance conflicts competes with a centralized firm (Case DC), the decentralized firm chooses a price on $[p, \bar{p}] \cup [p_1, 2v]$, where $p > p_C$ and $p_2 > p_1$ (see Figure 3.3(f)). In other words, when competing with a centralized firm without sales-finance conflicts, a centralized firm without sales-finance conflicts is more likely to choose a relatively low price compared to a decentralized firm with sales-finance conflicts, resulting in less profit. The rationale is as follows. Similar to Proposition 1, the sales division in a firm with sales-finance conflicts takes only profit margin and demand into account, not the total net profit including interest revenue and default loss as in a centralized firm (i.e., *sales-finance conflict effect*). Such a conflict may motivate the sales division to focus on sales profit with sacrifice levied on the consumer

finance division. Consequently, the sales division in a decentralized firm is more likely to increase the price to forgo the financial interest revenue with consumer financing by the consumer finance division. Interestingly, such a selfish move by the sales division with a higher price and consequent less consumer financing from the consumer finance division has the byproduct of softening the competition with the competitor on prices and consumer financing. The competitor realizes that it can now take advantage of capital-stranded low-income consumers left out by the decentralized firm with some probability due to its internal sales-finance conflict, by randomizing on a relatively high price $([p, \bar{p}]$ with a mass point at $\bar{p}$) and providing consumer financing to low-income consumers. Consequently, the sales-finance conflict in a decentralized firm when the sales and finance divisions make price and financing decisions separately alleviates the competition in the market, resulting in a higher profit for the decentralized firm compared to the case of a centralized firm.

Contrary to previous literature suggesting organizational coordination is crucial to business success (Lawrence and Lorsch 1967, Pinto et al. 1993, Hausman et al. 2002), we analyze the conflict between a sales division and a consumer finance division and find when and how firms can use the internal conflicts as a strategic tool to gain more profits in competition. Moreover, this research focuses on a commonly seen yet understudied area, i.e., conflicts between the sales and finance divisions. Rather than simply avoiding sales-finance conflicts, the result indicates practitioners sometimes should choose a decentralized structure, introduce the conflict between the sales and finance divisions, and take advantage of the intrafirm conflicts to neutralize the external interfirm conflict caused by competition on both pricing and consumer financing.

3.5 Organizational Structure

In the main model, we study firms' optimal prices and consumer financing decisions with an exogenous organizational structure, i.e., centralized without conflicts between the sales and finance divisions or decentralized with conflicts between the sales and finance divisions. In this section, we extend the model and study the equilibrium organizational structure and its implications if firms can choose the organizational structure in a duopoly market. The game sequence is as follows. At stage 1, two firms choose the organizational structure, a centralized one without conflicts between the sales and finance divisions or a decentralized one with conflicts between the sales and finance divisions. At stage 2, two firms decide the price p and then make the consumer credit granting decision $\Gamma \in \{N, F\}$. For a decentralized firm with sales-finance conflicts, the sales division decides price p and then the consumer finance division makes the credit granting decision $\Gamma \in \{N, F\}$. At stage 3, consumers decide whether to make a purchase with or without consumer financing provided by the finance divisions of the firms. At stage 4, consumers decide to repay or default on the debt if consumers use consumer financing. Similar to the main model, we compare the expected profits under different structures (i.e., DD, DC and CC) and derive the equilibrium structure. We denote the effective interest rate as $\Delta = \delta r + \delta - 1$, which is the interest rate discounted by the consumer default rate. Based on the equilibrium results, we find the following proposition.

Proposition 3. *In a duopoly market, if $\hat{c} < c < I_L + \frac{I_L}{1+r}$ and $\underline{\Delta} < \Delta < 1$, there exists $\hat{\alpha} < \alpha < \bar{\alpha}$ such that both firms will choose a decentralized structure with sales-finance conflicts; there exists $0 < \alpha < \tilde{\alpha}$ such that firms will choose an asymmetric structure, i.e., one firm chooses a decentralized structure with sales-finance conflicts and the other chooses a centralized one without sales-finance conflicts.*

Proposition 3 shows that in a duopoly market, a firm may choose a decentralized structure with internal conflicts between the sales and consumer finance divisions when the organizational structure is endogenous. This result contrasts with a monopoly market where a firm always chooses a centralized structure to avoid sales-finance conflicts. Proposition 3 further shows that firms' equilibrium organization structure choices depend on the size of loyal consumer segments. For a marginal cost $\hat{c} < c < I_L + \frac{I_L}{1+r}$, when the loyal segment is large $\hat{\alpha} < \alpha < \bar{\alpha}$, firms may choose a decentralized structure; when the loyal segment is small $0 < \alpha < \tilde{\alpha}$, firms may choose an asymmetric structure.

The intuition behind Proposition 3 is as follows. Recall that from Proposition 2, for high marginal costs ($\hat{c} < c < I_L + \frac{I_L}{1+r}$), a decentralized firm with sales-finance conflicts gains a higher profit than a centralized firm without sales-finance conflicts when competing with a centralized firm since the conflicts between the sales and consumer finance divisions soften the competition on pricing and consumer financing with the competitor. Therefore, when competing with a centralized firm, a firm will choose a decentralized organization structure. Correspondingly, the rival centralized firm may also decide whether to choose a decentralized or centralized organization structure, and this decision hinges on which one is more profitable. If both firms choose decentralized structures with sales-finance conflicts (Case DD, see Figure 3.2(b)), both firms' sales divisions ignore the financial profits of the finance divisions and randomize on a high price range $[\underline{p}, \bar{p}] \cup [\underline{p}_1, 2v]$ to optimize only sales profits due to *the sales-finance conflict effect*. When one firm chooses a centralized structure and the other firm chooses a decentralized structure (Case DC, see Figure 3.3(e) & (f)), the decentralized firm's sales division ignores the financial profit of the consumer finance division and will have less incentive to charge a price as low as a centralized firm to induce the consumer finance division to provide consumer financing (Subsection 4.2 Case 3). Thus, with some probability, the decentralized firm with sales-finance conflicts will choose a high price $2v$ and give up competing on low-income consumers with the centralized firm without sales-finance conflicts. In the meantime, with some probability, the centralized firm without sales-finance conflicts is more likely to choose a low price on $[\underline{p}, \bar{p}] \cup [\underline{p}_2, 2v]$ (with a mass at $\bar{p}$ and $\underline{p}_2 > \underline{p}_1$) and gains higher expected market share when competing with a firm with sales-finance conflicts. Comparing the centralized structure in Case DC with decentralized structure in Case DD, we find the decentralized structure with sales-finance conflicts in Case DD is more likely to choose a high price due to the sales-finance conflicts (See Subsection 4.2 Case 3).

The centralized structure without sales-finance conflicts has the advantage of offering a low price which on the one hand helps attract switching consumers. On the other hand, a low price makes providing consumer financing less risky and attracts low-income consumers as well. The low price, however, has the disadvantage to reduce the possible benefit for the firm to profit from loyal consumers and intensify the competition with the

competitor. In contrast, *the decentralized structure with sales-finance conflicts* has the advantage of charging a high price and profiting from selling to loyal consumers, in the meantime softening competition on pricing and consumer financing with the competitor, as shown in Proposition 2. Yet, the decentralized structure also has the disadvantage with a high price when competing for switching consumers with the competitor, and the high price also makes providing consumer financing riskier, thus making the decentralized structure less likely to compete for low-income consumers. The significance of advantage and disadvantage of both the centralized and the decentralized structures depend on the size of consumer loyal segments. When the loyal segment is small $0 < \alpha < \bar{\alpha}$, the disadvantage for the centralized structure is low and the advantage for the decentralized firm is also low, and therefore, a firm may be more likely to choose a centralized structure when competing with a decentralized firm, resulting in an asymmetric equilibrium organizational structure. In contrast, when the loyal segment is large $\hat{\alpha} < \alpha < \bar{\alpha}$ and the effective interest rate is high $\Delta > \underline{\Delta}$, the disadvantage of low price with a centralized structure is high, and the advantage of high price with a decentralized structure is also high such that both firms choose decentralized structures.

Proposition 3 offers important insights for firms, especially for those firms offering consumer financing. Under certain conditions, firms should strategically create intrafirm conflicts with the existence of interfirm conflicts caused by competition. Specifically, we find that firms could take advantage of internal conflicts between the sales and consumer finance division by choosing a centralized or a decentralized structure depending on the marginal production costs, the effective interest rate and the size of the loyal segment. If the loyal consumer segment is not too large, firms may choose a centralized structure without conflicts or a decentralized structure with conflicts, which offers possible explanations to what we observe in practice.

3.6 Conclusion

In this paper, we study the impact of sales-finance conflicts on pricing and credit granting decisions in a competitive market. Different from previous literature, we illustrate the conflict between sales and finance divisions which is an inevitable and crucial facet for firms that offer consumer financing, in both monopoly and duopoly markets. We show that firms can leverage on the sales-finance conflict and use it as a strategic tool to gain profits in a competitive market. Counterintuitively, a decentralized firm where two divisions make finance and price decisions separately can gain more profit when competing with a centralized firm.

In addition, our study has important managerial and public policy implications. First, although the marketing department needs to coordinate the consumer finance division and the sales division in practice, previous literature rarely discussed this problem. To the best of our knowledge, this is the first paper to study the unique interdependent and conflicting relationships between the sales and consumer finance divisions in a firm and to provide key insights on how to make price and financing decisions optimally at the same time. In a monopoly market with moderate production costs, if a firm adopts a centralized structure without sales-finance conflicts, choosing a relatively low price and offering consumer financing would be more beneficial.

Second, a firm could strategically create internal conflicts to neutralize the external conflicts caused by competition. Especially, for a firm that seeks to optimize organizational structure, a decentralized structure with sales-finance conflicts could be optimal when the production cost is high and loyal consumer segment is large. Third, the external market structure can drive firms' internal organizational structure when firms can decide on their organization structures endogenously. In a monopoly market, a firm benefits from avoiding sales-finance conflicts and chooses a centralized structure without conflicts between its sales and finance divisions. In contrast, in a competitive market, firms may embrace such conflicts by choosing a decentralized structure with conflicts between the sales and finance divisions. The sales-finance conflicts or other internal conflicts in a firm are crucial yet understudied in marketing research. We hope this paper opens a new window that reveals the significance of internal conflicts between marketing and other departments and the interaction with external conflicts, such as with competitors and suppliers. For future research, it would be interesting to further study how the sales-finance conflicts affect the distribution channel choice or the product line design.

Chapter 4

Online Retail Media, Data Sharing and Consumer Purchase Funnel

4.1 Introduction

First-party consumer data is more important than ever. Platforms with the largest caches of user data will benefit from their ad targeting abilities. Especially with the development in data mining and machine learning, tracking of consumers' online activities has enable advertisers to make inferences about consumers and then finely target ads to consumers (Lambrecht and Tucker 2013; Hoban and Bucklin 2015; Johnson et al. 2017; Sahni et al. 2019). However, the large-scale collection of data has heightened consumers' concerns about their privacy. For instance, 68% of the US Internet users report feeling concerned about “companies displaying ads based on their data” (eMarketer, 2018). As a result, some platforms designed new data privacy policy to restrict the collection of customer first-party data. For example, Apple's introduction of AppTrackingTransparency (ATT) in iOS 14.5 effectively deprecated the primary way advertisers track users on iOS platform.¹ This presents a challenge for advertisers on the platform to gain first-party data.

To get first-party consumer data, some retailers establish their own ad network, i.e., online retail media. Specifically, online retail media refers to the real-time ads served across search, display, and product pages when consumers are at or close to the point of purchase. Though ad networks have existed for years, retail media became more popular than ever when retailers realized their first-party purchase data is especially valuable for ad targeting (See Figure 4.1). Those are the coupons, offers, and featured products that show up while a shopper is actively browsing a digital retailer, such as Amazon, Instacart, CVS, Walmart, Kroger, and Best Buy. Moreover, between 2020 and 2021, the number of consumer packaged goods (CPG) brands working with retail media networks to gain access to first-party data nearly doubled from 33% to 62%, according to an October 2021 survey by Merkle. As we can see in Figure 4.2, eBay has won advertisers with its willingness

¹See <https://developer.apple.com/app-store/user-privacy-and-data-use/>.

Figure 4.1: Retail Media Ad Spending 2019-2024

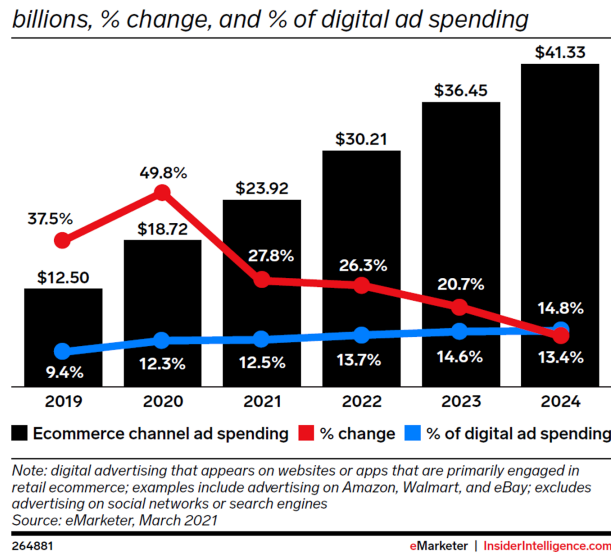
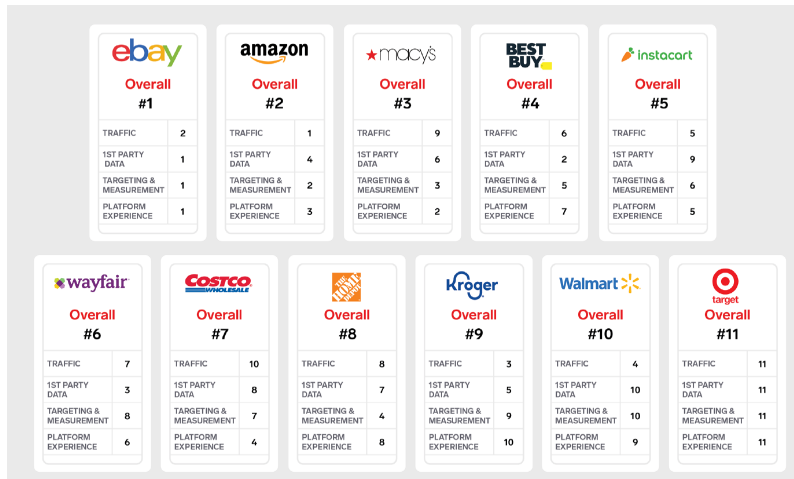


Figure 4.2: 2022 Retail Media Networks Rankings



to share more data than the competition.

In addition to first-party data sharing, retail properties of retail media are critical to getting ads in front of audiences when they're showing intent to purchase. Compared to the traditional ad platform such as Google, retail media are closer to the purchase point in consumer purchase funnel, which results in a higher traffic quality.² Therefore, retail media ads are becoming strong competitors for traditional ad platforms. For instance, Amazon continues to grow its ad revenue market share, which will reach 19.0% in 2021 as Google's share dips to 56.8%. However, interestingly, we find there are many arguments for using both.³For instance, some also argue "both Amazon and Facebook ads can be used to grow your business online, and each have

²See Insider Intelligence: Retail Media Networks Perception Benchmark 2022.

³See <https://www.finch.com/blog/google-ads-vs-amazon-advertising/> and <https://www.webfx.com/blog/marketing/amazon-vs-google/>.

unique values that complement different objectives. Facebook benefits from being able to find and target ads towards a huge number of relevant people, driving brand awareness and creating potential future customers, whereas Amazon has the advantage of being able to target those who are intending on making a purchase and ensuring it is your product that they buy.”⁴

As more retailers offer ads, more advertisers or suppliers are realizing that ads can provide them a positive return on investment, especially when the rise of digital marketing during the COVID-19 pandemic has made digital sales more important to more brands. Therefore, fierce competition among advertisers raises the ad price in auction in turn. With fierce competition for ad slots, and with high ad loads, it can be hard (or impossible) for a brand to be seen without paying.⁵

In this paper, we build a game-theoretic model to study the first-party consumer data strategies of traditional ad platform and the retailer and resolve the following questions. First, Why are some retailers/retail media more likely to share consumer data with advertisers through online advertising? Second, how should advertisers and consumers change their strategies in response to platform’s data sharing policy? Third, is the retail advertising complement/ substitute to the sales revenue/ platform advertising? We consider a model consists of an ad platform, a retailer with or without ad network and two competing suppliers. The ad platform, such as Google, sells ad impressions to suppliers via real-time bidding. A retailer may establish an ad network to sell ad impressions to suppliers as well. However, consumers on ad platform and on retail platform are in different state: consumers on ad platform are more likely to be in a browsing stage whereas the consumers on retail media are more close to purchase in their purchase funnel. Considering consumers’ ad wearout, i.e., seeing repeated ads of a brand can lead to negative responding, we allow the suppliers/advertisers to choose their bidding strategy on ad platform and retail media, if possible, to optimize their profits.

Based on the model, we show several interesting results. First, when the retailer does not have retail media, the ad platform sharing data with suppliers is better than not sharing. The retailer is more profitable in this case. Second, when the retailer has retail media, retailer advertising can be substitutes or complement to the ad platform advertising. Third, when the retailer has the retail media, platform sharing data with supplier can be worse off for suppliers and retailers and in this case the platform is better off sharing. Compared to benchmark where the retailer does not have retail media, the retailer, suppliers and the ad platform can be better off (win-win-win).

This research is highly related to three streams of literature: targeted advertising, consumer data sharing and consumer purchase journey. Previous literature on targeted advertising examines the impact of targeting on competition (softened competition, Iyer et al. 2005); ad intensity (Esteves and Resende, 2016); ad avoidance (Johnson 2013); ad pricing and social welfare (Bergemann and Bonatti, 2011); ad supply (Athey and Gans, 2010), etc. Other papers study the targeting strategy based on geographic information (Chen et al., 2017), personal demographic information (Anand and Shachar 2009, Piercy et al. 2011), past browsing or purchase

⁴See Search Laboratory US <https://www.searchlaboratory.com/us/2019/03/amazon-or-facebook-sponsored-adverts-which-platform-should-you-use/>.

