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Contract type and decision right of sales promotion in supply chain management with a capital constrained retailer[☆]

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ABSTRACT

From the practices of Chinese consumer electronics market, we find there are two key issues in supply chain management: The first issue is the contract type of either wholesale price contracts or consignment contracts with revenue sharing, and the second issue is the decision right of sales promotion (such as advertising, on-site shopping assistance, rebates, and post-sales service) owned by either manufacturers or retailers. We model a supply chain with one manufacturer and one retailer who has limited capital and faces deterministic demand depending on retail price and sales promotion. The two issues interact with each other. We show that only the combination (called as chain business mode) of a consignment contract with the manufacturer's right of sales promotion or a wholesale price contract with the retailer's right of sales promotion is better for both members. Moreover, the latter chain business mode is realized only when the retailer has more power in the chain and has enough capital, otherwise the former one is realized. But which one is preferred by customers? We find that the former is preferred by customers who mainly enjoy low price, while the latter is preferred by those who enjoy high sales promotion level.

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1. Introduction

This paper is motivated by practices of supply chain management in the Chinese consumer electronics industry which experienced enormous growth during the past few decades. It was reported that in 2011, the Chinese consumer electronics market achieved a total sales of RMB 1.2 trillion (Hu, 2012), which accounted for about 2.5% of the nation's GDP (State Statistics Bureau, 2011). In particular, Gome and Suning, two leading retailers in the Chinese consumer electronics market, have experienced unprecedented growth in such a time period. Fig. 1 shows sales and number of branches at these two firms from 2001 to 2011, with all the data from their annual reports. The vast Chinese market has also attracted many foreign retail giants. For example, Best Buy, a leading American multinational consumer electronics corporation, entered the market in 2003.

Gome, Suning, and Best Buy have gone through interesting journeys in how they managed the contractual relationship with their manufacturers. This story was reported in China Business News

Weekly (Shi, 2008) and we briefly summarize it as follows. In 1987, Gome's first retail outlet was opened in Beijing. At her early development stage, Gome basically served as a selling platform, on which her suppliers sold their products and employed their own persons for sales promotion. Gome simply charged a commission fee (or shared a portion of the revenue) for each transaction; that is, Gome and her manufacturers started with a consignment contract with revenue sharing arrangement (shortly a consignment contract). In 2005, Gome proposed "the zero sales promotion program" to take over the sales promotion decision right from her manufacturers. However, the program was boycotted by most manufacturers and soon abandoned. In May 2007, Gome raised 6.55 billion Hong Kong dollars to try again to gain the decision right of sales promotion and at the same time to change the contract type. As explained by Xiao Chen, the CEO of Gome at that time, they were planning a two-step transition. First, Gome would like to select some manufacturers (such as Haier, Changhong, Siemens, Sony, and Philips) to test wholesale price contracts (rather than to continue consignment contracts), and eventually spread such a practice to all manufacturers. Second, Gome would like to take back the decision right of sales promotion from her manufacturers. Later, Gome had achieved this goal in all the stores in Hong Kong and Macao, and some of the stores in Shanghai. Suning, another major Chinese consumer electronics retailer, was set up in 1994 and has experienced a similar development path to Gome.

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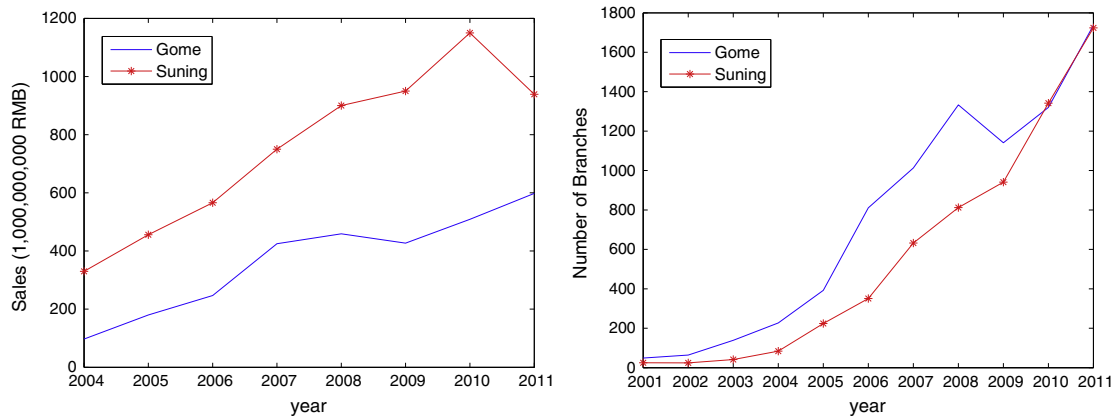


Fig. 1. Gome and Suning's sales and branch numbers.