⁵See eMarketer 2021.

data (Rossi et al. 1996, Agarwal et al. 2009, Rafieian and Yoganarasimhan 2021), etc., which may results multi-dimensional consumer heterogeneity. Following Narasimhan (1988)’s competition model, Zhang and Katona (2012) study the correlation between consumers’ content preferences and product preferences. They find that first, advertising through relevant content topics helps advertisers reach consumers with a strong preference for their product. Second, heterogeneity in consumers’ content preferences can be leveraged to reduce product market competition, especially when competition is intense (size of shoppers).

From a platform’s perspective, Levin and Milgrom (2010) argue that advertisers’ improved targeting can lower the platform’s revenue by dispersing competition and making ad auctions thinner. In the context of online advertising auctions, Sayedi (2018) shows how targeted real-time bidding will always benefit advertisers and publishers. Our research contributes to previous literature by studying online ad targeting on both ad platform and retail platform. Different from previous literature where personal information is used to price discriminate consumers, which is not very plausible when the buyer is not verifiable or for fear of a public relations backlash (Council of Economics Advisors, 2015), in our paper, advertisers use the information to ad target consumers in different purchase stage by optimizing their ad bidding strategy on both platforms. Rafieian and Yoganarasimhan (2021) study the role of targeting in online advertising and shows that ad networks may benefit from preserving customer privacy. Esteves and Resende (2016) show with targeted advertising and price discrimination, when the attractiveness of the weak segment is low, each firm advertises more intensively in its strong segment. The same result arises when the attractiveness of the weak segment is high and advertising is sufficiently expensive. Interestingly, when the attractiveness of the weak segment is high but advertising costs are sufficiently low, it is optimal for each firm to advertise more intensively in its weak segment. This result also applies to geo targeting strategies. Bergemann and Bonatti (2011) find an increase in targeting leads to an increase in the total number of consumer-product matches, and hence in the social value of advertising. Yet, targeting also increases the concentration of firms advertising in each market. Surprisingly, they then find that the equilibrium price of advertisements is first increasing, then decreasing, in the targeting capacity.

We also contribute to advertising strategy and data sharing in distribution channels, especially in-store media. De Corniere and De Nijs (2016) investigate the ad network’s incentive to disclose consumer information to advertisers and show disclosure improves the match between advertisers and consumers but increases product prices, even without price-discrimination, whereas in our paper, we consider both ad platform and retail media’s incentives to disclose consumer data or not. Other papers study advertising strategy in distribution channels. Dukes and Liu (2010) endogenize a firm’s choice of media and allow a retailer to have in-store media (ISM), endogenously decide the advertising rate, and study the effects of retailer in-store media on distribution channel relationships. They show that ISM has an important role in coordinating a distribution channel on advertising volume and product sales, and on mitigating supplier competition. Kuksov et al. (2017) further explore whether and under what conditions allowing competitor advertising in one’s store may be a beneficial strategy. In a duopoly market, they find that hosting a competitor ad for an

undifferentiated product can mitigate price competition and boost profits of both firms if the advertising commission is high enough. In a related paper, Cao and Ke (2019) consider a manufacturer, who coordinates with its retailers by sharing a fixed percentage of each retailer’s advertising cost and, at the same time, competes with its retailers and outside advertisers in search ad position auctions. They study the optimal cooperative advertising strategies from the manufacturer’s perspective and find that different from cooperative advertising in traditional media, it can be optimal for a manufacturer to cooperate with only a subset of its retailers even if they are *ex ante* the same. Different from previous literature, we focus on the online retail media and data sharing strategy. Some researchers study the cross-media or cross-channel relationship. For example, using a natural experiment, Goldfarb and Tucker (2011) study the substitution across advertising platforms, i.e., online advertising substitutes for offline advertising. Lambrecht et al. (2020) study how TV ads affect online browsing and sales, and show the intertemporal substitution effect where consumers move forward in time their online activities in response to TV advertising, leading to lower browsing and lower sales at times when no ad is airing.

In a related research stream on consumer privacy and purchase journey, Hann et al. (2008) study consumer concealment and deflection of advertising. In markets where the marginal cost of advertising is sufficiently low, efforts by low-benefit consumers to conceal themselves will increase the cost-effectiveness of advertising and lead sellers to market more. However, concealment by high-benefit consumers leads sellers to market less. Choi et al. (2021) investigate the impact of regulations that endow a consumer with the choice to opt in to have her activity be tracked or opt out of tracking. Consumers opt in or out of tracking depending on ad effectiveness. Due to the opt-in/-out choice, and compared to the pre-regulation benchmark of consumer data being tracked, consumer surplus increases and the advertiser’s and the ad network’s profits decrease. Different from their paper, we focus on firms’ reaction to privacy policy rather consumers’ opt-in/ -out choice and providing managerial implications under more strict privacy regulations.

The rest of the paper is organized as follows. In Section 2, we set up the model of the platform, the retailer and competing suppliers. In Section 3, we analyze the benchmark model where the retailer does not have ad network. In Section 4, we analyze the main model where the retailer has ad network. We extend the model and allow both the ad platform and the retail media share consumer data in Section 5. Section 6 concludes the paper.

4.2 Model Setup

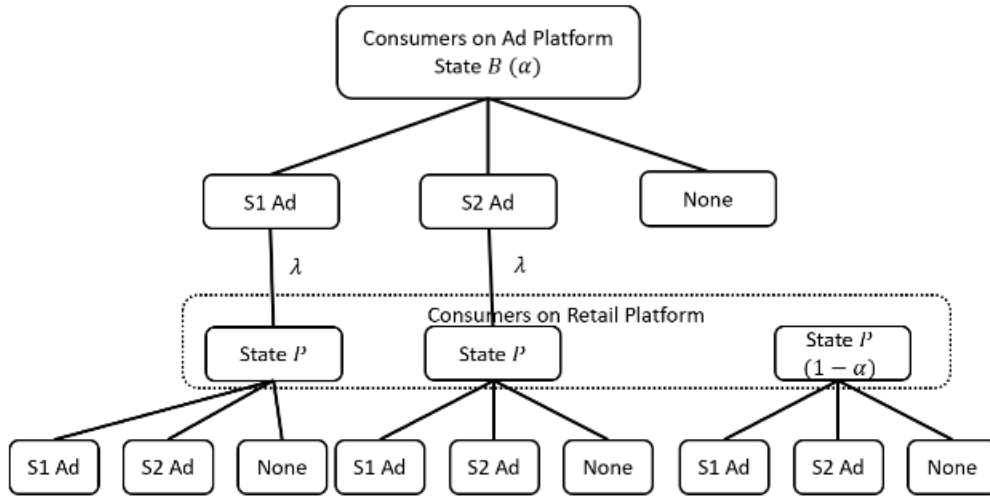
To capture the market features in practice, the model consists of two suppliers (S_k where $k \in 1, 2$), one ad platform selling ad impressions and one retailer who may have an ad network selling ad impressions.

Firms: For an traditional online ad platform, such as Google, it decides whether to share consumer data with suppliers or not. For a retailer, it provides a platform for suppliers to sell their products. If the retailer has retail ad network, the suppliers can do advertisement on the retail media as well. In this case, the retailer

not only sets the retail price but also decides to share data with its suppliers or not. Note that the retailer and the platform rarely share data with each other since they are competing for suppliers' advertising revenue. For suppliers, if the ad platform or the retail media shares consumer data, suppliers ($k = 1$ or 2) can ad target consumers through bidding strategy. After the ad auction, profits are realized.

Consumers: Consumers with heterogeneous preferences locate on a Hotelling line $[0, 1]$ with unit transportation cost t . As we mentioned, some of consumers (proportion of $1 - \alpha$) are in purchasing state P and start from the retail platform; others (proportion of α) are in browsing state B and start from the ad platform. In this way, we capture consumers' heterogeneity in their states of purchasing journey. However, the retail media does not know whether a consumer has seen their ad on the platform or not so that they may target the same consumer again on the retail media. Consumers may become aware of a brand through the ad platform or retail media and then shop through the retailer. Note that they can decide to buy a brand or not only after they know the brand through advertising. Consumer purchase funnel is shown in Figure 4.3.

Figure 4.3: Consumer Purchase Funnel



As shown in Figure 4.3, α proportion of consumers are initially in browsing state and $1 - \alpha$ proportion of consumers are initially in purchasing state. Consumers in state B may switch to purchasing state P and go to the retailer website with probability of λ if they see an ad from any supplier. If they see the advertisement from the same supplier again on retail media, there could be an ad satiation effect or ad wearout so that the conversion rate becomes $\lambda\gamma$ where $\gamma < 1$. Consumers in state P may see an ad on retail media and will buy the product as long as the utility is positive; if consumers in state P did not see an ad on retail media, they will not buy.

4.3 Retailer Without Retail Media

To analyze the role of retail media, we start with a benchmark model where the retailer does not have an ad network in this section. Then in the next section, we analyze the main model where the retailer has an ad network and needs to decide whether to share consumer data or not.

In this section, we consider a benchmark model with one ad platform, one retailer without retail media and two suppliers. The model sequence is as follows. At stage 1, the platform decides whether to share customer data or not $\sigma \in \{\mathcal{D}, \mathcal{P}\}$ where $\mathcal{D}$ denotes sharing and $\mathcal{P}$ denotes not sharing. At stage 2, the retailer sets price p (share a proportion of β with the supplier). At stage 3, the ad platform sets reserve price R_p . At stage 4, suppliers choose their bidding strategy x_k on the ad platform. At stage 5, consumers buy or not.

Note that first, consistent with previous literature and the practice, the suppliers' bidding strategy, especially when the platform uses real-time bidding, are more flexible than their pricing strategy. Therefore, the retailer decides prices first and the suppliers may choose their bidding strategies accordingly. Second, consumers' preference and consumer state (B or P) are private information but the platform or retail media can infer based on the first-party data. They may decide whether to share the consumer data with suppliers or not. If the supplier does not have consumer data and bids on expectation; once the suppliers have access to consumer data, they would ad target consumers by bidding on consumers' preference. Third, to simplify the model, there is one ad slot on the platform or the retail media such that suppliers need to bid in an auction to win the consumer impressions based on the first-party consumer data if provided. To be consistent with the practice, we follow the online advertising and real-time bidding literature (De Corniere and De Nijs 2016 and Sayedi 2018) and consider a second-price auction to determine which supplier will appear on the consumer's screen. Fourth, the ad platform and retail media may compete for ad revenue but only retailer can sell the product. Ads on ad platform and the retail media play different role in consumer purchasing journey as we mentioned before. Lastly, after the demand is realized, the retailer and suppliers will share the sales revenue. For simplicity, we assume the revenue sharing contract β is exogenous. We solve the game by backward induction and focus on the symmetric supplier case.

4.3.1 Ad Platform Sharing Data

In this subsection, we study the case where the ad platform shares consumer data with supplier so that suppliers can bid on consumer preference. Here we consider a symmetric case where two suppliers will bid same amount of impressions.

Stage 5: Consumer Purchase Decisions At stage 5, consumers decide whether to buy the product or not. Their decisions depend on whether they are aware of the brand and whether the product is a fit. The former part depends on suppliers' advertising strategy and the latter depends on pricing strategy. For consumers who have never seen an ad on any platform, they will not make a purchase. For consumers who are exposed to only one brand, as long as the utility of buying is positive, i.e., $U = 1 - t\theta_i - p_1 \geq 0$, they

will make a purchase. For consumers who are exposed to two brands, they will compare the two products and choose the one with higher positive utility, i.e., $\max\{1 - t\theta_i - p_1, 1 - t(1 - \theta_i) - p_2\}$. Or formally, if $\theta_i < \min\{\frac{1-p_1}{t}, \frac{p_2-p_1+t}{2t}\}$, they will choose product 1; if $\theta_i > \max\{1 - \frac{1-p_2}{t}, \frac{p_2-p_1+t}{2t}\}$, they will choose product 2. If the consumer sees the same ad twice, there could be an ad satiation effect or ad wearout so that the conversion rate becomes $\lambda\gamma$ where $\gamma < 1$. In the case where only the ad platform shares the consumer data, suppliers will target consumers based on their preference and consumers will only be exposed to one brand at most.

Stage 4: Suppliers' Bidding Strategies For supplier k , the profit includes sales revenue net the advertisement fee. Supplier k will choose an optimal bidding strategy x_k to maximize its profit given reserve price and retail price p_k . For example, supplier 1's profit is shown in the following equation.

$$\Pi_1 = \alpha(\beta\lambda p_1 d_1 - R_p x_1) \quad (4.1)$$

where $d_1 = \min\{\frac{1-p_1}{t}, x_1\}$. For a low reserve price R_p , if $x_1 \leq \frac{1-p_1}{t}$, $d_1 = x_1$ so we can derive the optimal bidding strategy $x_1^{BR} = \frac{1-p_1}{t}$. Similarly, If $x_1 > \frac{1-p_1}{t}$, $d_1 = \frac{1-p_1}{t}$ so we can derive the optimal bidding strategy $x_1^{BR} = \frac{1-p_1}{t}$. Thus, $x_1^{BR} = \frac{1-p_1}{t}$ and $x_2^{BR} = \frac{1-p_2}{t}$.

Stage 3: Platform's Reserve Price Expecting suppliers and retailer's decisions, the ad platform will choose a reserve price to maximize the following profit.

$$\Pi_p = \alpha R_p (x_1 + 1 - x_2) \quad (4.2)$$

If we plug in the best responses of suppliers, we can derive the optimal reserve price $R_p = \beta\lambda p$.

Stage 2: Retailer's Pricing Decisions For the retailer without retail media, the profit consists of sales margin from two suppliers. Since the platform shares consumer data, suppliers could target consumers using platform ads but after consumers go to the retailer's platform, no ads are shown. For consumers who are initially in purchase state, they will not make a purchase. Given the bidding strategy that supplier 1 bids impressions $[0, x_1]$ and supplier 2 bids impressions $[x_2, 1]$ based on shared consumer data, the retailer will set retail prices p_k to maximize its profit shown in the following equation.

$$\Pi_r = (1 - \beta)\alpha\lambda(d_1 p_1 + d_2 p_2) \quad (4.3)$$

where $d_1 = \min\{\frac{1-p_1}{t}, x_1\}$ and $d_2 = \min\{\frac{1-p_2}{t}, 1 - x_2\}$. Thus, if we plug in the best responses, the retailer will set $p_1^{BR} = 1 - x_1 t$ and $p_2^{BR} = 1 - (1 - x_2)t$. In sum, if the ad platform shares data, we can derive the profit for the ad platform $\Pi_p = \alpha\beta\lambda(1 - \frac{t}{2})$.

4.3.2 Ad Platform Not Sharing Data

In this subsection, we study the case where the ad platform does not share consumer data with supplier so that suppliers cannot observe location of each consumer on the Hotelling line nor can they target consumers through ads. Therefore, the expected value of each supplier for each impression is $1 - \frac{t}{2}$.

At stage 5, consumers' purchase decisions are similar as in previous subsection. At stage 4, for supplier k , supplier k will choose an x_k as high as possible as long as the reservation value is low enough (i.e., $R_p \leq \beta\lambda p d_1$); otherwise, supplier k will not bid at all. Thus, we have $x_k = \frac{1}{2}$. At stage 3, expecting suppliers' decisions, the ad platform will choose a reserve price to maximize the profit. Since suppliers will bid as much as possible as long as $R_p \leq \beta\lambda d_1$, the ad platform will set $R_p = \frac{1}{2}\beta\lambda(1 - \frac{t}{2})$. At stage 2, the retailer sets retail prices $p_k = 1 - \frac{t}{2}$ to maximize its profit. If we plug in the best responses, we can derive the profit for the ad platform $\Pi_p = \frac{1}{2}\alpha\beta\lambda(1 - \frac{t}{2})$.

4.3.3 Equilibrium Without Retail Media

If we compare the case where the ad platform shares consumer data and the case where the ad platform does not share, we can derive the equilibrium. The ad platform is profitable to share consumer data without retail media, which is consistent with previous literature (Sayed, 2018). For the retailer, although the retail price is the same, the market share is higher with consumer data since the suppliers will bid impressions with higher conversion rate. Overall, the retailer is better off with consumer data. The results are summarized in the following proposition.

Proposition 1. *When the retailer does not have an ad network, the ad platform will choose to share consumer data and the retailer can be better off with consumer data.*

We can also see that in equilibrium that the ad platform does not share consumer data, the reserve price is lower so that the platform is worse off. Intuitively, without sharing consumer data, the conversion rate of ad impressions is low so to incentivize suppliers to bid more impressions, the platform will choose a relatively low reserve price. In this case, the platform will choose a reserve price to extract all suppliers' surplus. For the retailer, suppliers bidding impressions with higher conversion rate improves retailer's profit overall. Moreover, since the retailer does not bear the advertisement fee, the retailer is better off with data sharing. For the platform, comparing the two cases, sharing consumer data improves reserve price due to a higher conversion rate. Therefore, the ad platform will share consumer data in equilibrium.

4.4 Retailer With Retail Media

In this section, we study the main model with one ad platform, one retailer with retail media and two suppliers. In the main model, we allow the platform or the retailer to share consumer data with the suppliers.⁶

⁶We extend the model and allow the both of the platform and the retailer to share in the next section.

Here the model sequence is as follows. At stage 1, the retailer or the ad platform decide whether to share customer data or not $\sigma \in \{\mathcal{D}, \mathcal{P}\}$. At stage 2, the retailer sets retail price p (share a proportion of β with the supplier). At stage 3, the ad platform set reserve price R_p and the retailer set reserve price R_r . At stage 4, suppliers choose their bidding strategy x_k on the ad platform and then y_k on retail media. At stage 5, consumers buy or not.

Note that in this case, the ad platform or the retail media will have to decide whether to share data and set reserve prices. Accordingly, the suppliers choose bidding strategy on ad platform and then on retail media. To simplify the model, we assume suppliers adopt symmetric strategies following previous literature (Guo, 2021). The rest of the model are the same as the benchmark. In the model extension, we consider both the platform and the retailer can share consumer data.

4.4.1 Retail Media Data Sharing Decision

In the subsection, we focus on the case where the retailer decides whether to share data or not whereas the ad platform does not have such capability. Thus, when the supplier bids on ad platform, it does not know the exact location of consumers. When the supplier bids on retail media, it may or may not know the location of consumers depending on retailer's sharing strategy.

Retailer Sharing Data

Here we first look at the case where the retailer shares consumer data with suppliers.

Stage 5: consumer purchase decisions. Consumer decisions do not change across cases except that consumers may see two ad on ad platform and retail platform. For consumers who are exposed to only one brand, as long as the utility of buying is positive, i.e., $U = 1 - t\theta_i - p_1 \geq 0$, they will make a purchase. For consumers who are exposed to two brands, they will compare the two products and choose the one with higher positive utility, i.e., $\max\{1 - t\theta_i - p_1, 1 - t(1 - \theta_i) - p_2\}$. Or formally, if $\theta_i < \min\{\frac{1-p_1}{t}, \frac{p_2-p_1+t}{2t}\}$, they will choose product 1; if $\theta_i > \max\{1 - \frac{1-p_2}{t}, \frac{p_2-p_1+t}{2t}\}$, they will choose product 2. If the consumer sees the same ad twice, there could be an ad satiation effect or ad wearout so that the conversion rate becomes $\lambda\gamma$ where $\gamma < 1$.

Stage 4: Suppliers' Bidding Strategies For supplier k , the profit includes sales revenue net the advertisement fee. Since the retail media share consumer data, suppliers cannot target consumers in browsing state using platform ads but for consumers who are initially in purchase state, suppliers could target consumers using retail media ads. Once consumers are in purchase state, the retailer is not able to know if they have seen an ad or not. Given reserve prices and retail price, supplier 1 bids impressions z_1 impressions on ad platform and $[0, y_1]$ on retail media; supplier 2 bids impressions z_2 impressions on ad platform and $[y_2, 1]$ on

retail media.⁷ When the retail price is low ($\frac{1-p}{t} \geq \frac{1}{2}$), the supplier's profit is as follows.

$$\Pi_1 = \beta p_1(\alpha\lambda(y_1\gamma z_1 + (\frac{1}{2} - y_1)z_1) + (1 - \alpha)y_1) - R_p z_1 \alpha - R_r y_1(1 - \alpha + \alpha\lambda) \quad (4.4)$$

Given z_1, z_2 , we resolve for the best responses y_1 and y_2 by maximizing the supplier 1's profit function 4.4. Given z_1 , the supplier chooses y_1 to maximize profit: for $R_r < \frac{(1-\alpha)\beta p}{1+\alpha(-1+\lambda)}$, if $z < \mathcal{Z}_1 = \frac{(1-\alpha)\beta p - R_r + (1-\lambda)\alpha R_r}{\alpha\beta\lambda p(1-\gamma)}$, $y = \frac{1}{2}$; otherwise, $y = 0$ (substitute effect, see Lemma 1). If we denote the bidding strategy as $\{z, y\}$, we have: for $R_r < \frac{(1-\alpha)\beta p}{1+\alpha(-1+\lambda)}$, the supplier chooses $\{\min\{\mathcal{Z}_1, \frac{1}{2}\}, \frac{1}{2}\}$ if $R_p < \frac{\beta\lambda\gamma p}{2}$ and $\{\frac{1}{2}, 0\}$ otherwise; for $R_r > \frac{(1-\alpha)\beta p}{1+\alpha(-1+\lambda)}$, the supplier chooses $\{\min\{\mathcal{Z}_1, \frac{1}{2}\}, 0\}$ if $R_p < \frac{\beta\lambda p}{2}$ and $\{0, 0\}$ otherwise. Similarly, when the retail price is high ($\frac{1-p}{t} < \frac{1}{2}$), the supplier chooses y_1 to maximize profit: if $z > \mathcal{Z}_2 = \frac{R_r - (1-\lambda)\alpha R_r - (1-\alpha)\beta p}{\alpha\beta\lambda p\gamma}$, $y = \frac{1}{2}$; otherwise, $y = 0$ (complement effect, see Lemma 1). In this case, we have: if $R_p < \frac{\beta\lambda\gamma(1-p)p}{t}$, the supplier chooses $\{\frac{1}{2}, \frac{1-p}{t}\}$, if $R_p > \frac{\beta\lambda\gamma(1-p)p}{t}$, the supplier chooses $\{\mathcal{Z}_2, \frac{1-p}{t}\}$.

Lemma 1 (Substitutes/Complements). *If the retail media decides to share consumer data, if $\frac{1-p}{t} > \frac{1}{2}$ and $0 < R_r < \frac{(1-\alpha)\beta p}{1+\alpha(-1+\lambda)}$, y decreases with z ; if $\frac{1-p}{t} < \frac{1}{2}$, y increases with z .*

Lemma 1 shows that retail advertising can substitute/complement ad platform advertising if the retailer has retail media and the retail media shares consumer data. When suppliers decide on bidding strategies, they need to tradeoff between the synergy effect of two media ($yz\gamma$) and the competition effect $(\frac{1}{2} - y)z$. When the retail price is low and the reserve price of the retail media is low, advertising on retail media is more profitable than advertising on ad platform due to the low cost. Therefore, suppliers may switch to advertise on retail media. However, when the retail price is high, the competition effect is less significant than the synergy between two media.

Stage 3: Platform and Retailer's Reserve Price Expecting suppliers' decisions, the ad platform and the retail media will choose reserve prices to maximize the ad revenue.

$$\Pi_p = \alpha R_p(x_1 + 1 - x_2) \quad (4.5)$$

$$\Pi_{ra} = (\alpha\lambda + 1 - \alpha)R_r(y_1 + 1 - y_2) \quad (4.6)$$

If we plug in the best responses of suppliers, we can derive the optimal retail media's reserve price $R_r = \frac{(1-\alpha)\beta p}{1+\alpha(-1+\lambda)}$ and the platform's reserve price $R_p = \beta\lambda\gamma p \frac{1-p}{t}$ if the retail price is high. In this case, the supplier will bid $\{\frac{1}{2}, \frac{1-p}{t}\}$ impressions on the platform and retail media accordingly. If the retail price is low, the optimal retail media's reserve price $R_r = \beta p \frac{2-\alpha(2+\lambda(1-\gamma))}{2(1-\lambda(1-\gamma))}$ and the ad platform can choose $R_p = \beta\lambda\gamma p/2$, and the supplier will bid $\{\frac{1}{2}, \frac{1}{2}\}$ impressions on the platform and retail media accordingly.

Stage 2: Retail Price At stage 2, the retailer will set retail prices p_k to maximize its profit shown in the following equation. The retailer's profit function is shown in Equation 4.7, which consists of sales

⁷We can interpret z_k as the probability of a consumer seeing an ad from supplier k on ad platform. When both suppliers bid for the same impression, the ad impression will be assign to either supplier randomly.

revenue and advertising revenue. For consumers who are initially in the purchasing state, they would buy from the supplier who targets them and generate revenue of $(1 - \alpha)(y_1 p_1 + (1 - y_2)p_2)$ for the retailer. For consumers who are initially in the browsing state, consumers may see the ad on the platform and switch to the purchasing state with probability λ . Consumers who are exposed to the ads on the retail media again would purchase the product with probability of $\gamma\lambda$ if the utility is positive; for those who are not exposed to retail media ads would purchase the product with probability of λ . Consumers who locate on $[x_1, \hat{\theta}]$ do not see the ad on the platform and do not buy the product.

$$\begin{aligned} \Pi_r = & (1 - \beta)[\alpha\lambda((y_1\gamma z_1 + (\frac{1}{2} - y_1)z_1)p_1 + (z_2\gamma(1 - y_2) + (y_2 - \frac{1}{2})z_2)p_2) \\ & + (1 - \alpha)(y_1 p_1 + (1 - y_2)p_2)] + R_r(y_1 + 1 - y_2)(\alpha\lambda + 1 - \alpha) \end{aligned} \quad (4.7)$$

If we resolve for the subgame equilibrium and get the following lemma.

Lemma 2. *If the retail media shares the consumer data: the retailer will choose $p = 1 - \frac{t}{2}$ and $R_r = \frac{\beta(2-t)(1-\alpha)}{2(1-\alpha(1-\lambda))}$; the platform will choose $R_p = \frac{\beta\gamma\lambda}{2}(1 - \frac{t}{2})$ and suppliers will bid $\{\frac{1}{2}, \frac{1}{2}\}$.*

In Lemma 2, we show the subgame equilibrium when the retail media has data sharing capability and chooses to share. When the revenue share β for supplier is higher, the reserve prices of ad platform and retail media increase accordingly. When the conversion rate λ or ad effectiveness γ is higher, the reserve prices increase as well.

Retailer Not Sharing Data

In the case where the retail media does not share data, suppliers do not know the exact location of consumers. Consumers decisions are similar to the previous case at stage 5. At stage 4, given reserve prices and the retail price, supplier 1 bids w_1 impressions on retail media and z_1 impressions on ad platform and supplier 2 bids w_2 impressions on retail media and z_2 impressions on ad platform. Consumers who start from the platform are exposed to supplier 1's ad with probability z_1 and move to purchase stage with probability γ . At the retail media, those consumers may be exposed to supplier 1's ad again with probability w_1 and buy if it is a fit (generating a demand of $\alpha\lambda\frac{z_1 w_1 \gamma}{2}$), or supplier 2's ad with probability w_2 and compare the two products (generating a demand of $\alpha\lambda\frac{z_1 w_2}{2}$). Similarly, there is a proportion of consumers who see supplier 2's ad on the platform and see supplier 1's ad on the retail media, and decide to buy from supplier 1 ($\alpha\lambda\frac{z_2 w_1}{2}$). For those who see an ad on the platform but not on the retail media, they will buy from supplier 1 if it is a fit (generating a demand of $\alpha\lambda\frac{z_1(1-w_1-w_2)}{2}$). For consumers who start from the purchase state, they would buy with probability of $\frac{w_1}{2}$. At stage 3, the platform and the retailer will decide the reserve prices. At stage 2, the retailer's profit consists of sales margin and ad revenue. In a symmetric case, we have

$$\Pi_r = 2(1 - \beta)p(\alpha\lambda(z\gamma\frac{w}{2} + \frac{z}{2}) + (1 - \alpha)\frac{w}{2}) + 2R_r w((1 - \alpha) + \alpha\lambda) \quad (4.8)$$

Here we have the best response price is $p = 1 - \frac{t}{2}$. If we solve the best responses of suppliers, we can derive the optimal retail media's and the platform's reserve prices as shown in the following lemma.

Lemma 3. *If the retail media does not share the consumer data: the platform will choose $R_p = \frac{1}{8}\beta\lambda(2 + \gamma)(2 - t)$, the retailer will choose $R_r = \frac{(1-\alpha)\beta(2-t)}{4-4\alpha(1-\lambda)}$, and suppliers will bid $\{\frac{1}{2}, \frac{1}{2}\}$.*

If we compare the case where the retailer shares and does not share consumer data, interestingly, we find that retail media will set a higher reserve price with consumer data whereas the ad platform will set a lower reserve price with consumer data. The intuition is as follows. When the retail media shares consumer data, suppliers can target consumers on retail media which is not possible on ad platform. Therefore, the value for ad impressions on retail media is higher compared with no data sharing. Furthermore, if we compare the retailer's profit, we can derive the following proposition.

Proposition 2. *When the retailer has ad media has the data sharing capability, $\frac{2}{2+(1-\beta)(2-\gamma)\lambda} < \alpha < 1$, the retailer will not share consumer data; when $0 < \alpha < \frac{2}{2+(1-\beta)(2-\gamma)\lambda}$, the retailer will share consumer data.*

See Appendix for proof. The retailer is more likely to share consumer data when the proportion of browsing consumers α is low (or alternatively when β, γ, λ are high). This is consistent with the case where Bestbuy and Wayfair are more likely to share consumer data than Target and Walmart since consumers visiting Bestbuy and Wayfair are more likely to shop with a purpose. The intuition is as follows. The retailer's profit consists of sales revenue and advertising revenue. When the proportion of browsing consumers α is low (there are more consumers in purchasing state), advertising revenue and the sale revenue from consumers in purchasing more weight than the sales revenue from consumers in browsing state. On one hand, sharing data can bring in more advertising revenue by charging a higher reserve price; on the other hand, the demand increases due to better targeting. However, when the proportion of browsing consumers α is high, the sales revenue from consumers in browsing state are more important than other component. In addition, there are some consumers who saw an ad from the competitor, were attracted to the retailer's website and made a purchase. In this case, not sharing data may lead to higher profit.

4.4.2 Ad Platform Data Sharing Decision

In the subsection, we focus on the case where the ad platform decides whether to share data or not whereas the retailer does not have such capability. Thus, when the supplier bids on retail media, it does not know the exact location of consumers. When the supplier bids on ad platform, it may or may not know the location of consumers depending on the platform's sharing strategy. We first look at the case where the platform shares consumer data. We solve the game by backward induction. At stage 5, consumers decisions are similar to the previous case.

Stage 4: Suppliers' Bidding Strategies For supplier k , the profit includes sales revenue net the advertisement fee. Since only the ad platform shares consumer data, suppliers could target consumers in

browsing state using platform ads but suppliers could not target consumers using retail media ads. Given reserve prices and the bidding strategy that supplier 1 bids impressions $[0, x_1]$ on ad platform and w_1 impressions on retail media and supplier 2 bids impressions $[x_2, 1]$ on ad platform and w_2 impressions on retail media,⁸ the retailer will set retail prices p_k to maximize its profit shown in the following equation. Consumers who start from the browsing state and locate on $[0, x_1]$ are exposed to supplier 1's ad and move to the purchase state with probability λ . If those consumers are exposed to supplier 1's ad again, they will buy with probability γ if it is a fit, generating a demand of $\alpha\lambda x_1\gamma w_1$; if those consumers are exposed to supplier 2's ad, they will compare and buy if it is a fit. For those who do not see an ad on the retail media, they will buy from supplier 1 if it is a fit, generating a demand of $\alpha\lambda x_1(1 - w_1 - w_2)$. Supplier k will choose an optimal bidding strategy x_k and w_k to maximize its profit given reserve prices and expecting retail price p_k . For example, supplier 1's profit is shown in the following equation.

$$\Pi_1 = \beta p_1(\alpha\lambda(x_1 w_1 \gamma + x_1(1 - w_1)) + (1 - \alpha)w_1) - R_p x_1 \alpha - R_r w_1(1 - \alpha) \quad (4.9)$$

Stage 3: Platform's Reserve Price Expecting suppliers' decisions and given retail price, the ad platform and the retail media will choose reserve prices to maximize the ad revenue.

$$\Pi_p = \alpha R_p(x_1 + 1 - x_2) \quad (4.10)$$

$$\Pi_{ra} = (\alpha\lambda + 1 - \alpha)R_r(w_1 + w_2) \quad (4.11)$$

At stage 2, the retailer's profit consists of sales margin from two suppliers and ad revenue.

$$\begin{aligned} \Pi_r = & (1 - \beta)[\alpha\lambda((x_1\gamma w_1 + x_1(1 - w_1))p_1 + ((1 - x_2)\gamma w_2 + (1 - x_2)(1 - w_2))p_2) \\ & + (1 - \alpha)(w_1 p_1 + w_2 p_2)] + R_r(w_1 + w_2)(\alpha\lambda + 1 - \alpha) \end{aligned} \quad (4.12)$$

Thus, same as the benchmark, the retailer will set $p_1^{BR} = 1 - x_1 t$ and $p_2^{BR} = 1 - (1 - x_2)t$. If we plug in the best responses of suppliers, we can derive the optimal retail media's and the platform's reserve prices as shown in the following lemma.

Lemma 4. *If the platform shares the consumer data: the retailer will choose $p = 1 - \frac{t(1-\alpha)}{4\alpha\lambda(1-\gamma)}$ and $R_r = \frac{(1-\alpha)\beta p}{4-4\alpha(1-\lambda)}$, the platform will choose $R_p = \frac{\beta p(1-\alpha(1-\lambda\gamma))}{\alpha}$, and suppliers will bid $\{\frac{1-\alpha}{4\alpha\lambda(1-\gamma)}, 1\}$.*

Compared to the benchmark where the retailer does not have retail media, we find that the retailer chooses a lower retail price and reserve price. Suppliers bid less on the platform when the platform shares consumer data. In the case where the platform does not share data, suppliers do not know the exact location of consumers. The equilibrium is the same as Subsection 4.1.2. If we compare the two cases, we can get the equilibrium as in Proposition 3.

⁸We can interpret w_k as the probability of a consumer seeing an ad from supplier k on retail media.

Proposition 3. *When the ad platform has the data sharing capability, there exists $0 < \alpha < \frac{1}{1+\lambda}$ such that the ad platform will share the consumer data if t is low $t < \min\{\hat{t}, 1\}$ (low consumer heterogeneity) and does not share otherwise.*

If we compare Proposition 3 with Proposition 1, we can see that with retail media, the platform is more likely to share consumer data with suppliers when the consumer heterogeneity is low. This could potentially explain why BestBuy and Wayfair which have a more heterogeneous consumers compared to Walmart and Target are more likely to share data with their suppliers since the ad platform is less willing to. This result complements Sayedi (2018) which shows targeted real-time bidding will always benefit advertisers and publishers. In this paper, we incorporate the role of the retail media and show that when the retailer does not have a retail media, suppliers' targeted bidding using consumer data will benefit the platform, but this may not be the case when the retailer has retail media. Moreover, if we compare the equilibrium results with the benchmark, we find that when γ is low or λ is low, the retailer, the platform and suppliers are better off compared with the benchmark, which means the existence of retail media can result in the win-win-win situation for all three parties.

4.5 Both Sharing Data $\{\mathcal{D}, \mathcal{D}\}$

In this section, we extend our model by allowing both the ad platform and the retail media share data with suppliers.

Stage 5: consumer purchase decisions. Consumer decisions do not change across cases except that consumers may see two ad on ad platform and retail platform. For consumers who are exposed to only one brand, as long as the utility of buying is positive, i.e., $U = 1 - t\theta_i - p_1 \geq 0$, they will make a purchase. For consumers who are exposed to two brands, they will compare the two products and choose the one with higher positive utility, i.e., $\max\{1 - t\theta_i - p_1, 1 - t(1 - \theta_i) - p_2\}$. Or formally, if $\theta_i < \min\{\frac{1-p_1}{t}, \frac{p_2-p_1+t}{2t}\}$, they will choose product 1; if $\theta_i > \max\{1 - \frac{1-p_2}{t}, \frac{p_2-p_1+t}{2t}\}$, they will choose product 2. If the consumer sees the same ad twice, there could be an ad satiation effect or ad wearout so that the conversion rate becomes $\lambda\gamma$ where $\gamma < 1$.