Interestingly, such a growth pattern has been exemplified by Best Buy as well in the U.S. in the late 1980s. After entering the Chinese market in 2003, Best Buy attempted to copy her practice in the U.S. (i.e., take wholesale price contracts and simultaneously control sales promotion). Unfortunately, Best Buy did not work well and finally closed all nine stores in China in 2011 (Lu et al., 2011).

From the above industry observations, there are two issues that the consumer electronics retailers and their manufacturers have been wrestling with. One is about which contract type to take. Two contract types have been commonly used in supply chains: a consignment contract (where the manufacturer sets a retail price and the retailer is rewarded by a portion of sales revenue) and a wholesale price contract (where the manufacturer sets a wholesale price and the retailer then determines a retail price). The other issue is regarding the decision right of sales promotion, i.e., who should own the sales promotion decision. When analyzing Best Buy's failure in China, Wharton Knowledge Online (2011) also points out that these two issues play important roles. For convenience, we refer to each combination of a contract type and an owner of the decision right as a chain business mode, or simply mode.

This leads to a number of questions on how to manage a distribution channel in the consumer electronics industry. What are the preferences of channel members with respect to the contract type and sales promotion decision right? What factors cause Gome, Suning, and Best Buy change their original chain business mode? What is the impact of the supply chain management practice on consumer and social welfare? How to explain the aforementioned firm behaviors in the Chinese market?

The purpose of this paper is to develop a framework to shed some lights on these questions. To our knowledge, this is the first study to understand the chain business mode's change and the interaction between the contract type and decision right of sales promotion. We consider a distribution channel consisting of a retailer and a manufacturer. Market demand depends on both retail price and sales promotion. As explained above, there are two contract types and the decision right of sales promotion can be assigned to either the manufacturer or retailer. So there are four modes.

The main findings of this paper include the following several aspects. First, it is better that one firm fully controls the market demand and the other firm moves first. That is why in the consumer electronics industry, the common mode is either a consignment contract with the manufacturer's right of sales promotion (Gome and Suning's original mode under which the manufacturer fully controls the market demand) or a wholesale price contract with the retailer's right of sales promotion (Best Buy's mode under which the retailer fully controls the market demand). This interaction of the

two issues has never been revealed in the literature. Second, Best Buy's mode will be applied only when the retailer has more power than or equal power to the manufacturer and at the same time has enough available capital; Otherwise, Gome and Suning's original mode will be applied. This result explains why Gome and Suning wanted to change their modes with their fast growth. The third important result is from the viewpoint of the chain, consumers, and social welfare that among the four modes: Gome and Suning's original mode generates the lowest retail price and the largest demand; While Best Buy's mode generates the highest level of sales promotion, chain and consumer surpluses, as well as social welfare. The results above are based on iso-elastic demand. We also study what happens under linear demand, in which case the chain members prefer the first-mover advantage and the retailer's right of sales promotion. However, we find evidences that iso-elastic demand is proper for the Chinese consumer electronics industry.

The remainder of this paper is organized as follows. Section 2 reviews the related literature and Section 3 presents the model and preliminary analysis. We analyze the interaction between the contract type and decision right of sales promotion in Section 4 and the chain members' strategic preferences in Section 5. Section 6 discusses social welfare implications under different chain modes. Section 7 extends the analysis to linear demand. The paper concludes with Section 8. All proofs are given in the appendix.