Stage 4: Suppliers' Bidding Strategies For supplier k , the profit includes sales revenue net the advertisement fee. Since both the ad platform and retail media share consumer data, suppliers could target consumers in browsing state using platform ads and for consumers who are initially in purchase state, suppliers could target consumers using retail media ads. Once consumers are in purchase state, the retailer is not able to know if they have seen an ad or not. Given reserve prices and the bidding strategy that supplier 1 bids impressions $[0, x_1]$ on ad platform and $[0, y_1]$ on retail media and supplier 2 bids impressions $[x_2, 1]$ on ad platform and $[y_2, 1]$ on retail media based on shared consumer data, supplier k will choose an optimal bidding strategy x_k and y_k to maximize its profit given reserve prices and retail price p_k . Now we discuss two cases where the supplier may bid more impressions on the ad platform or bid more impressions on the retail media.

For example, if suppliers bid more ad impressions on the ad platform than the retail media $x_1 > y_1$, supplier 1's profit is shown in the following equation.

$$\Pi_1 = \beta p_1(\alpha\lambda(y_1\gamma + x_1 - y_1) + (1 - \alpha)y_1) - R_p x_1 \alpha - R_r y_1(1 - \alpha + \alpha\lambda) \quad (4.13)$$

Given x_1, x_2 , we resolve for the best responses y_1 and y_2 by maximizing the supplier 1's profit function 4.13. Similarly, if $y_1 > x_1$, we have $\Pi_1 = \beta p_1(\alpha\lambda(x_1\gamma) + (1 - \alpha)y_1) - R_p x_1 \alpha - R_r y_1(1 - \alpha + \alpha\lambda)$. We define $r_1 = \frac{\beta p(1 - \alpha - \alpha\lambda(1 - \gamma))}{1 - \alpha + \alpha\lambda}$ and $r_2 = \frac{\beta p(1 - \alpha)}{1 - \alpha + \alpha\lambda}$. If $0 < R_p < \beta\lambda\gamma p$ and $0 < R_r < r_1$, the supplier will bid $x = \frac{1}{2}$ and $y = \frac{1 - p_1}{t}$; if $0 < R_p < \beta\lambda\gamma p$ and $R_r < r_1$, the supplier will bid $x = \frac{1 - p_1}{t}$ and $y = 0$; if $R_p > \beta\lambda\gamma p$ and $R_r < r_2$, the supplier will bid $x = 0$ and $y = \frac{1 - p_1}{t}$; otherwise, the supplier will bid $x = y = 0$.

Stage 3: Platform's Reserve Price Expecting suppliers' decisions, the ad platform and the retail media will choose reserve prices to maximize the ad revenue.

$$\Pi_p = \alpha R_p(x_1 + 1 - x_2) \quad (4.14)$$

$$\Pi_{ra} = (\alpha\lambda + 1 - \alpha)R_r(y_1 + 1 - y_2) \quad (4.15)$$

If we plug in the best responses of suppliers, we can derive the optimal retail media's reserve price $R_r = r_1$ and the ad platform can choose $R_p = \beta\lambda\gamma p$. In this case, the supplier will bid $\{\frac{1}{2}, \frac{1 - p}{t}\}$ impressions on the platform and retail media accordingly.

Stage 2: retailer's pricing decisions. For the retailer with retail media, the profit consists of sales margin from two suppliers and ad revenue. The retailer's profit function is shown in Equation 4.16, which consists of sales revenue and advertising revenue. For consumers who are initially in the purchasing state, they would buy from the supplier who targets them and generate revenue of $(1 - \alpha)(y_1 p_1 + (1 - y_2)p_2)$ for the retailer. For consumers who are initially in the browsing state, consumers who locate on $[0, x_1]$ see the ad on the platform and switch to the purchasing state with probability λ . Consumers who are exposed to the ads on the platform would purchase the product with probability of γ . Consumers who locate on $[x_1, \hat{\theta}]$ do not see the ad on the platform and do not buy the product.

$$\Pi_r = (1 - \beta)[\alpha\lambda((y_1\gamma + x_1 - y_1)p_1 + ((1 - y_2)\gamma + y_2 - x_2)p_2) + (1 - \alpha)(y_1 p_1 + (1 - y_2)p_2)] + R_r(y_1 + 1 - y_2)(1 - \alpha + \alpha\lambda) \quad (4.16)$$

Thus, same as the benchmark, the retailer will set $p_1 = p_2 = \min\{1 - \frac{t}{2}, \frac{2 + \alpha(-2 + \lambda(-2 + 2\gamma + t - \beta t))}{4 + 4\alpha(-1 + \lambda(-1 + \gamma))}\}$. We use $\{x, y\}$ to denote the bidding strategy of suppliers on the platform and the retail media. We solve for the subgame equilibrium and have the following lemma.

Lemma 5. *If both the platform and the retailer share the consumer data: when $0 < \alpha < \frac{2(1-t)}{2(1-t) + \lambda(2 + 2\gamma(-1+t) - t - \beta t)}$ or $\frac{1}{1 + \lambda - \lambda\gamma} < \alpha < 1$, the retailer will choose $p = 1 - \frac{t}{2}$; when $\frac{2(1-t)}{2(1-t) + \lambda(2 + 2\gamma(-1+t) - t - \beta t)} < \alpha < \frac{1}{1 + \lambda - \lambda\gamma}$, the retailer will choose $p = \frac{2 + \alpha(-2 + \lambda(-2 + 2\gamma + t - \beta t))}{4 + 4\alpha(-1 + \lambda(-1 + \gamma))}$. The platform will choose $R_p = \beta\gamma\lambda p$, the retailer will choose*

$$R_r = \frac{-(\beta(-2+\alpha(2+\lambda(2-2\gamma+(-1+\beta)t))))}{4+4\alpha(-1+\lambda(-1+\gamma))}, \text{ suppliers will bid } \{\frac{1}{2}, \frac{1-p}{t}\}.$$

If we compare the four cases, we can get the equilibrium when the conversion rate is low and ad wearout effect is not significant, only the retail media will share consumer data. Interestingly, when the ad wearout effect increases, the ad platform may be more willing to share consumer data along with the retail media.

4.6 Conclusion

In this paper, we study online advertising auction on traditional ad platform and retail media. Prior to the advertising auction, the ad platform or the retail media decides whether to allow advertisers to access consumer data. We show when the data sharing can be profitable for the platform, the retailer and suppliers. We also adopt the consumer purchasing journey to capture consumers' different stage in the purchase funnel. Our research bridges the in-store media literature, targeted online advertising and consumer purchase journey. Interestingly, we show how the retail advertising can be substitutes and complements to the platform advertising. When the retailer does not have retail media, platform sharing data with suppliers is better than not sharing for suppliers and retailers. However, when the retailer has the retail media, the ad platform, the retailer and suppliers are better off compared to benchmark where the retailer does not have retail media (win-win-win).

For future research, we can consider asymmetric equilibrium and asymmetric suppliers. For example, some suppliers have higher quality products or brand awareness than others. Another interesting direction is to consider personalized pricing and advertisement targeting. For example, Amazon uses both advertisement targeting as well as personalized pricing. It would be also interesting to empirically test the effect of the consumer heterogeneity in their preferences on firms' data sharing strategy.

References

- Agarwal, N., Athey, S., and Yang, D. (2009). Skewed bidding in pay-per-action auctions for online advertising. *American Economic Review*, 99(2):441–47.
- Ailawadi, K. L. and Harlam, B. A. (2009). Findings—retailer promotion pass-through: A measure, its magnitude, and its determinants. *Marketing Science*, 28(4):782–791.
- Amar, M., Ariely, D., Ayal, S., Cryder, C. E., and Rick, S. I. (2011). Winning the battle but losing the war: The psychology of debt management. *Journal of Marketing Research*, 48(SPL):S38–S50.
- Anand, B. N. and Shachar, R. (2009). Targeted advertising as a signal. *QME*, 7(3):237–266.
- Athey, S. and Gans, J. S. (2010). The impact of targeting technology on advertising markets and media competition. *American Economic Review*, 100(2):608–13.
- Athreya, K., Tam, X. S., and Young, E. R. (2012). A quantitative theory of information and unsecured credit. *American Economic Journal: Macroeconomics*, 4(3):153–83.
- Babich, V. and Tang, C. S. (2012). Managing opportunistic supplier product adulteration: Deferred payments, inspection, and combined mechanisms. *Manufacturing & Service Operations Management*, 14(2):301–314.
- Balasubramanian, S. and Bhardwaj, P. (2004). When not all conflict is bad: Manufacturing-marketing conflict and strategic incentive design. *Management Science*, 50(4):489–502.
- Bergemann, D. and Bonatti, A. (2011). Targeting in advertising markets: implications for offline versus online media. *The RAND Journal of Economics*, 42(3):417–443.
- Besanko, D., Dubé, J.-P., and Gupta, S. (2005). Own-brand and cross-brand retail pass-through. *Marketing Science*, 24(1):123–137.
- Biais, B. and Gollier, C. (1997). Trade credit and credit rationing. *The Review of Financial Studies*, 10(4):903–937.
- Brennan, M. J., Maksimovics, V., and Zechner, J. (1988). Vendor financing. *The Journal of Finance*, 43(5):1127–1141.

- Bricker, J., Dettling, L., Henriques, A., Hsu, J., Jacobs, L., Moore, K., Pack, S., Sabelhaus, J., Thompson, J., and Windle, R. (2017). Changes in u.s. family finances from 2013 to 2016: Evidence from the survey of consumer finances. *Federal Reserve Bulletin*.
- Burkart, M. and Ellingsen, T. (2004). In-kind finance: A theory of trade credit. *American Economic Review*, 94(3):569–590.
- Cao, X. and Ke, T. T. (2019). Cooperative search advertising. *Marketing Science*, 38(1):44–67.
- Chatterjee, S., Corbae, D., Nakajima, M., and Ríos-Rull, J.-V. (2007). A quantitative theory of unsecured consumer credit with risk of default. *Econometrica*, 75(6):1525–1589.
- Chatterjee, S., Corbae, D., and Rios-Rull, J.-V. (2008). A finite-life private-information theory of unsecured consumer debt. *Journal of Economic Theory*, 142(1):149–177.
- Chen, L.-H. and Kang, F.-S. (2010). Integrated inventory models considering the two-level trade credit policy and a price-negotiation scheme. *European Journal of Operational Research*, 205(1):47–58.
- Chen, Y., Li, X., and Sun, M. (2017). Competitive mobile geo targeting. *Marketing Science*, 36(5):666–682.
- Chen, Y., Narasimhan, C., and Zhang, Z. J. (2001a). Consumer heterogeneity and competitive price-matching guarantees. *Marketing Science*, 20(3):300–314.
- Chen, Y., Narasimhan, C., and Zhang, Z. J. (2001b). Individual marketing with imperfect targetability. *Marketing Science*, 20(1):23–41.
- Chod, J. (2016). Inventory, risk shifting, and trade credit. *Management Science*, 63(10):3207–3225.
- Choi, W. J., Jerath, K., and Sarvary, M. (2021). Consumer purchase journey, targeted advertising, and privacy choices. *revision invited at Journal of Marketing Research*.
- Corkery, M. and Silver-Greenberg, J. (2017). Profits from store-branded credit cards hide depth of retailers’ troubles. *The New York Times*.
- Daripa, A. and Nilsen, J. (2011). Ensuring sales: A theory of inter-firm credit. *American Economic Journal: Microeconomics*, 3(1):245–79.
- De Corniere, A. and De Nijs, R. (2016). Online advertising and privacy. *The RAND Journal of Economics*, 47(1):48–72.
- Desai, P., Koenigsberg, O., and Purohit, D. (2004). Strategic decentralization and channel coordination. *Quantitative Marketing and Economics*, 2(1):5–22.
- Dockner, E. J. and Fruchter, G. E. (2014). Coordinating production and marketing with dynamic transfer prices. *Production and Operations Management*, 23(3):431–445.

- Domowitz, I. and Sartain, R. L. (1999). Determinants of the consumer bankruptcy decision. *The Journal of Finance*, 54(1):403–420.
- Dubé, J.-P. and Gupta, S. (2008). Cross-brand pass-through in supermarket pricing. *Marketing Science*, 27(3):324–333.
- Dukes, A. and Liu, Y. (2010). In-store media and distribution channel coordination. *Marketing Science*, 29(1):94–107.
- Edeling, A. and Fischer, M. (2016). Marketing’s impact on firm value: Generalizations from a meta-analysis. *Journal of Marketing Research*, 53(4):515–534.
- Edeling, A., Srinivasan, S., and Hanssens, D. M. (2020). The marketing–finance interface: A new integrative review of metrics, methods, and findings and an agenda for future research. *International Journal of Research in Marketing*.
- Einav, L., Jenkins, M., and Levin, J. (2012). Contract pricing in consumer credit markets. *Econometrica*, 80(4):1387–1432.
- Einav, L., Jenkins, M., and Levin, J. (2013). The impact of credit scoring on consumer lending. *The RAND Journal of Economics*, 44(2):249–274.
- Esteves, R.-B. and Resende, J. (2016). Competitive targeted advertising with price discrimination. *Marketing Science*, 35(4):576–587.
- Fay, S., Hurst, E., and White, M. J. (2002). The household bankruptcy decision. *American Economic Review*, 92(3):706–718.
- Ferris, J. S. (1981). A transactions theory of trade credit use. *The Quarterly Journal of Economics*, 96(2):243–270.
- Fisher, R. J., Maltz, E., and Jaworski, B. J. (1997). Enhancing communication between marketing and engineering: The moderating role of relative functional identification. *Journal of Marketing*, 61(3):54–70.
- Gangwar, M., Kumar, N., and Rao, R. C. (2014). Consumer stockpiling and competitive promotional strategies. *Marketing Science*, 33(1):94–113.
- Gerardi, K., Herkenhoff, K., Ohanian, L. E., and Willen, P. (2013). Unemployment, negative equity, and strategic default. *Available at SSRN 2293152*.
- Gerstner, E. and Hess, J. D. (1995). Pull promotions and channel coordination. *Marketing Science*, 14(1):43–60.
- Goldfarb, A. and Tucker, C. (2011). Search engine advertising: Channel substitution when pricing ads to context. *Management Science*, 57(3):458–470.

- Gross, D. B. and Souleles, N. S. (2002). Do liquidity constraints and interest rates matter for consumer behavior? evidence from credit card data. *The Quarterly Journal of Economics*, 117(1):149–185.
- Guo, L. (2021). Endogenous evaluation and sequential search. *Marketing Science*, 40(3):413–427.
- Gurnani, H. and Shi, M. (2006). A bargaining model for a first-time interaction under asymmetric beliefs of supply reliability. *Management Science*, 52(6):865–880.
- Hann, I.-H., Hui, K.-L., Lee, S.-Y. T., and Png, I. P. (2008). Consumer privacy and marketing avoidance: A static model. *Management science*, 54(6):1094–1103.
- Hausman, W. H., Montgomery, D. B., and Roth, A. V. (2002). Why should marketing and manufacturing work together?: Some exploratory empirical results. *Journal of Operations Management*, 20(3):241–257.
- Hoban, P. R. and Bucklin, R. E. (2015). Effects of internet display advertising in the purchase funnel: Model-based insights from a randomized field experiment. *Journal of Marketing Research*, 52(3):375–393.
- Homburg, C. and Jensen, O. (2007). The thought worlds of marketing and sales: which differences make a difference? *Journal of Marketing*, 71(3):124–142.
- Iyer, G., Soberman, D., and Villas-Boas, J. M. (2005). The targeting of advertising. *Marketing Science*, 24(3):461–476.
- Jensen, M. C. and Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics*, 3(4):305–360.
- Jeuland, A. P. and Shugan, S. M. (1983). Managing channel profits. *Marketing Science*, 2(3):239–272.
- Johnson, G. A., Lewis, R. A., and Nubbemeyer, E. I. (2017). Ghost ads: Improving the economics of measuring online ad effectiveness. *Journal of Marketing Research*, 54(6):867–884.
- Johnson, J. P. (2013). Targeted advertising and advertising avoidance. *The RAND Journal of Economics*, 44(1):128–144.
- Kouvelis, P. and Zhao, W. (2012). Financing the newsvendor: supplier vs. bank, and the structure of optimal trade credit contracts. *Operations Research*, 60(3):566–580.
- Kouvelis, P. and Zhao, W. (2015). Supply chain contract design under financial constraints and bankruptcy costs. *Management Science*, 62(8):2341–2357.
- Kouvelis, P. and Zhao, W. (2017). Who should finance the supply chain? impact of credit ratings on supply chain decisions. *Manufacturing & Service Operations Management*, 20(1):19–35.
- Kuksov, D., Prasad, A., and Zia, M. (2017). In-store advertising by competitors. *Marketing Science*, 36(3):402–425.

- Kuksov, D. and Zia, M. (2020). Benefits of customer loyalty in markets with endogenous search costs. *Management Science*, Advance online publication.
- Kumar, N., Rajiv, S., and Jeuland, A. (2001). Effectiveness of trade promotions: Analyzing the determinants of retail pass through. *Marketing Science*, 20(4):382–404.
- Lambrecht, A. and Tucker, C. (2013). When does retargeting work? information specificity in online advertising. *Journal of Marketing research*, 50(5):561–576.
- Lambrecht, A., Tucker, C. E., and Zhang, X. (2020). Tv advertising and online sales: The role of inter-temporal substitution. *Available at SSRN 3530105*.
- Lawrence, P. R. and Lorsch, J. W. (1967). Differentiation and integration in complex organizations. *Administrative Science Quarterly*, pages 1–47.
- Lennox (2019). Why consumer financing is important. *Lennoxpro*.
- Levin, J. and Milgrom, P. (2010). Online advertising: Heterogeneity and conflation in market design. *American Economic Review*, 100(2):603–07.
- Li, W. and Sarte, P.-D. (2006). Us consumer bankruptcy choice: The importance of general equilibrium effects. *Journal of Monetary Economics*, 53(3):613–631.
- Livshits, I. (2015). Recent developments in consumer credit and default literature. *Journal of Economic Surveys*, 29(4):594–613.
- Livshits, I., MacGee, J., and Tertilt, M. (2007). Consumer bankruptcy: A fresh start. *American Economic Review*, 97(1):402–418.
- Lopes, P. (2008). Credit card debt and default over the life cycle. *Journal of Money, Credit and Banking*, 40(4):769–790.
- McGuire, T. W. and Staelin, R. (1983). An industry equilibrium analysis of downstream vertical integration. *Marketing Science*, 2(2):161–191.
- McShane, B. B., Chen, C., Anderson, E. T., and Simester, D. I. (2016). Decision stages and asymmetries in regular retail price pass-through. *Marketing Science*, 35(4):619–639.
- Mian, S. L. and Smith Jr, C. W. (1992). Accounts receivable management policy: theory and evidence. *The Journal of Finance*, 47(1):169–200.
- Moorthy, K. S. (1987). Managing channel profits: Comment. *Marketing Science*, pages 375–379.
- Moorthy, S. (2005). A general theory of pass-through in channels with category management and retail competition. *Marketing Science*, 24(1):110–122.

- Narajabad, B. N. (2012). Information technology and the rise of household bankruptcy. *Review of Economic Dynamics*, 15(4):526–550.
- Narasimhan, C. (1988). Competitive promotional strategies. *Journal of Business*, pages 427–449.
- Navarro-Martinez, D., Salisbury, L. C., Lemon, K. N., Stewart, N., Matthews, W. J., and Harris, A. J. (2011). Minimum required payment and supplemental information disclosure effects on consumer debt repayment decisions. *Journal of Marketing Research*, 48(SPL):S60–S77.
- Nijs, V., Misra, K., Anderson, E. T., Hansen, K., and Krishnamurthi, L. (2010). Channel pass-through of trade promotions. *Marketing Science*, 29(2):250–267.
- Perdikaki, O., Kumar, S., and Sriskandarajah, C. (2017). Managing retail budget allocation between store labor and marketing activities. *Production and Operations Management*, 26(9):1615–1631.
- Peura, H., Yang, S. A., and Lai, G. (2017). Trade credit in competition: A horizontal benefit. *Manufacturing & Service Operations Management*, 19(2):263–289.
- Piercy, N., Campbell, C., and Heinrich, D. (2011). Suboptimal segmentation: Assessing the use of demographics in financial services advertising. *Journal of Financial Services Marketing*, 16(3):173–182.
- Pinto, M. B., Pinto, J. K., and Prescott, J. E. (1993). Antecedents and consequences of project team cross-functional cooperation. *Management Science*, 39(10):1281–1297.
- Rafieian, O. and Yoganarasimhan, H. (2021). Targeting and privacy in mobile advertising. *Marketing Science*, 40(2):193–218.
- Raju, J. and Zhang, Z. J. (2005). Channel coordination in the presence of a dominant retailer. *Marketing Science*, 24(2):254–262.
- Raju, J. S., Srinivasan, V., and Lal, R. (1990). The effects of brand loyalty on competitive price promotional strategies. *Management Science*, 36(3):276–304.
- Rossi, P. E., McCulloch, R. E., and Allenby, G. M. (1996). The value of purchase history data in target marketing. *Marketing Science*, 15(4):321–340.
- Rubel, O., Zhou, C., Grewal, R., and Raju, J. S. (2019). Managing conflicts between marketing and sales: Customer acquisition in business markets. *Available at SSRN*, <https://ssrn.com/abstract=3493361>.
- Sahni, N. S., Narayanan, S., and Kalyanam, K. (2019). An experimental investigation of the effects of retargeted advertising: The role of frequency and timing. *Journal of Marketing Research*, 56(3):401–418.
- Sanchez, J. (2010). The it revolution and the unsecured credit market. federal reserve bank of st. Technical report, Louis Working Paper 2010-022A. WP 2010-022A.

- Sayed, A. (2018). Real-time bidding in online display advertising. *Marketing Science*, 37(4):553–568.
- Schwartz, R. A. (1974). An economic model of trade credit. *Journal of Financial and Quantitative Analysis*, 9(4):643–657.
- Seiler, S., Tuchman, A., and Yao, S. (2021). The impact of soda taxes: Pass-through, tax avoidance, and nutritional effects. *Journal of Marketing Research*, 58(1):22–49.
- Shi, T., Chhajed, D., Wan, Z., and Liu, Y. (2020). Distribution channel choice and divisional conflict in remanufacturing operations. *Production and Operations Management*, 29(7):1702–1719.
- Shugan, S. M. (2004). Finance, operations, and marketing conflicts in service firms. *Journal of Marketing*, 68(1):24–26.
- Shugan, S. M. (2005). Brand loyalty programs: are they shams? *Marketing Science*, 24(2):185–304.
- Sogomonian, A. G. and Tang, C. S. (1993). A modeling framework for coordinating promotion and production decisions within a firm. *Management Science*, 39(2):191–203.
- Soman, D. and Cheema, A. (2002). The effect of credit on spending decisions: The role of the credit limit and credibility. *Marketing Science*, 21(1):32–53.
- Srinivasan, S. and Hanssens, D. M. (2018). Marketing and firm value: Metrics, methods, findings, and future directions. *LONG-TERM IMPACT OF MARKETING: A Compendium*, pages 461–519.
- Surane, J. (2017). Bank behind gap, jc penney store cards looks beyond retail. *Bloomberg Technology*.
- Tan, Y. and Mookerjee, V. S. (2005). Allocating spending between advertising and information technology in electronic retailing. *Management Science*, 51(8):1236–1249.
- Toktay, L. B. and Wei, D. (2011). Cost allocation in manufacturing–remanufacturing operations. *Production and Operations Management*, 20(6):841–847.
- Trautmann, S. T. and Vlahu, R. (2013). Strategic loan defaults and coordination: An experimental analysis. *Journal of Banking & Finance*, 37(3):747–760.
- Tyagi, R. K. (1999). A characterization of retailer response to manufacturer trade deals. *Journal of Marketing Research*, 36(4):510–516.
- Varian, H. R. (1980). A model of sales. *The American Economic Review*, 70(4):651–659.
- Villas-Boas, J. M. (2004). Consumer learning, brand loyalty, and competition. *Marketing Science*, 23(1):134–145.
- Wilcox, K., Block, L. G., and Eisenstein, E. M. (2011). Leave home without it? the effects of credit card debt and available credit on spending. *Journal of Marketing Research*, 48(SPL):S78–S90.

- Wu, J., Ouyang, L.-Y., Cárdenas-Barrón, L. E., and Goyal, S. K. (2014). Optimal credit period and lot size for deteriorating items with expiration dates under two-level trade credit financing. *European Journal of Operational Research*, 237(3):898–908.
- Yang, S. A. and Birge, J. R. (2017). Trade credit, risk sharing, and inventory financing portfolios. *Management Science*, 64(8):3667–3689.
- Zhang, K. and Katona, Z. (2012). Contextual advertising. *Marketing Science*, 31(6):980–994.

Appendix A: Proofs of Chapter 2

This appendix contains the technical aspects of the paper omitted from the main text.

Proof. RETAILER'S BEST RESPONSE We compare the profit functions of the retailer's different strategies and derive the retailer's best response:

When the retailer chooses a low price $p \in [0, I_L + \frac{\delta(I_L - k)}{1+r}]$ (i.e., "low price strategy") and offers consumer financing, if $p \leq I_L$, low-income consumers will make a purchase without credits and the retailer's profit from selling to both segments is $\pi_1 = p - w$; whereas when $p \in (I_L, I_L + \frac{\delta(I_L - k)}{1+r}]$, low-income consumers will buy with credits if $U = d - I_L - (p - I_L)(1 + r) \geq 0$ (i.e., $p \leq p_L$) and the retailer's profit is $\pi_1(p, F) = p - w + r(p - I_L)/2$. Here the retailer gets profit $p - w$ from selling to all consumers and interest revenue from low-income consumers $r(p - I_L)/2$. To maximize the profit, the retailer will choose a best response price $p = \min\{p_L, I_L + \frac{\delta(I_L - k)}{1+r}\} = p_L$. Therefore, if $I_L \leq d < \underline{d} \equiv I_L + (I_L - k)\delta$, the retailer offers consumer financing and sells to all consumers, and the optimal profit under this condition is $\pi_1(p, F) = p - w + r(p - I_L)/2$ with an optimal price $p^* = p_L$; if $\underline{d} \leq d < I_H$, the retailer offers consumer financing and sells only to high-income consumers, and the optimal profit under this condition is $\pi_1(p, F) = (p - w)/2$ with an optimal price $p^* = I_L + \frac{\delta(I_L - k)}{1+r}$. The latter is strictly dominated by charging a high price and offering consumer financing since $\pi_N^H(d, N) = (d - w)/2 < \pi_1(\underline{d}, F) = (\underline{d} - w)/2$ and $d > \underline{d}$. Notice that offering consumer financing improves the ability to pay of low-income consumers from I_L to d and the retailer can increase the price from I_L to p_L accordingly when the wholesale price is low. Since low-income consumers will surely repay in this case, offering consumer financing increases the retailer's profit through higher profit margin and interest revenue.

When the retailer chooses a medium price $p \in (I_L + \frac{\delta(I_L - k)}{1+r}, I_L + \frac{\delta I_L}{1+r}]$ (i.e., "medium price strategy"), low-income consumers cannot afford the product without consumer financing. Thus, the retailer can choose to pass through credits to consumers and a lower price to sell to both high and low segments with some consumer default risk or choose not to pass through credits to consumers and a higher price to sell only to the high segment without any consumer default risk. In this case, if the retailer offers consumer financing, low-income consumers will buy if $p \leq p_H$ and will repay without expense shock and default with expense shock. The retailer, accordingly, will choose a best response price $p = \min\{p_H, I_L + \frac{\delta I_L}{1+r}\}$ to maximize the profit $\pi_2(p, F) = \frac{1}{4}(p - w + r(p - I_L)) + \frac{1}{2}(p - w) + \frac{1}{4}(I_L + I_L\delta - k\delta - w)$. Here the retailer's profit consists of

three parts: low-income consumers without expense shock who will repay ($\frac{1}{4}(p - w + r(p - I_L))$); low-income consumers with expense shock who will default and the retailer can get part of the net asset ($\frac{1}{4}(I_L + I_L\delta - k\delta)$) but lose the production cost ($\frac{1}{4}w$); and high-income consumers who will buy without using credits ($\frac{1}{2}(p - w)$). Specifically, when the retailer chooses a medium price $p \in (I_L + \frac{\delta(I_L - k)}{1+r}, I_L + \frac{\delta I_L}{1+r}]$, if $d < \underline{d}$, consumers will not buy; if $\underline{d} \leq d < \bar{d} \equiv I_L + \delta(I_L - k\lambda)$, all consumers buy (low-income consumers will buy and may default and high-income consumers will buy) and the total profit of the retailer is $\pi_2(p_H, F)$; if $d > \bar{d}$, all consumers buy (low-income consumers will buy and may default and high-income consumers will buy) and the total profit of the retailer is $\pi_2(I_L + \frac{\delta I_L}{1+r}, F)$; if the retailer sells only to high-income consumers, the retailer will charge a high price. In this case, consumer financing can improve consumers' ability to pay and expand the market; however, part of consumers will default, resulting in consumer default loss for the retailer.

When the retailer chooses a high price $p \in (I_L + \frac{\delta I_L}{1+r}, I_H]$ (i.e., "high price strategy"),⁹ low-income consumers cannot afford the product without consumer financing. Low-income consumers will make a purchase if $d > \bar{d}$ and will default in the next period. Thus, the retailer can choose to pass through credits to consumers to sell to both high and low segments with consumer default risk or choose not to pass through credits to consumers to sell only to the high segment without any consumer default risk. If the retailer chooses to pass through credits to consumers and $d > \bar{d}$, the total profit is $\pi_3(d, F) = \frac{1}{2}(p - w) + \frac{1}{2}(I_L + I_L\delta - \frac{1}{2}k\delta - w)$. Here the retailer's profit from high-income consumers is the same $\frac{1}{2}(p - w)$ and the payoff from low-income consumers is $\frac{1}{2}(I_L + I_L\delta - \frac{1}{2}k\delta - w)$. In this case, offering consumer financing induces the retailer to charge a high retail price so that the profit margin from high-income consumers will be high, and the confiscated asset and the first period down-payment from low-income consumers can offset part of the default loss.

To sum up, the analytical expressions of the retailer's best response depend on three qualitatively different ranges of the product value d : (1) low product value: $I_L \leq d < \underline{d}$; (2) moderate product value: $\underline{d} \leq d < \bar{d}$; and (3) high product value $\bar{d} \leq d < I_H$. We find that for $r > \hat{r} = \frac{k}{2I_L - k}$:

Case 1: when $I_L \leq d < \underline{d}$, rational default will not be in the equilibrium result because the product value is not high enough such that consumers will default even though they know they cannot repay in the future. Thus, the high price strategy and medium price strategy will not survive in the equilibrium. In addition, an extreme low price without consumer financing is dominated by the low price strategy since $\pi_1(p_L, F) - \pi_N^L(I_L, N) = \frac{(d - I_L)(2+r)}{2(1+r)} > 0$. Therefore, the retailer will choose the low price strategy when $w \leq w_1 = \frac{d+rI_L}{1+r}$ and choose a high price with consumer financing otherwise. In equilibrium, we find that when $w \leq w_1$, the retailer will choose to provide consumer financing and set $p^* = p_L$ to sell to both segments; when $w > w_1$, the retailer will choose not to pass through credits to consumers and set $p^* = d$.

Case 2: when $\underline{d} \leq d < \bar{d}$, low-income consumers will buy if $p \leq \min\{d, p_H\}$ and high-income consumers will buy if $p \leq d$. In this case, the medium price strategy dominates the low-price strategy since the product

⁹Here we assume the income difference is high enough $I_L + \frac{\delta I_L}{1+r} < I_H$ to capture the consumer heterogeneity that low-income consumers are more likely to use consumer financing while high-income consumers are not. If $I_L + \frac{\delta I_L}{1+r} \geq I_H$, the retailer may set a high price such that even high-income consumers need financing to make a purchase, which is not consistent with the practice.

value is relatively high ($d \geq \underline{d}$) such that the increased profit margin from offering consumer financing will outweigh the default loss but not high enough to make the high price strategy optimal. However, the product value is still not high enough to induce the retailer to adopt a high price strategy, in which case the default loss is too high. In addition, rational default will not be in the equilibrium result. Therefore, for $r > \hat{r}$, when $w \leq w_2 = \frac{2d + I_L(-1+r-\delta) + k\delta}{1+r}$, the retailer will adopt the medium price strategy (i.e., set $p^* = \min\{d, p_H\} = p_H$ and offer credits to both low- and high-income consumers); when $w > w_2$, the retailer will set $p^* = d$ and not offer credits to low-income consumers.

Case 3: when $\bar{d} \leq d < I_H$, it is possible that low-income consumers will buy and rationally default, and high-income consumers will buy if $p \leq d$. If the retailer chooses a low-price strategy, the optimal price is $p^* = I_L + \frac{\delta(I_L - k)}{1+r}$ and all consumers will buy and repay. If the retailer chooses a medium price strategy, the optimal price is $p^* = I_L + \frac{\delta I_L}{1+r}$ since $p_H > I_L + \frac{\delta I_L}{1+r}$ in this case and all consumers will buy. However, the product value is high enough such that the high price strategy dominates the medium price strategy in that the increased profit margin from increased price will outweigh the default loss. Therefore, when $w \leq w_3 = I_L + I_L\delta - (k\delta)/2$, the retailer will adopt the high price strategy (i.e., set $p^* = d$ and offer credits to low-income consumers); when $w > w_3$, the retailer will set $p^* = d$ and not offer consumer financing.

To sum up, the best responses of the retailer $\{p^{BR}, G^{BR}\}$ are as follows: (1) If $I_L \leq d < \underline{d}$, when $w \leq w_1$, the optimal strategy is $\{p_L, F\}$; when $w > w_1$, the optimal strategy is $\{d, N\}$. (2) If $\underline{d} \leq d < \bar{d}$, when $w \leq w_2$, the optimal strategy is $\{p_H, F\}$; when $w > w_2$, the optimal strategy is $\{d, N\}$. (3) If $\bar{d} \leq d < I_H$, when $w \leq w_3$, the optimal strategy is $\{d, F\}$; when $w > w_3$, the optimal strategy is $\{d, N\}$. $\square$

Proof. PROOF OF PROPOSITION 1 Expecting the retailer's best responses above, the supplier chooses an optimal wholesale price to maximize its expected profit. We denote the equilibrium strategy as $\{w^*, p^*, G^*\}$. When the supplier sells through a financially distressed retailer with bankruptcy risk who has the capability to offer consumer financing, in equilibrium:

(1) For $I_L \leq d < \underline{d}$ and $c \leq c_1$, the optimal strategy is $\{\tilde{w}_1, p_L, F\}$ when $\underline{a}_1 = \frac{I_L r + d(2+r)}{6(1+r)} < a < \bar{a}_1 = \frac{3I_L r + d(2-r)}{2(1+r)}$ where $\tilde{w}_1 = \frac{I_L r + 2a(1+r) + d(2+r)}{4(1+r)}$; $\{w_1, p_L, F\}$ when $a \leq \underline{a}_1$ (the retailer does not have bankruptcy risk) or $a \geq \bar{a}_1$. Here $\bar{a}_1$ solves $w_1 = \tilde{w}_1$, and $\underline{a}_1$ solves $a = \pi_1^R(p_L, F)$. Therefore, when $a \leq \underline{a}_1$, the retailer does not have bankruptcy risk and the supplier will charge a wholesale price of w_1 and gain $\pi_1^M(w_1|p_L, F)$; when $\underline{a}_1 < a < \bar{a}_1$, the supplier will lower the wholesale price ($\tilde{w}_1 < w_1$) and incentivize the retailer to pass through credits to consumers to sell to all consumers, gaining $E[\Pi^M(\tilde{w}_1|p_L, F)]$; when $a \geq \bar{a}_1$, the supplier will not lower the wholesale price and charge w_1 , gaining $E[\Pi^M(w_1|p_L, F)]$.

(2) For $\underline{d} \leq d < \bar{d}$ and $c \leq c_2$, the optimal strategy is $\{\tilde{w}_2, p_H, F\}$ when $\underline{a}_2 = \frac{d(3+r) + I_L(-1+r-\delta) + k\delta}{6(1+r)} < a < \bar{a}_2 = \frac{d(5-r) + 3(I_L(-1+r-\delta) + k\delta)}{2(1+r)}$ where $\tilde{w}_2 = \frac{-I_L + I_L r + 2a(1+r) + d(3+r) - I_L\delta + k\delta}{4(1+r)}$; $\{w_2, p_H, F\}$ otherwise. Here $\bar{a}_2$ solves $w_2 = \tilde{w}_2$, and $\underline{a}_2$ solves $a = \pi_2^R(p_H, F)$. Therefore, when $a \leq \underline{a}_2$, the retailer does not have bankruptcy risk and the supplier will charge a wholesale price of w_2 and gain $\pi_2^M(w_2|p_H, F)$; when $\underline{a}_2 < a < \bar{a}_2$, the supplier will lower the wholesale price ($\tilde{w}_2 < w_2$) and incentivize the retailer to pass through credits to consumers to sell to all consumers, gaining $E[\Pi^M(\tilde{w}_2|p_H, F)]$; when $a \geq \bar{a}_2$, the supplier will not lower the

wholesale price and charge w_2 , gaining $E[\Pi^M(w_2|p_H, F)]$.