2. Related literature

There are three streams of research related to our paper. The first stream considers performance of the two contract types. Both types of wholesale price contracts and consignment contracts are widely used in practice and studied by Lariviere and Porteus (2001) and Sun and Debo (2014), and by Hu, Li, and Govindan (2014), respectively. However, the revenue sharing arrangement used in a consignment contract has also been implemented under settings other than consignment (Wang & Hu, 2011; Yao, Leung, & Lai, 2008). Several papers investigate which contract type channel members prefer under different settings. Yao et al. (2008) find that the provision of revenue sharing in a contract leads to better chain performance than a wholesale price contract. Pan, Lai, Leung, and Xiao (2010) discuss and compare different channel power structures to check whether it is beneficial for manufacturers or retailers to use a wholesale price contract or a consignment contract. Similar to Pan et al. (2010), we also consider the manufacturer's and the retailer's preferences over the two contract types;

however, we mainly study the interaction of the contract type with the decision right of sales promotion.

The second stream involves sales promotion decisions. Most papers in this area concentrate on designing a contractual mechanism to coordinate supply chains (Krishnan, Kapuscinski, & Butz, 2010). Other related researches study different settings where channel members compete in both price and sales promotion without considering who should provide sales promotion (Tsay & Agrawal, 2000; Winter, 1993). Wang and Hu (2011) consider the contract type and sales promotion issues when discussing business models but with partial results. A closely related paper is Xia and Gilbert (2007), who consider a supply chain with one manufacturer and one retailer under linear demand. The manufacturer chooses to provide sales promotion himself or to outsource it to the retailer and the retailer decides whether to price the product jointly or separately. Our paper differs from theirs in that we consider the interaction of the contract type and decision right of sales promotion.

The third stream studies power shifting in supply chains. Weng (1995) assumes that manufacturers are more powerful and so are leaders of Stackelberg games, which are called as manufacturer Stackelberg games. However, as Raju and Zhang (2005) point out, bargaining power in some industries has shifted from manufacturers to retailers. Iyer and Villas-Boas (2003) give such examples in industries of grocery, construction, and automobile. Therefore, some researches consider different channel power structures and learn its effect on decisions. Choi (1991) uses Nash games, manufacturer Stackelberg games, and retailer Stackelberg games to study price competition in a channel structure with a common retailer. Xue, Demirag, and Niu (2014) investigate how different power schemes affect the supply chain members' performance and consumer surplus. Based on these studies we investigate a high level game, referred to as a strategic game, where the decisions include choosing a contract type and an owner of the decision right of sales promotion.

3. Model setting and preliminary analysis

We study a supply chain consisting of a manufacturer (referred to as "he") and a retailer (referred to as "she"). The manufacturer produces a product with a constant marginal cost c and distributes the product through the retailer. Market demand depends on both retail price p and sales promotion investment s . The sales promotion activities include, but not limited to, advertising, on-site shopping assistance, rebates, and post-sales service. Sales promotion is important in stimulating demand and may constitute a significant portion of a firm's operating expenses (Xiao, Yu, & Sheng, 2005). Specifically, we consider iso-elastic demand commonly used in the literature (Wang, Jiang, & Shen, 2004; Xiao et al., 2005): $D(p, s) = D_0 p^{-\alpha} s^\beta$, where $D_0 > 0$ represents the basic demand scale, α and β are the price-elasticity and promotion-elasticity indices, respectively. We assume $\alpha > 1$ and $0 < \beta < 1$ to ensure $D'_p < 0, D'_s > 0$, and $D''_s < 0$; that is, the demand function is price-elastic and increases in promotion investment but at a decreasing rate.

Based on the practices of Gome, Suning, and Best Buy, we consider two contract types. Under a wholesale price contract (denoted by P), the manufacturer first sets a wholesale price w and then the retailer chooses a retail price p . Under a consignment contract (denoted by C), the retailer first chooses her revenue share rate $\gamma \in [0, 1]$ from product sales and then the manufacturer determines a retail price p . Furthermore, the chain members need to decide the manufacturer (denoted by M) or the retailer (denoted by R) owning the decision right of sales promotion. Then, there are four chain modes, denoted by $MP, MC, RP,$ and RC , respectively. For example, MP represents that the manufacturer invests in sales

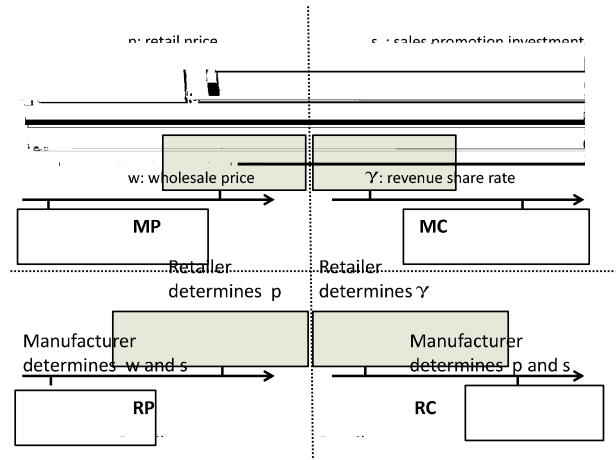


Fig. 2. Sequence of events for the four modes.

promotion under a wholesale price contract. The sequence of events under each mode is described below and also illustrated in Fig. 2.

Mode MP. The manufacturer first sets a wholesale price w and a sales promotion investment s . Then, the retailer determines a retail price p .

Mode MC. The retailer first chooses a revenue share rate γ . Then, the manufacturer sets p and s .

Mode RP. The manufacturer first sets w . Then, the retailer determines p and s .

Mode RC. The retailer first determines γ and s . Then, the manufacturer sets p .

Gome started with Mode MC , tried Mode RC unsuccessfully in 2005, and today is pushing toward Mode RP . By analyzing and comparing different chain modes, we will provide some plausible explanations of these industry observations later.

In reality, a firm may be capital constrained, especially if it is newly founded. To incorporate this realistic element, we denote by $L \geq 0$ the retailer's available operating capital. Then, when the retailer makes decisions, all her expenses must be less than or equal to L . For instance, under Mode RP , the retailer's expenses include payment $wD(p, s)$ to the manufacturer for purchasing the product, and investment s in sales promotion, and so $wD(p, s) + s \leq L$ must be satisfied.¹ In contrast, under Mode MC , the retailer does not need to pay for either the product or sales promotion. So, the capital constraint is trivial and the retailer can ignore it. It is worth noting that we do not include a capital constraint for the manufacturer because in the consumer electronics industry, manufacturers' brands are normally well-established (e.g., Hair and Siemens) and thus the capital constraint is less of a concern.

Essentially there is a Stackelberg game underlying each chain mode. Let subscript $i = m, r$ denote the manufacturer and retailer, respectively, and let superscript $j (= MP, MC, RP, RC)$ denote Mode j . Let π_i^j be firm i 's profit under Mode j . Then, the Stackelberg game under each mode can be expressed as follows:

¹ In reality, the magnitudes in quantities $wD(p, s)$ and s may be different, but it is easy to adjust their magnitudes with no impact on the main tradeoffs. For example, if the cost of providing sales promotion s is ks^2 for some constant $k > 0$ as in Xia and Gilbert (2007). Let $\hat{s} = ks^2$. Then, the demand function becomes $D(p, \hat{s}) = D_0 k^{-\frac{\beta}{2}} p^{-\alpha} \hat{s}^{\frac{\beta}{2}}$. By letting $\hat{D}_0 = D_0 k^{-\frac{\beta}{2}}$ and $\hat{\beta} = \frac{\beta}{2}$, the demand function can be expressed as $D(p, \hat{s}) = \hat{D}_0 p^{-\alpha} \hat{s}^{\hat{\beta}}$, the same form as ours. We thank one anonymous reviewer for suggesting this discussion.

MP	Stage 1:	$\max_{w,s} \pi_m^{MP}(w,s) = (w - c)D(p,s) - s$
	Stage 2:	$\max_p \pi_r^{MP}(p w,s) = (p - w)D(p,s)$ s.t. $wD(p,s) \leq L$
MC	Stage 1:	$\max_{\gamma} \pi_r^{MC}(\gamma) = \gamma p D(p,s)$
	Stage 2:	$\max_{p,s} \pi_m^{MC}(p,s \gamma) = [(1 - \gamma)p - c]D(p,s) - s$
RP	Stage 1:	$\max_w \pi_m^{RP}(w) = (w - c)D(p,s)$
	Stage 2:	$\max_{p,s} \pi_r^{RP}(p,s w) = (p - w)D(p,s) - s$ s.t. $wD(p,s) + s \leq L$
RC	Stage 1:	$\max_{\gamma,s} \pi_r^{RC}(\gamma,s) = \gamma p D(p,s) - s$ s.t. $s \leq L$
	Stage 2:	$\max_p \pi_m^{RC}(p s,\gamma) = [(1 - \gamma)p - c]D(p,s)$