(3) For $\bar{d} \leq d < I_H$ and $c \leq c_3$, the optimal strategy is $\{\tilde{w}_3, d, F\}$ when $c \leq c_3$ and $\underline{a}_3 = \frac{2d-k\delta+2I_L(1+t)}{12} < a < \bar{a}_3 = \frac{3(-k\delta+2I_L(1+\delta))-2d}{4}$ where $\tilde{w}_3 = \frac{4a+2d+2I_L+2I_L\delta-k\delta}{8}$; $\{w_3, d, F\}$ otherwise. Here $\bar{a}_3$ solves $w_3 = \tilde{w}_3$, and $\underline{a}_3$ solves $a = \pi_3^R(d, F)$. Therefore, when $a \leq \underline{a}_3$, the retailer does not have bankruptcy risk and the supplier will charge a wholesale price of w_3 and gain $\pi_3^M(w_3|d, F)$; when $\underline{a}_3 < a < \bar{a}_3$, the supplier will lower the wholesale price ($\tilde{w}_3 < w_3$) and incentivize the retailer to pass through credits to consumers to sell to all consumers, gaining $E[\Pi^M(\tilde{w}_3|p_L, F)]$; when $a \geq \bar{a}_3$, the supplier will not lower the wholesale price and charge w_3 , gaining $E[\Pi^M(w_3|p_H, F)]$.

(4) For $c > c_i$ ($i \in \{1, 2, 3\}$ respectively) the optimal strategy is $\{\tilde{w}, d, N\}$ if $\underline{a} = \frac{d}{6} < a < \bar{a} = \frac{d}{2}$ where $\tilde{w} = a + \frac{d}{2}$; $\{d, d, N\}$ otherwise. Here $\bar{a}$ solves $d = \tilde{w}$, and $\underline{a}$ solves $a = \pi^R(d, N)$. Therefore, when $a \leq \underline{a}$, the retailer does not have bankruptcy risk and the supplier will charge a wholesale price of d and gain $\pi^M(d|d, F)$; when $\underline{a} < a < \bar{a}$, the supplier will lower the wholesale price ($\tilde{w} < d$) and incentivize the retailer to pass through credits to consumers to sell to all consumers, gaining $E[\Pi^M(\tilde{w}|d, F)]$; when $a \geq \bar{a}$, the supplier will not lower the wholesale price and charge d , gaining $E[\Pi^M(d|d, F)]$.

Here c_1, c_2, c_3 solve $E[\Pi^M(w^*|p^{BR}, F)] = E[\Pi^M(w^*|p^{BR}, N)]$ when the product value is low, moderate and high, respectively, and denote the cutoff values that the supplier induces the retailer to pass through credits to consumers ($c \leq c_i, i \in \{1, 2, 3\}$) or not ($c > c_i$) for the sake of exposition. The specific value varies with different ranges of asset shock variance a . Now we discuss the cutoff values of marginal cost in three cases below.

Case 1: $I_L \leq d < \underline{d}$, $\underline{a} < \underline{a}_1 < \bar{a} < \bar{a}_1$. When $a \leq \underline{a}$, the retailer does not have bankruptcy risk regardless of marginal production cost and $c_1 = \frac{d-dr+2I_Lr}{1+r} \equiv \hat{c}_1$; when $\underline{a} < a \leq \underline{a}_1$, the retailer does not have bankruptcy risk when the production cost is low but has bankruptcy risk otherwise, so $c_1 = \frac{1}{16}(\frac{4d(7-r)+32I_Lr}{1+r} - 4a - d^2/a)$; when $\underline{a}_1 < a < \bar{a}$, the retailer has bankruptcy risk and the supplier will reduce the wholesale price regardless of production cost, so $c_1 = \frac{(d+I_Lr)(I_Lr+4(1+r)+d(3+2r))}{16(1+r)^2} \equiv \tilde{c}_1$; when $\bar{a} < a < \bar{a}_1$, the retailer has bankruptcy risk regardless of the production cost and the supplier will reduce the wholesale price only when the marginal cost is low, so $c_1 = \frac{1}{16}(4a - \frac{4(d-I_L)r}{1+r} + \frac{(I_Lr+d(2+r))^2}{a(1+r)^2}) \equiv \bar{c}_1$; when $a \geq \bar{a}_1$, the retailer has bankruptcy risk and the supplier will not reduce the wholesale price regardless of the production cost, so $c_1 = \frac{a(1+r)(d(1-r)+2I_Lr)+(d-I_L)r(d+I_Lr)}{2a(1+r)^2}$.

Case 2: $\underline{d} \leq d < \bar{d}$, $\underline{a} < \underline{a}_2 < \bar{a} < \bar{a}_2$. When $a \leq \underline{a}$, the retailer does not have bankruptcy risk regardless of marginal production cost and $c_2 = \frac{-d(-3+r)+2I_L(-1+r-\delta)+2k\delta}{1+r} \equiv \hat{c}_2$; when $\underline{a} < a \leq \underline{a}_2$, the retailer does not have bankruptcy risk when the production cost is low but has bankruptcy risk otherwise, so $c_2 = \frac{1}{16}(\frac{4(d(-15+r)-8k\delta+8I_L(1-r+\delta))}{1+r} - 4a - d^2/a)$; when $\underline{a}_2 < a < \bar{a}$, the retailer has bankruptcy risk and the supplier will reduce the wholesale price regardless of production cost, so $c_2 = \tilde{c}_2 = \frac{2d+I_L(-1+r-\delta)+k\delta(4a(1+r)+2d(2+r)+I_L(-1+r-\delta)+k\delta)}{16a(1+r)^2}$; when $\bar{a} < a < \bar{a}_2$, the retailer has bankruptcy risk regardless of the production cost and the supplier will reduce the wholesale price only when the marginal cost is low, so $c_2 = \frac{-I_L+I_Lr+2a(1+r)+d(3+r)-I_L\delta+k\delta)^2}{16a(1+r)^2} - \frac{d}{2} \equiv \bar{c}_2$; when $a \geq \bar{a}_2$, the retailer has

bankruptcy risk and the supplier will not reduce the wholesale price regardless of the production cost, so $c_2 = \frac{1}{8} \left(\frac{12(2d+I_L(-1+r-\delta)+k\delta)}{1+r} - \frac{(d(-1+r)-k\delta+I_L(1-r+\delta))^2}{a(1+r)^2} - 4a \right)$.

Case 3: $\bar{d} \leq d < I_H$, $\underline{a} < \underline{a}_3 < \bar{a} < \bar{a}_3$. When $a \leq \underline{a}$, the retailer does not have bankruptcy risk regardless of marginal production cost and $c_3 = \hat{c}_3 = 2I_L(1+\delta) - d - k\delta$; when $\underline{a} < a \leq \underline{a}_3$, the retailer does not have bankruptcy risk when the production cost is low but has bankruptcy risk otherwise, so $c_2 = 2I_L + 2I_L\delta - k\delta - (a/4) - d/4 - d^2/(16a)$; when $\underline{a}_3 < a < \bar{a}$, the retailer has bankruptcy risk and the supplier will reduce the wholesale price regardless of production cost, so $c_3 = \frac{(8a+4d+2I_L+2I_L\delta-k\delta)(-k\delta+2I_L(1+\delta))}{64a} \equiv \tilde{c}_3$; when $\bar{a} < a < \bar{a}_3$, the retailer has bankruptcy risk regardless of the production cost and the supplier will reduce the wholesale price only when the marginal cost is low, so $c_3 = \frac{16a^2-8a(2d+k\delta-2I_L(1+\delta))+(2d-k\delta+2I_L(1+\delta))^2}{64a} \equiv \bar{c}_3$; when $a \geq \bar{a}_3$, the retailer has bankruptcy risk and the supplier will not reduce the wholesale price regardless of the production cost, so $c_3 = 2 \left(\frac{(2d-k\delta+2I_L(1+\delta))^2}{64a} - \frac{d}{4} \right)$.

Based on the equilibrium results, we find that when the product value is high ($\bar{d} \leq d < I_H$) and the marginal production cost is low ($c \leq c_3$), the retailer will adopt a high price strategy ($p^* = d$) and offers consumer financing even though low-income consumers do not repay. $\square$

Proof. PROOF OF LEMMA 3 The retailer's profit is

$$\pi_R(p, G) = \begin{cases} p - w, & N, p \in [0, I_L] \\ \frac{p-w}{2}, & N, p \in (I_L, d] \\ p - w + r(p - I_L)/2 & F, p \in [I_L, I_L + \frac{\delta(I_L-k)}{1+r}] \\ \frac{1}{4}(p - w + r(p - I_L) - w + I_L + I_L\delta - k\delta) + \frac{1}{2}(p - w), & F, p \in (I_L + \frac{\delta(I_L-k)}{1+r}, I_L + \frac{\delta I_L}{1+r}] \\ (p - w)/2 + (I_L + I_L\delta - k\delta/2 - w)/2, & F, p \in (I_L + \frac{\delta I_L}{1+r}, I_H], \end{cases}$$

where $G = N$ denotes choosing not to offer consumer financing/ pass through credits to consumers and $G = F$ denotes choosing to offer consumer financing/ pass through credits to consumers. At stage 1, the supplier decides its wholesale price to maximize profit $\pi^M = Q(w - c)$ where Q denotes the demand. Now we compare the profit functions of different strategies with best response price.

Case 1: If $I_L \leq d < \underline{d}$, low-income consumers will buy if $p \leq p_L \equiv \frac{d+rI_L}{1+r} (< d)$ and high-income consumers will buy if $p \leq d$. Furthermore, rational default will not be in the equilibrium result because the product value is not high enough such that consumers will default even though they know they cannot repay in the future. Thus, the high price strategy and medium price strategy will not survive in the equilibrium. In addition, an extreme low price without consumer financing is dominated by the low price strategy since $\pi_1(p_L) - \pi_N^L(I_L) = \frac{(d-I_L)(2+r)}{2(1+r)} > 0$. Therefore, the retailer will choose the low price strategy when $w \leq w_1 = \frac{d+rI_L}{1+r}$ and choose a high price without consumer financing otherwise. In equilibrium, we find that when $w \leq w_1$, the retailer will choose to provide consumer financing and set $p^* = p_L$ to sell to both segments ("low price strategy"); when $w > w_1$, the retailer will choose not to pass through credits to consumers and set $p^* = d$.

Case 2: If $\underline{d} \leq d < \bar{d}$, low-income consumers will buy if $p \leq \min\{d, p_H\}$ and high-income consumers will buy if $p \leq d$. In this case, the medium price strategy dominates the low price strategy since the product value is relatively high ($d \geq \underline{d}$) such that the increased profit margin from offering consumer financing will outweigh the default loss but not high enough to make the high price strategy optimal. However, the product value is still not high enough to induce the retailer to adopt a high price strategy, in which case the default loss is too high. In addition, rational default will not be in the equilibrium result. Therefore, when $w < W$, the retailer will adopt the medium price strategy (i.e., set $p^* = \min\{d, p_H\}$ and offer credits to both low- and high-income consumers); when $w \geq W$, the retailer will set $p^* = d$ and not offer credits to low-income consumers. $\tilde{d} \equiv \frac{I_L(1-r+\delta)-k\delta}{1-r}$ solves $d = p_H$ and $\tilde{d} > \bar{d}$ if and only if $r > \hat{r}$. Specifically, if $r \leq \hat{r}$, when $\underline{d} \leq d < \tilde{d}$, $p^* = p_H$ and $W = w_2 = \frac{2d+I_L(-1+r-\delta)+k\delta}{1+r}$ and when $\tilde{d} \leq d < \bar{d}$, $p^* = d$ and $W = w'_2 = \frac{I_L(2+2r+2\delta+r\delta)}{1+r} - d - (k\delta)/2$. If $r > \hat{r}$, $p^* = p_H$ and $W = w_2$.

Case 3: If $\bar{d} \leq d < 2I_L$, it is possible that low-income consumers will buy and rationally default, and high-income consumers will buy if $p \leq d$. If the retailer chooses a low-price strategy, the optimal price is $p^* = I_L + \frac{\delta(I_L-k)}{1+r}$ and all consumers will buy and repay. If the retailer chooses a medium price strategy, the optimal price is $p^* = \min\{d, I_L + \frac{\delta I_L}{1+r}\}$ since $p_H > I_L + \frac{\delta I_L}{1+r}$ in this case and all consumers will buy. Specifically, if $\bar{d} \leq d < I_L + \frac{\delta I_L}{1+r}$ ($r < \hat{r}$), the optimal price is $p^* = d$ and if $I_L + \frac{\delta I_L}{1+r} \leq d < 2I_L$, the optimal price is $p = I_L + \frac{\delta I_L}{1+r}$. If $r \geq \hat{r}$, the optimal price is $p^* = I_L + \frac{\delta I_L}{1+r}$. If $\bar{d} \leq d < I_L + \frac{\delta I_L}{1+r}$ ($r < \hat{r}$), when $w \leq w'_2$, the retailer will adopt the medium price strategy; when $w > w'_2$, the retailer will set a high price $p^* = d$ without consumer financing. However, if $r \geq \hat{r}$ or $r < \hat{r}$ and $I_L + \frac{\delta I_L}{1+r} \leq d < 2I_L$, the product value is high enough such that the high price strategy dominates the medium price strategy in that the increased profit margin from increased price will outweigh the default loss. Therefore, when $w \leq w_3 = I_L + I_L\delta - (k\delta)/2$, the retailer will adopt the high price strategy (i.e., set $p^* = d$ and offer credits to low-income consumers); when $w > w_3$, the retailer will set $p^* = d$ and not offer credits.

We denote the equilibrium results as $\{w^*, p^*, G^*\}$. (1) If $I_L \leq d < \underline{d}$, when $c \leq \hat{c}_1 = \frac{d-dr+2I_Lr}{1+r}$, the retailer will choose $\{p_L, F\}$ and the supplier will choose a wholesale $w = w_1$ accordingly; when $c > \hat{c}_1$, the retailer will choose $\{d, N\}$ and the supplier will choose a wholesale $w = d$ accordingly. (2) If $\underline{d} \leq d < \bar{d}$ and $r \geq \hat{r}$, or $\underline{d} \leq d < \tilde{d}$ and $r < \hat{r}$, when $c \leq \hat{c}_2 = \frac{-d(-3+r)+2I_L(-1+r-\delta)+2k\delta}{1+r}$, the retailer will choose $\{p_H, F\}$ and the supplier will choose a wholesale $w = w_2$ accordingly; when $c > \hat{c}_2$, the retailer will choose $\{d, N\}$ and the supplier will choose a wholesale $w = d$ accordingly. If $\tilde{d} \leq d < I_L + \frac{\delta I_L}{1+r}$ and $r < \hat{r}$, when $c \leq \hat{c}_2' = dr - k\delta + I_L(1-r+\delta)$, the retailer will choose $\{d, F\}$ and the supplier will choose a wholesale $w = w'_2$ accordingly; when $c > \hat{c}_2'$, the retailer will choose $\{d, N\}$ and the supplier will choose a wholesale $w = d$ accordingly. (3) If $\bar{d} \leq d < 2I_L$ and $r \geq \hat{r}$, or $I_L + \frac{\delta I_L}{1+r} \leq d < 2I_L$ and $r < \hat{r}$, when $c \leq \hat{c}_3 = -d - k\delta + 2I_L(1+\delta)$, the retailer will choose $\{d, F\}$ and the supplier will choose a wholesale $w = w_3$ accordingly; when $c > \hat{c}_3$, the retailer will choose $\{d, N\}$ and the supplier will choose a wholesale $w = d$ accordingly.