We solve the Stackelberg games by backward induction and the details are given in the appendix. The equilibrium results are listed in Table 1. For the equilibrium under Mode $j(j = MP, RP, RC)$, there is a threshold L^j such that the equilibrium depends on $L < L^j$ but is independent of $L \geq L^j$. The capital constraint is irrelevant under Mode MC, and so we set $L^{MC} = 0$. Note that the retailer's profit increases in $L < L^j$ in all modes. Thus, we can view L^j as the smallest capital amount required to achieve the largest profit for the retailer under Mode j . It can be readily shown that

$$L^{RP} > \max\{L^{MP}, L^{RC}\} > L^{MC} = 0.$$

The first inequality is intuitive because under Mode RP, the retailer needs to invest in both the product and sales promotion, while she only needs to invest in the product or sales promotion under Mode MP or RC. However, the relationship between L^{MP} and L^{RC} depends on values of α and β . In fact, $\frac{L^{MP}}{L^{RC}} = [(\alpha - 1)\alpha^{-\beta}]^{\frac{1}{1-\beta}}\beta^{-1}$, which increases in α but decreases in β .

4. Interaction between contract type and promotion decision right

We now study the interaction between the contract type and sales promotion decision right. We focus on two questions: First, which contract type is preferred by each firm given an owner of the sales promotion decision right? And reversely, which firm should control the sales promotion decision given a specific contract type? We also explore how the firms' preferences depend on the retailer's available capital.

4.1. Preference over contract type

Consider a situation where the manufacturer is responsible for sales promotion. In this case, the firms choose a consignment contract or a wholesale price contract, or equivalently, Mode MC or MP. This essentially determines which firm controls the decision on retail price p . Based on the equilibrium results given in Table 1, we have the following proposition.

Proposition 1. $\pi_r^{MC} > \pi_r^{MP}(L)$ and $\pi_m^{MC} > \pi_m^{MP}(L)$ for any available capital L .

It is interesting that when the manufacturer has the decision right of sales promotion, both the retailer and manufacturer prefer a consignment contract, irrespective of the retailer's available capital. Under a consignment contract, the retailer enjoys the first-mover advantage by choosing her revenue share rate first and is free from any investment burden (the manufacturer invests in sales promotion). The MC mode also benefits the manufacturer because he has full control of the market demand: He can determine both p and s , the two key drivers of market demand. Thus, the manufacturer can better coordinate pricing and sales promotion investment to make himself better off. In contrast, under Mode MP the manufacturer only has partial control (he only determines s). The equilibrium results show that Mode MC always generates higher demand than Mode MP, which explains why both firms prefer Mode MC to MP.

Table 1
Equilibrium results under the four modes.