To sum up, if the supplier sells through a retailer who has the capability to offer consumer financing, in

equilibrium, (1) If $I_L \leq d < \underline{d}$, when $c \leq \hat{c}_1$, the optimal strategy is $\{w_1, p_L, F\}$; when $c > \hat{c}_1$, the optimal strategy is $\{d, d, N\}$; (2) If $\underline{d} \leq d < \bar{d}$ and $r \geq \hat{r}$, or $\underline{d} \leq d < \bar{d}$ and $r < \hat{r}$, when $c \leq \hat{c}_2$, the optimal strategy is $\{w_2, p_H, F\}$; when $c > \hat{c}_2$, the optimal strategy is $\{d, d, N\}$. If $\bar{d} \leq d < I_L + \frac{\delta I_L}{1+r}$ and $r < \hat{r}$, when $c \leq \hat{c}_2'$, the optimal strategy is $\{w_2', d, F\}$; when $c > \hat{c}_2'$, the optimal strategy is $\{d, d, N\}$. (3) If $\bar{d} \leq d < I_H$ and $r \geq \hat{r}$, or $I_L + \frac{\delta I_L}{1+r} \leq d < 2I_L$ and $r < \hat{r}$, when $c \leq \hat{c}_3$, the optimal strategy is $\{w_3, d, F\}$; when $c > \hat{c}_3$, the optimal strategy is $\{d, d, N\}$. $\square$

Proof. PROOF OF PROPOSITION 3 For $\bar{d} \leq d < I_H$ and $c \leq c_3$, the optimal strategy is $\{\tilde{w}_3, d, F\}$ when $c \leq \bar{c}_3$ and $\underline{a}_3 < a < \bar{a}_3$ ($\bar{a}_3 > \bar{a}$ requires $d < \frac{3}{4}(2I_L + 2I_L\delta - k\delta)$); $\{w_3, d, F\}$ otherwise. For $c > c_3$ respectively, the optimal strategy is $\{\tilde{w}, d, N\}$ if $\underline{a} < a < \bar{a}$; $\{d, d, N\}$ otherwise. Therefore, when $\bar{d} \leq d < \frac{3}{4}(2I_L + 2I_L\delta - k\delta)$, there exists $a \in (\bar{a}, \bar{a}_3)$ such that the retailer has bankruptcy risk and the supplier will share the risk if $c \leq \bar{c}_3 = \frac{16a^2 - 8a(2d + k\delta - 2I_L(1+\delta)) + (2d - k\delta + 2I_L(1+\delta))^2}{64a}$ and the retailer has bankruptcy risk but the supplier will not share the risk otherwise. If we compare $\bar{c}_3$ and $\hat{c}_3$ (the cutoff value for the non-distressed retailer), we find that $\bar{c}_3 > \hat{c}_3$ when $\bar{d} \leq d < \hat{d}$. Thus, if $a \in (\bar{a}, \bar{a}_3)$ and $c \in (\hat{c}_3, \bar{c}_3]$, the financially distressed retailer will offer consumer financing whereas the non-distressed retailer will not. $\square$

Proof. PROOF OF PROPOSITION 2 & 4 If the supplier sells through a financially distressed retailer, $r > \hat{r}$ and $\underline{a}_i < a < \bar{a}$ ($i \in \{1, 2, 3\}$), expecting the retailer's decisions, the supplier maximizes his expected profits as in Equations (5)-(7). We denote the equilibrium strategy as $\{w^*, p^*, G^*\}$: (1) for $I_L \leq d < \underline{d}$ and $\underline{a}_1 < a < \bar{a}$, when $c \leq \bar{c}_1$, the optimal strategy is $\{\tilde{w}_1, p_L, F\}$ where $\tilde{w}_1 = \frac{I_L r + 2a(1+r) + d(2+r)}{4(1+r)}$; otherwise, $\{\tilde{w}, d, N\}$ where $\tilde{w} = a + \frac{d}{2}$; for $I_L \leq d < \underline{d}$ and $\bar{a} < a < \bar{a}_1$, when $c \leq \bar{c}_1$, the optimal strategy is $\{\tilde{w}_1, p_L, F\}$; otherwise, $\{2I_L - d, d, N\}$. (2) for $\underline{d} \leq d < \bar{d}$ and $\underline{a}_2 < a < \bar{a}$, when $c \leq \bar{c}_2$, the optimal strategy is $\{\tilde{w}_2, p_H, F\}$ where $\tilde{w}_2 = \frac{-I_L + I_L r + 2a(1+r) + d(3+r) - I_L \delta + k\delta}{4(1+r)}$; otherwise, $\{\tilde{w}, d, N\}$; for $\underline{d} \leq d < \bar{d}$ and $\bar{a} < a < \bar{a}_2$, when $c \leq \bar{c}_2$, the optimal strategy is $\{\tilde{w}_2, p_H, F\}$; otherwise, $\{2I_L - d, d, N\}$. (3) for $\bar{d} \leq d < I_H$ and $\underline{a}_3 < a < \bar{a}$, when $c \leq \bar{c}_3$, the optimal strategy is $\{\tilde{w}_3, d, F\}$ where $\tilde{w}_3 = \frac{4a + 2d + 2I_L + 2I_L \delta - k\delta}{8}$; otherwise, $\{\tilde{w}, d, N\}$; for $\bar{d} \leq d < I_H$ and $\bar{a} < a < \bar{a}_3$, when $c \leq \bar{c}_3$, the optimal strategy is $\{\tilde{w}_3, d, F\}$; otherwise, $\{2I_L - d, d, N\}$.

To sum up, when $\underline{a}_i < a < \bar{a}$ ($i \in \{1, 2, 3\}$), the supplier will charge a lower wholesale price if the supplier sells through a financially distressed retailer than through a non-distressed retailer (Proposition 2). When the marginal cost is low $c \leq \tilde{c}_0$ and $4I_L < 3d$, if we compare the equilibrium results, a supplier will not lower the wholesale price if the financially distressed retailer does not have the capability to offer consumer financing; whereas a supplier will lower the wholesale price if the financially distressed retailer has the capability to offer consumer financing (Proposition 4). $\square$

Proof. PROOF OF PROPOSITION 5 When the retailer does not have the capability to offer consumer financing, sets price at I_L and sells to both segments, consumer surplus is $CS_N^L = d - I_L$; if the retailer chooses to sell only to the high-income consumers, consumer surplus is $CS_N^H = 0$.

When the retailer has the capability to offer consumer financing, we study three cases (low product value, moderate product value and high product value) based on the equilibrium results. When the product

value is low ($I_L \leq d < \underline{d}$), the retailer sets the price at p_L and offers consumer financing to sell to both segments when the marginal production cost is low ($c \leq c_1$). Low-income consumers will buy, pay interest and repay, gaining a surplus of $d - I_L - (-I_L + p_L)(1 + r)$; high-income consumers will buy directly and gain $d - p_L$. Thus, consumer surplus is $CS_1 = 1/2(d - I_L - (-I_L + p_L)(1 + r)) + 1/2(d - p_L)$. When the product value is moderate ($\underline{d} \leq d < \bar{d}$), the retailer sets the price at p_H and offers consumer financing to sell to both segments when the marginal production cost is low ($c \leq c_2$). Low-income consumers will buy and may default, gaining a surplus of $d - I_L - (-I_L + p_H)(1 + r)$ if they repay or $d - I_L - (I_L - k)\delta$ if they default; high-income consumers will buy directly and gain $d - p_H$. Thus, consumer surplus is $CS_2 = (d - I_L - (I_L - k)\delta)/4 + (d - I_L - (-I_L + p_H)(1 + r))/4 + 1/2(d - p_H)$. When the product value is high ($\bar{d} \leq d < I_H$), the retailer sets the price at d and offers consumer financing to sell to both segments when the marginal production cost is low ($c \leq c_3$). Low-income consumers will buy and default, gaining a surplus of $d - I_L - (I_L - k/2)\delta$; high-income consumers will buy directly and gain 0. Thus, consumer surplus is $CS_3 = (d - I_L - (I_L - k/2)\delta)/2$. When the marginal production cost is high ($c > c_i$, $i \in \{1, 2, 3\}$) regardless of the product value, the retailer sets the price at d , does not pass through credits to consumers and sells only to the high-income consumers. In this case, consumer surplus is $CS^H = 0$. If we compare consumer surplus with and without the capability to offer consumer financing, we find that counterintuitively, when the marginal production cost is low ($c \leq \hat{c}_0$), consumer surplus is lower with the capability to offer consumer financing ($CS_i < CS_N^L$). Specifically, $CS_1 - CS_N^L = \frac{-((d - I_L)(2 + r))}{2(1 + r)} < 0$; $CS_2 - CS_N^L = \frac{-(d(3 + r) + k\delta - I_L(3 + r + \delta))}{2(1 + r)} < \frac{-(\underline{d}(3 + r) + k\delta - I_L(3 + r + \delta))}{2(1 + r)} = \frac{-(I_L - k)(2 + r)\delta}{2(1 + r)} < 0$; $CS_3 - CS_N^L = 1/4(-2d - 2I_L(-1 + \delta) + k\delta) < 1/4(-2\bar{d} - 2I_L(-1 + \delta) + k\delta) = 1/2(-2I_L + k)\delta < 0$. $\square$

Appendix B: Proofs of Chapter 3

Proof. PROOF OF LEMMA 1 For a decentralized firm with sales-finance conflicts, the sales division and the consumer finance division will make separate decisions (price and credit granting decisions) to maximize the profits respectively. If we compare the payoffs of offering and not offering consumer financing for the consumer finance division, the credit granting decision $\Gamma^{BR}(\cdot|p) =$

$$\begin{cases} N & \text{if } I_L < p \leq \hat{p}, \frac{I_L}{1+r} + I_L < p \leq 2v; \\ F & \text{if } \hat{p} < p \leq \frac{I_L}{1+r} + I_L. \end{cases} \quad (\text{B.1})$$

Therefore, if the price is either high or low ($I_L < p \leq \hat{p}, \bar{p} < p \leq 2v$), the consumer finance division will not offer consumer financing because either the interest is not high enough or low-income consumers cannot pay off the debts on expectation. If the price is moderate ($\hat{p} < p \leq \bar{p}$), the consumer finance division will offer consumer financing. Expecting the finance division's best response, the sales division's payoff is $\pi^s(p|\Gamma^{BR}) =$

$$\begin{cases} \frac{1-\alpha}{2}(p-c) & \text{if } I_L < p \leq \hat{p}, \bar{p} < p \leq 2v, \Gamma = N; \\ (1-\alpha)(p-c) & \text{if } \hat{p} < p \leq \bar{p}, \Gamma = F. \end{cases} \quad (\text{B.2})$$

Therefore, we solve for the optimal price and credit granting rule (p^*, Γ^*). If we plug the optimal decisions back into Equation (8) to (10), we can get the profits for the sales division and the finance division. The firm's profit is the sum of the sales profit and the finance profit:

$$\pi = \begin{cases} \frac{1-\alpha}{2}\delta(I_L + (1+r)(\bar{p} - I_L) - c) + \frac{1-\alpha}{2}(1-\delta)(I_L + v_s - c) + \frac{1-\alpha}{2}(\bar{p} - c) & \text{if } c \leq \tilde{c}; \\ \frac{1-\alpha}{2}(2v - c) & \text{if } c > \tilde{c}, \end{cases} \quad (\text{B.3})$$

where $\bar{p} = \frac{I_L}{1+r} + I_L$. Therefore, we have Lemma 1: *In equilibrium, a firm with sales-finance conflicts will choose $(\frac{I_L}{1+r} + I_L, F)$ when the marginal cost is low (i.e., $c \leq \tilde{c}$) with a sales division profit of $\pi^s = (1-\alpha)(I_L + \frac{I_L}{1+r} - c)$, a finance division profit of $\pi^f = (1-\alpha)((I_L + v_s)(1-\delta) + 2I_L\delta - I_L - \frac{I_L}{1+r})$ and the firm profit of $\pi = \frac{1-\alpha}{2}((1-\delta)v_s + (\frac{1}{1+r} + 2 + \delta)I_L - 2c)$. A firm with sales-finance conflicts will choose $(2v, N)$ when the*

marginal cost is high (i.e., $c > \tilde{c}$) with a sales division profit of $\pi^s = \frac{1-\alpha}{2}(2v - c)$, a finance division profit of $\pi^f = 0$ and firm profit of $\pi = \frac{1-\alpha}{2}(2v - c)$. $\square$

Proof. PROOF OF LEMMA 2 For a centralized firm without sales-finance conflicts, the sales division and the consumer finance division will make integrated decisions (price and credit granting decisions) to maximize the profit. The firm's profit is as follows.

$$\pi(\Gamma|p \leq I_L) = (1 - \alpha)(p - c) \text{ for any } \Gamma.$$

$$\pi(\Gamma|I_L < p \leq \bar{p}) = \begin{cases} \frac{1-\alpha}{2}(p - c) & \text{if } \Gamma = N; \\ \frac{1-\alpha}{2}\delta(I_L + (1+r)(p - I_L) - c) + \frac{1-\alpha}{2}(1 - \delta)(I_L + v_s - c) + \frac{1-\alpha}{2}(p - c) & \text{if } \Gamma = F. \end{cases} \quad (\text{B.4})$$

$$\pi(\Gamma|\bar{p} < p \leq 2v) = \begin{cases} \frac{1-\alpha}{2}(p - c) & \text{if } \Gamma = N; \\ \frac{1-\alpha}{2}(1 - \delta)(I_L + v_s - c) + \frac{1-\alpha}{2}(p - c) & \text{if } \Gamma = F. \end{cases} \quad (\text{B.5})$$

Given a price, the finance division compares the profits of offering and not offering consumer financing to make an optimal choice. We assume if the finance division is indifferent between offering and not offering, the finance division will not offer. We find if the firm chooses a moderate price ($\hat{p}_C < p \leq \frac{I_L}{1+r} + I_L$ where $\hat{p}_C = I_L + \frac{c - I_L - v_s + v_s \delta}{\delta(1+r)}$ solves $\frac{1-\alpha}{2}\delta(I_L + (1+r)(p - I_L) - c) + \frac{1-\alpha}{2}(1 - \delta)(I_L + v_s - c) + \frac{1-\alpha}{2}(p - c) = \frac{1-\alpha}{2}(p - c)$), it will choose offering consumer financing since the remaining debt and interest $(1+r)(p - I_L)$ are high enough and low-income consumers expect that they can pay off the debts. In this case, if low-income consumers repay, they generate a profit of $I_L + (1+r)(p - I_L) - c$; if they default, the firm can gain only first period down-payment I_L and the residual value v_s . If the firm chooses either a high or a low price ($p \leq \hat{p}_C, \frac{I_L}{1+r} + I_L < p \leq 2v$), the firm will not offer consumer financing because either the interest is not high enough or low-income consumers cannot pay off the debts on expectation. Thus, the credit granting decision $\Gamma^{BR}(\cdot|p) =$

$$\begin{cases} N & \text{if } p \leq \hat{p}_C, \frac{I_L}{1+r} + I_L < p \leq 2v; \\ F & \text{if } \hat{p}_C < p \leq \frac{I_L}{1+r} + I_L, \end{cases} \quad (\text{B.6})$$

With a high or a low price, the firm will not offer consumer financing, whereas with a moderate price, the firm will offer consumer financing. Therefore, we solve for the optimal price and credit granting rule (p^*, Γ^*). If we plug the optimal decisions back into Equation (12) and (13), we have the firm's profit:

$$\pi = \begin{cases} \frac{1-\alpha}{2}\delta(I_L + (1+r)(\bar{p} - I_L) - c) + \frac{1-\alpha}{2}(1 - \delta)(I_L + v_s - c) + \frac{1-\alpha}{2}(\bar{p} - c) & \text{if } c \leq \hat{c}; \\ \frac{1-\alpha}{2}(2v - c) & \text{if } c > \hat{c}. \end{cases} \quad (\text{B.7})$$

The equilibrium is summarized as Lemma 2: *In equilibrium, a firm without sales-finance conflicts will choose $(\frac{I_L}{1+r} + I_L, F)$ with a profit of $\pi = \frac{1-\alpha}{2}((1 - \delta)v_s + (\frac{1}{1+r} + 2 + \delta)I_L - 2c)$ when the marginal cost is low*

(i.e., $c \leq \hat{c}$) and choose $(2v, N)$ with a profit of $\pi = \frac{1-\alpha}{2}(2v - c)$ when the marginal cost is high (i.e., $c > \hat{c}$). $\square$

Proof. PROOF OF PROPOSITION 1 In a monopoly market, firms may have or not have sales-finance conflicts. According to Lemma 1 and 2: *In equilibrium, the centralized firm without sales-finance conflicts will choose $(\frac{I_L}{1+r} + I_L, F)$ when the marginal cost is low (i.e., $c \leq \hat{c}$) and choose $(2v, N)$ when the marginal cost is high (i.e., $c > \hat{c}$). For a decentralized firm with sales-finance conflicts, the sales and consumer finance divisions choose $(\frac{I_L}{1+r} + I_L, F)$ if the marginal cost is low (i.e., $c \leq \tilde{c}$); the sales and consumer finance divisions choose $(2v, N)$ otherwise.* Therefore, in a monopoly market, when $c \in (\tilde{c}, \hat{c})$, a centralized firm without sales-finance conflicts will choose a low price $p^* = \frac{I_L}{1+r} + I_L$ and offer consumer financing whereas a decentralized firm with sales-finance conflicts will choose a high price $p^* = 2v$ and not offer consumer financing.

In addition, one can easily show that $\hat{c} - \tilde{c} = v_s - v_s\delta + \frac{I_L(-1+\delta+r\delta)}{1+r}$, $\frac{d(\hat{c}-\tilde{c})}{dr} > 0$ and $\frac{d(\hat{c}-\tilde{c})}{d\delta} > 0$. Therefore, the size of the parameter space of $(\tilde{c}, \hat{c})$ increases as interest rate r increases or as δ increases.

To sum up, we have Proposition 1: *In a monopoly market, when $\tilde{c} < c \leq \hat{c}$, a firm without sales-finance conflicts will choose a low price $p^* = \bar{p}$ and offer consumer financing whereas a firm with sales-finance conflicts will choose a high price $p^* = 2v$ and not to offer. The size of the parameter space of $(\tilde{c}, \hat{c})$ increases as interest rate r increases ($\frac{d(\hat{c}-\tilde{c})}{dr} > 0$) or as δ increases ($\frac{d(\hat{c}-\tilde{c})}{d\delta} > 0$).* $\square$

Proof. PROOF OF LEMMA 3 For decentralized firms with sales-finance conflicts, without loss of generality, we assume $p_j < p_{-j}$. Now we discuss the following cases.

Case 1: No Consumer Financing $\{NN\}$. If finance divisions do not offer consumer financing, only high-income consumers will buy without seller-initiated financing. Since firm $-j$'s price is higher, high-income loyal consumers of firm j and switchers (a proportion of $\frac{1-\alpha}{2}$) will buy at firm j and only high-income loyal consumers (a proportion of $\frac{\alpha}{2}$) will buy at firm $-j$. Since no consumer financing is provided, finance divisions of firm j and firm $-j$ will gain:

$$\pi_j^f(NN|p_j < p_{-j}) = 0, \quad (\text{B.8})$$

$$\pi_{-j}^f(NN|p_j < p_{-j}) = 0. \quad (\text{B.9})$$

Case 2: Asymmetric Consumer Financing $\{FN\}$ or $\{NF\}$. If firm j offers consumer financing and firm $-j$ does not $\{FN\}$, low-income consumers can buy only from firm j . Since firm $-j$'s price is higher, loyal consumers of firm j and switchers (a proportion of $1 - \alpha$) will buy at firm j and only high-income loyal consumers of firm $-j$ (a proportion of $\alpha/2$) will buy at firm $-j$.

Since the finance division of firm j chooses to offer consumer financing, all consumers can afford the product, but low-income consumers may buy and default. With probability $1 - \delta$, low-income consumers default due to the risk of unemployment and the finance division will get first period down-payment I_L and residual value v_s , generating a financial profit of $\frac{1-\alpha}{2}(1 - \delta)(I_L + v_s - p_j)$; with probability of δ , low-income consumers repay and the financial division will get first period down-payment I_L and the remaining debt plus interest

$(1+r)(p-I_L)$, generating a financial profit of $\frac{1-\alpha}{2}\delta(I_L+(1+r)(p-I_L)-p_j)$. High-income consumers are similar as the case without consumer financing. Since no consumer financing is provided by firm $-j$, its financial profit is zero. Therefore, finance divisions of firm j and firm $-j$ will gain:

$$\pi_j^f(FN|p_j < p_{-j}) = \frac{1-\alpha}{2}((1-\delta)(I_L+v_s) + \delta(I_L+(1+r)(p_j-I_L)) - p_j), \quad (\text{B.10})$$

$$\pi_{-j}^f(FN|p_j < p_{-j}) = 0. \quad (\text{B.11})$$

Similarly, if the finance division of firm $-j$ offers consumer financing and the finance division of firm j does not $\{NF\}$, loyal consumers of firm $-j$ and low-income switchers (a proportion of $\frac{1}{2}$) will buy at firm $-j$ and high-income loyal consumers of firm j and high-income switchers (a proportion of $\frac{1-\alpha}{2}$) will buy at firm j . Therefore, finance divisions of firm j and firm $-j$ will gain:

$$\pi_j^f(NF|p_j < p_{-j}) = 0, \quad (\text{B.12})$$

$$\pi_{-j}^f(NF|p_j < p_{-j}) = \frac{1-\alpha}{2}((1-\delta)(I_L+v_s) + \delta(I_L+(1+r)(p_{-j}-I_L)) - p_{-j}). \quad (\text{B.13})$$

Case 3: Symmetric Consumer Financing $\{FF\}$. If both firms' finance divisions offer consumer financing, both low-income and high-income consumers can buy at either firm. Since firm $-j$'s price is higher, loyal consumers of firm $-j$ and switchers (a proportion of $1-\alpha$) will buy at firm j and loyal consumers of firm j (a proportion of α) will buy at firm $-j$. Therefore, finance divisions of firm j and firm $-j$ will gain:

$$\pi_j^f(FF|p_j < p_{-j}) = \frac{1-\alpha}{2}((1-\delta)(I_L+v_s) + \delta(I_L+(1+r)(p_j-I_L)) - p_j), \quad (\text{B.14})$$

$$\pi_{-j}^f(FF|p_j < p_{-j}) = \frac{\alpha}{2}((1-\delta)(I_L+v_s) + \delta(I_L+(1+r)(p_{-j}-I_L)) - p_{-j}). \quad (\text{B.15})$$

If we compare the objective function for the finance division, we find *for a decentralized firm with sales-finance conflicts, when $\hat{p} < p_j < \bar{p}$, the firm will offer consumer financing; otherwise, the firm will not.* $\square$

Proof. PROOF OF PROPOSITION 2 In a duopoly market where two decentralized firms with sales-finance conflicts compete, both firms will adopt mixed strategies based on Appendix A, Case DD. When the marginal cost is high $c \geq \bar{c}$, both firms will choose a price on the support of $p_A, p_B \in [\underline{p}, \bar{p}] \cup [\underline{p}_1, 2v]$. Both firms obtain expected profit of $E[\pi_D] = \int_{\underline{p}}^{\bar{p}} \pi_F f^s(p) dp + \int_{\underline{p}_1}^{2v} \pi_N f^s(p) dp$. We can rewrite the profit of the decentralized firm as the sum of the sales and financial profits, i.e.,

$$E[\pi_D] = \frac{\alpha}{2}(2v-c) + \int_{\underline{p}}^{\bar{p}} \frac{1}{2}[(\alpha+(1-F^s(p))(1-2\alpha))((1-\delta)(I_L+v_s) + \delta(I_L+(1+r)(p-I_L)) - p)] f^s(p) dp. \quad (\text{B.16})$$

For simplicity, we denote the financial profit as $H(p, \alpha) = \int_{\underline{p}}^{\bar{p}} \frac{1}{2}[(\alpha+(1-F^s(p))(1-2\alpha))((1-\delta)(I_L+v_s) + \delta(I_L+(1+r)(p-I_L)) - p)] f^s(p) dp = \frac{1}{16(1-2\alpha)} \left(\frac{(c-2v)^2 \alpha^2 (v_s(-1+\delta) + c\Delta - I_L(2/R+1)\Delta)}{(\bar{p}-c)^2} + 4(-1+\alpha)(-I_L - v_s + \right.$

$(I_L + 2v + v_s)\alpha + (RI_L + v_s - (R(I_L + 2v) + v_s)\alpha)\delta + c(-1 + 2\alpha)\Delta)$ where $\Delta = 1 + \delta + \delta r$, $R = 1 + r$. If we compare it with the benchmark, when $\tilde{c} < c < \hat{c}$, the profit of a decentralized firm in a monopoly market is

$$\pi_D^M = \frac{1 - \alpha}{2}(2v - c). \quad (\text{B.17})$$

If we compare Equation B.14 and B.15, equivalently, we are comparing $H(p, \alpha)$ with $\frac{1-2\alpha}{2}(2v - c)$. If $\alpha \rightarrow \frac{1}{2}^-$, $H(p, \alpha) \rightarrow +\infty$, $\frac{1-2\alpha}{2}(2v - c) \rightarrow 0$. We can show $\lim_{\alpha \rightarrow \frac{1}{2}} \frac{H(p, \alpha)}{\frac{1-2\alpha}{2}(2v - c)} > 1$. Thus, there exists $\bar{\alpha}$ such that when $\bar{\alpha} < \alpha < \frac{1}{2}$, $H(p, \alpha) > \frac{1-2\alpha}{2}(2v - c)$, i.e., $E[\pi_D] > \pi_D^M$. Therefore, we have Proposition 2 that *there exists $\bar{\alpha} < \alpha < \frac{1}{2}$ such that competing with another decentralized firm is more profitable than selling as a monopoly firm.* $\square$

Proof. PROOF OF LEMMA 4 When a centralized firm j without sales-finance conflicts competes with a decentralized firm $-j$ with sales-finance conflicts, for $p_j < p_{-j}$, the best response is the same as in Lemma 3. For $p_j > p_{-j}$, we discuss the following cases.

Case 1: No Consumer Financing $\{NN\}$. If firms do not offer consumer financing, only high-income consumers will buy without seller-initiated financing. Since firm j 's price is higher, high-income loyal consumers of firm j (a proportion of $\frac{\alpha}{2}$) will buy at firm j and high-income loyal consumers of firm $-j$ and switchers (a proportion of $\frac{1-\alpha}{2}$) will buy at firm $-j$. Therefore, firm j and firm $-j$ will gain:

$$\pi_j(NN|p_j > p_{-j}) = \frac{\alpha}{2}(p_j - c), \quad (\text{B.18})$$

$$\pi_{-j}^f(NN|p_j > p_{-j}) = 0. \quad (\text{B.19})$$

Case 2: Asymmetric Consumer Financing $\{FN\}$ or $\{NF\}$. Now we first study an asymmetric consumer financing case where only one firm offers consumer financing, i.e., firm j offers consumer financing and firm $-j$ does not. Low-income consumers can buy only from firm j despite the high price. Since firm j chooses a higher price but offers consumer financing, loyal consumers and low-income switchers (a proportion of $\frac{1}{2}$) will buy at firm j and high-income loyal consumers of firm $-j$ (a proportion of $\frac{1-\alpha}{2}$) will buy at firm $-j$.

Since only loyal high-income consumers will buy at firm $-j$, its financial profit is 0. If firm j chooses a higher price and offers consumer financing, all consumers can afford the product, but low-income consumers may buy and default. With probability $1 - \delta$, low-income consumers default due to the risk of unemployment and firms will get first period down-payment I_L and residual value v_s , generating a profit of $\frac{1-\alpha}{2}(1 - \delta)(I_L + v_s - c)$; with probability of δ , low-income consumers repay and firms will get first period down-payment I_L and the remaining debt plus interest $(1 + r)(p - I_L)$, generating a profit of $\frac{1-\alpha}{2}\delta(I_L + (1 + r)(p - I_L) - c)$. High-income loyal consumers of firm j will generate a profit of $\frac{\alpha}{2}(p_j - c)$. Therefore, firm j and firm $-j$ will gain:

$$\pi_j(FN|p_j < p_{-j}) = \frac{1 - \alpha}{2}((1 - \delta)(I_L + v_s) + \delta(I_L + (1 + r)(p_j - I_L)) - c) + \frac{\alpha}{2}(p_j - c), \quad (\text{B.20})$$

$$\pi_{-j}^f(FN|p_j < p_{-j}) = 0. \quad (\text{B.21})$$

Similarly, if firm $-j$ offers consumer financing and firm j does not $\{NF\}$, loyal consumers of firm $-j$ and switchers (a proportion of $1 - \alpha$) will buy at firm $-j$ and high-income loyal consumers of firm j (a proportion of $\frac{\alpha}{2}$) will buy at firm j . Therefore, firm j and firm $-j$ will gain:

$$\pi_j(NF|p_j < p_{-j}) = \frac{\alpha}{2}(p_j - c), \quad (\text{B.22})$$

$$\pi_{-j}^f(NF|p_j < p_{-j}) = \frac{1-\alpha}{2}((1-\delta)(I_L + v_s) + \delta(I_L + (1+r)(p_{-j} - I_L)) - p_{-j}). \quad (\text{B.23})$$

Case 3: Symmetric Consumer Financing $\{FF\}$. If both firms offer consumer financing, both low-income and high-income consumers can buy at either firm if the product is affordable. Since firm j 's price is higher, loyal consumers of firm $-j$ and switchers (a proportion of $1 - \alpha$) will buy at firm $-j$ and loyal consumers of firm j (a proportion of α) will buy at firm j . Therefore, firm j and firm $-j$ will gain:

$$\pi_j(FF|p_j < p_{-j}) = \frac{\alpha}{2}(p_j - c + (1-\delta)(I_L + v_s) + \delta(I_L + (1+r)(p_j - I_L)) - c), \quad (\text{B.24})$$

$$\pi_{-j}^f(FF|p_j < p_{-j}) = \frac{1-\alpha}{2}((1-\delta)(I_L + v_s) + \delta(I_L + (1+r)(p_{-j} - I_L)) - p_{-j}). \quad (\text{B.25})$$

If we compare the profits across the three cases, we get the best response of consumer finance divisions as follows. *For a centralized firm without sales-finance conflicts*, when $\hat{p}_C < p_j \leq p_{-j} < \bar{p}$ where $\hat{p}_C = I_L + \frac{c - I_L - v_s + v_s \delta}{\delta(1+r)} < c$, both firms offer consumer financing; when $\hat{p}_C < p_j < \bar{p} < p_{-j}$, only firm j offers consumer financing; when $p_j < \hat{p}_C < p_{-j} < \bar{p}$, only firm $-j$ offers consumer financing; otherwise, neither offers consumer financing. The best response of a firm's financial division in Case DC is summarized in Lemma 4: *When firm j without sales-finance conflicts competes with firm $-j$ with sales-finance conflicts: For firm j , if $\hat{p}_C < p_j < \bar{p}$, firm j offers consumer financing; otherwise, firm j does not offer. For firm $-j$, if $\hat{p} < p_{-j} < \bar{p}$, firm $-j$ offers consumer financing; otherwise, firm $-j$ does not offer.* $\square$

Proof. PROOF OF PROPOSITION 3 According to Appendix A, if we compare the two cases (DC and CC) when $\hat{c} < c < I_L + \frac{I_L}{1+r}$, we find Proposition 3, the profit of a decentralized firm competing with a centralized firm is higher than that of a centralized firm competing with another centralized firm. Formally,

$$\pi_{CC} = \frac{\alpha}{2}(2v - c), \quad (\text{B.26})$$

$$\pi_{DC} = \frac{\alpha}{2}(2v - c) + \int_{p_D}^{\bar{p}} \pi_F f^s(p) dp, \quad (\text{B.27})$$

where $\int_{p_D}^{\bar{p}} \pi_F f^s(p) dp > 0$. One can easily show that when $\hat{c} < c < I_L + \frac{I_L}{1+r}$, $\pi_{DC} > \pi_{CC}$. Therefore, we have Proposition 3: *if $\hat{c} < c < I_L + \frac{I_L}{1+r}$, the profit of a decentralized firm competing with a centralized firm is higher than that of a centralized firm competing with another centralized firm.* $\square$

Proof. PROOF OF PROPOSITION 4 According to Appendix A, when the marginal cost is high ($\hat{c} < c < I_L + \frac{I_L}{1+r}$), we compare the profits under different structures and derive the equilibrium. According to Proposition 3, $\pi_{DC} > \pi_{CC}$. Next, for a decentralized firm with sales-finance conflicts in Case DD, the profit is

$$\pi_{DD} = \frac{\alpha}{2}(2v - c) + \int_{\underline{p}}^{\bar{p}} \pi_F f^s(p) dp. \quad (\text{B.28})$$

For a centralized firm without sales-finance conflicts in Case DC, based on Equation A.19, the profit is

$$\pi_{CD} = \frac{\alpha}{2}(2v - c) + (1 - F_{-j}(2v)) \frac{1 - 2\alpha}{2}(2v - c). \quad (\text{B.29})$$

One can show that $\pi_{CD} < \frac{\alpha}{2}(2v - c) + \frac{1-2\alpha}{2}(2v - c)$. Recall from Proposition 2, there exists $\bar{\alpha} < \alpha < \frac{1}{2}$ such that $\int_{\underline{p}}^{\bar{p}} \pi_F f^s(p) dp > \frac{1-2\alpha}{2}(2v - c)$. This still holds for high costs $\hat{c} < c < I_L + \frac{I_L}{1+r}$ since the distribution function and the financial profit do not change. Therefore, there exists $\bar{\alpha}$ such that when $\bar{\alpha} < \alpha < \frac{1}{2}$, $\pi_{CD} < \frac{\alpha}{2}(2v - c) + \frac{1-2\alpha}{2}(2v - c) < \pi_{DD} = \frac{\alpha}{2}(2v - c) + \int_{\underline{p}}^{\bar{p}} \pi_F f^s(p) dp$. *In equilibrium, for high marginal costs $\hat{c} < c < I_L + \frac{I_L}{1+r}$, there exists $\bar{\alpha} < \alpha < \frac{1}{2}$ such that firms will choose a decentralized structure with sales-finance conflicts.*

In addition, when $\alpha \rightarrow 0$, we have $f^s(p) = \frac{(2v-c)\alpha}{2(p-c)^2(1-2\alpha)} \rightarrow 0$ and $\pi_{DD} = 0$, whereas $\pi_{CD} = F_{-j}(2v)(2v - c) > \pi_{DD} = 0$. Thus, there exists $0 < \alpha < \tilde{\alpha}$ such that $\pi_{CD} > \pi_{DD}$. According to Proposition 3, we also have $\pi_{DC} > \pi_{CC}$. *In equilibrium, for high marginal costs $\hat{c} < c < I_L + \frac{I_L}{1+r}$, there exists $0 < \alpha < \tilde{\alpha}$ such that firms will choose asymmetric structure, i.e., one firm chooses a decentralized structure with sales-finance conflicts and the other chooses a centralized one without sales-finance conflicts.*

Appendix C: Proofs of Chapter 4

Proof. PROOF OF PROPOSITION 1 When the retailer does not have retail media, suppliers advertise on the ad platform. If the ad platform shares consumer data with suppliers, suppliers will know consumers' location. By backward induction, we can derive the optimal decisions without retail media. If the ad platform shares consumer data, then the platform will set the reserve price at $R_p = \beta\lambda$ and gain a profit of $\pi_p = \frac{\alpha\beta\lambda}{2}(1 - \frac{t}{2})$; the suppliers will bid $\frac{1}{2}$ and gain $\pi_s = 0$; the retailer will set the retail price at $p = 1 - \frac{t}{2}$ and gain $\pi_r = \alpha(1 - \beta)\lambda(1 - \frac{t}{2})$. If the ad platform does not share consumer data, then the platform will set the reserve price at $R_p = \frac{\beta\lambda}{2}(1 - \frac{t}{2})$ and gain a profit of $\pi_p = \frac{1}{2}\alpha\beta\lambda(1 - \frac{t}{2})$; the suppliers will bid $\frac{1}{2}$ and gain $\pi_s = 0$; the retailer will set the retail price at $p = 1 - \frac{t}{2}$ and gain $\pi_r = \frac{1}{2}(1 - \beta)\alpha\lambda(1 - \frac{t}{2})$.

If we compare the ad platform's profits of sharing and not sharing consumer data, the ad platform will share consumer data. For the retailer, the market share is higher with consumer data since the suppliers will bid more impressions with higher conversion rate on the platform. Overall, the retailer is better off with consumer data. The results are summarized in the Proposition 1. $\square$

Proof. PROOF OF PROPOSITION 2 When the retailer has retail media and data sharing capability, we derive retailer's profit functions under data sharing and no data sharing case. If the retailer shares consumer data, he gets:

$$\Pi_r = \frac{1}{8}(-2 + \alpha(2 + (-1 + \beta)\lambda\gamma))(-2 + t) \quad (\text{C.1})$$

If the retailer does not share consumer data, he gets:

$$\Pi_r = \frac{1}{16}(-2 + \alpha(2 + (-1 + \beta)\lambda(2 + \gamma)))(-2 + t) \quad (\text{C.2})$$

If we compare these two functions, when the retail media has the data sharing capability, $\frac{2}{2+(1-\beta)(2-\gamma)\lambda} < \alpha < 1$, the retailer will not share consumer data; when $0 < \alpha < \frac{2}{2+(1-\beta)(2-\gamma)\lambda}$, the retailer will share consumer data. $\square$

Proof. PROOF OF PROPOSITION 3 When the ad platform has data sharing capability, we derive platform's profit functions under data sharing and no data sharing case. If the ad platform shares consumer data, he

gets:

$$\Pi_p = \frac{(-1 + \alpha)\beta(1 + \alpha(-1 + \lambda + \lambda\gamma))(4\alpha\lambda(-1 + \gamma) + t - \alpha t)}{32\alpha^3\lambda^2(-1 + \gamma)^2} \quad (\text{C.3})$$

If the ad platform does not share consumer data, he gets:

$$\Pi_p = \frac{1}{8}\beta\lambda(2 - t) \quad (\text{C.4})$$

If we compare these two functions, when the retail media has the data sharing capability, $0 < \alpha < \frac{1}{1+\lambda}$ or $\alpha > \frac{1}{1+\lambda}$ and $(-1 + \alpha - \alpha\lambda)/(2\alpha\lambda) + 1/2\sqrt{(-3 + 6\alpha - 3\alpha^2 - 2\alpha\lambda + 2\alpha^2\lambda + 9\alpha^2\lambda^2)/(\alpha^2\lambda^2)} < \gamma < 1$, the retailer will share consumer data; otherwise, the retailer will not share consumer data. $\square$