MP	$L \geq L^{MP}$	$L < L^{MP}$
p	$\alpha^2(\alpha - 1)^{-2}c$	$[\alpha^{\beta-1}\beta^\beta(\alpha - 1)^{1-2\beta}D_0c^\beta L^{\beta-1}]^{\frac{1}{\alpha+\beta-1}}$
s	$[\alpha^{-2\alpha}(\alpha - 1)^{2\alpha-1}\beta D_0c^{1-\alpha}]^{\frac{1}{1-\beta}}$	$[\alpha^\alpha\beta^{\alpha-1}D_0^{-1}c^{\alpha-1}L^\alpha(\alpha - 1)^{-2\alpha+1}]^{\frac{1}{\alpha+\beta-1}}$
w	$\alpha(\alpha - 1)^{-1}c$	$[\alpha^{-\alpha}\beta^\beta(\alpha - 1)^{\alpha-\beta}D_0c^\beta L^{\beta-1}]^{\frac{1}{\alpha+\beta-1}}$
(D, π_m, π_r)	$(\frac{\alpha-1}{\beta c} s^{MP}, \frac{1-\beta}{\beta} s^{MP}, \frac{\alpha}{\beta(\alpha-1)} s^{MP})$	$(\frac{\alpha-1}{\beta c} s^{MP}, L - \frac{\alpha-\beta-1}{\beta} s^{MP}, \frac{1}{\alpha-1} L)$
MC	L	
p	$\alpha^2(\alpha - 1)^{-1}(\alpha + \beta - 1)^{-1}c$	
s	$[\alpha^{-2\alpha}\beta(\alpha - 1)^{\alpha-1}(\alpha + \beta - 1)^\alpha D_0c^{1-\alpha}]^{\frac{1}{1-\beta}}$	
γ	$\frac{1-\beta}{\alpha}$	
(D, π_m, π_r)	$(\frac{\alpha-1}{\beta c} s^{MC}, \frac{1-\beta}{\beta} s^{MC}, \frac{\alpha(1-\beta)}{\beta(\alpha+\beta-1)} s^{MC})$	
RP	$L \geq L^{RP}$	$L < L^{RP}$
p	$\alpha(\alpha - \beta)(\alpha - 1)^{-2}c$	$[\alpha^{-1}\beta^\beta(\alpha + \beta - 1)^{1-\beta}D_0L^{\beta-1}]^{\frac{1}{\alpha+\beta-1}}$
s	$[\alpha^{-\alpha}\beta D_0c^{1-\alpha}(\alpha - 1)^{2\alpha-2}(\alpha - \beta)^{1-\alpha}]^{\frac{1}{1-\beta}}$	$\frac{\beta}{\alpha+\beta-1}L$
w	$(\alpha - \beta)(\alpha - 1)^{-1}c$	$[\alpha^{-\alpha}\beta^\beta D_0L^{\beta-1}(\alpha - 1)^{\alpha-1}(\alpha + \beta - 1)^{1-\beta}]^{\frac{1}{\alpha+\beta-1}}$
(D, π_m, π_r)	$(\frac{(\alpha-1)^2}{\beta c(\alpha-\beta)} s^{RP}, \frac{(1-\beta)(\alpha-1)}{\beta(\alpha-\beta)} s^{RP}, \frac{1-\beta}{\beta} s^{RP})$	$(\frac{\alpha-1}{\alpha+\beta-1} \frac{L}{w^{RP}}, (\frac{\alpha-1}{\alpha+\beta-1}) (\frac{w^{RP}-c}{w^{RP}}) L, \frac{1-\beta}{\beta} s^{RP})$
RC	$L \geq L^{RC}$	$L < L^{RC}$
p	$\alpha^2(\alpha - 1)^{-2}c$	$\alpha^2(\alpha - 1)^{-2}c$
s	$[\alpha^{1-2\alpha}\beta D_0c^{1-\alpha}(\alpha - 1)^{2\alpha-2}]^{\frac{1}{1-\beta}}$	L
γ	$\frac{1}{\alpha}$	$\frac{1}{\alpha}$
(D, π_m, π_r)	$(\frac{(\alpha-1)^2}{\beta c\alpha} s^{RC}, \frac{\alpha-1}{\beta\alpha} s^{RC}, \frac{1-\beta}{\beta} s^{RC})$	$((p^{RC})^{-\alpha}D_0L^\beta, \frac{\alpha-1}{\alpha}\gamma(p^{RC})^{-\alpha-1}D_0L^\beta, \gamma(p^{RC})^{1-\alpha}D_0L^\beta - L)$

Now suppose the retailer is responsible for sales promotion. Then, the firms choose Mode RC or RP. Similarly, we have the following proposition.

Proposition 2. *There are two thresholds $L_r^{RC-RP} > L_m^{RC-RP}$ such that $\pi_i^{RP}(L) > \pi_i^{RC}(L)$ if and only if $L > L_i^{RC-RP}$, $i = r, m$.*

When the retailer has the decision right of sales promotion, the manufacturer's and retailer's preferences depend on the retailer's available capital. When the retailer has enough capital, both firms prefer a wholesale price contract, i.e., the RP mode. Again, this is because that under Mode RP, the retailer can fully control the market demand, which yields higher demand due to coordinated pricing and sales promotion investment and so benefits both the manufacturer and retailer.

However, when the retailer's capital is small ($L < L_m^{RC-RP}$), both chain members prefer a consignment contract, i.e., Mode RC. This means that the firms would like to share the market controlling power (i.e., p and s are controlled by different firms). When L is small, if the retailer has to invest in both the product and sales promotion, then the retailer has to either order a low quantity or make a suboptimal investment in sales promotion, both of which hurt the chain. However, such a problem can be alleviated under Mode RC, since the retailer does not have to invest in the product, but can spend all her resources only on sales promotion. As to the manufacturer, he gains the pricing power under Mode RC, compared to Mode RP. As shown in the equilibrium results under Mode RP, the best response of the retailer depends not only on the manufacturer's decision, but also on the available capital. So, the manufacturer's advantage of moving first is weakened compared with the case where the retailer is less capital-constrained ($L > L^{RP}$). Thus, the manufacturer would like to give up the leadership but gain the power of directly controlling the market demand.

However, the inequality $L_r^{RC-RP} > L_m^{RC-RP}$ (in Proposition 2) indicates that when the retailer's available capital lies between the two thresholds ($L_m^{RC-RP} < L < L_r^{RC-RP}$), there is a conflict between the two firms: While the manufacturer prefers a wholesale price contract, the retailer would choose a consignment contract. This is because the retailer believes that the capital is still not sufficient to cover both the product and sales promotion investment and so she prefers a consignment contract, but the manufacturer believes that the retailers' capital has reached an acceptable level and so prefers a wholesale price contract.

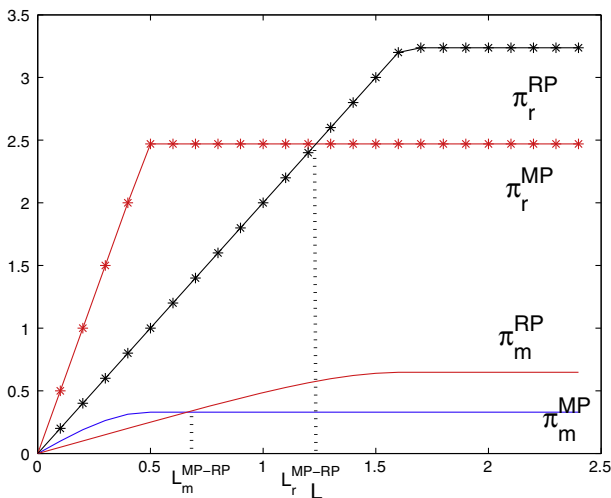


Fig. 3. The manufacturer's and retailer's profits under Modes MP and RP.

4.2. Preference over promotion decision right

Under a wholesale price contract, which firm should control sales promotion? That is, which one is chosen between Mode RP or MP? The following proposition answers this question.

Proposition 3. *There is a threshold L_i^{MP-RP} such that $\pi_i^{RP}(L) > \pi_i^{MP}(L)$ if and only if $L > L_i^{MP-RP}$, $i = m, r$.*

We can explain Proposition 3 similar to Proposition 2. The only difference is that the retailer invests in sales promotion under Mode RC while instead invests in the product under Mode MP. Although we cannot analytically compare the two thresholds, we did lots of numerical studies all of which show $L_r^{MP-RP} > L_m^{MP-RP}$, as shown in Fig. 3.

The next proposition characterizes the firms' preferences when a consignment contract is used. In this case, the firms choose a mode between RC and MC.

Proposition 4.

- (1) $\pi_m^{MC} > \pi_m^{RC}(L)$ for any available capital L .
- (2) For each given α , there is a unique $\beta^* \in (1 - \frac{e-1}{e}\alpha, 1)$ such that if $\beta \in (\beta^*, 1)$ then $\pi_r^{MC} > \pi_r^{RC}(L)$ for all L ; Otherwise, $\pi_r^{MC} > \pi_r^{RC}(L)$ if and only if $L < L_r^{MC-RC}$ for some threshold L_r^{MC-RC} . Moreover, $\beta^* = 0$ when $\alpha > \frac{e}{e-1} \approx 1.582$.

From Proposition 4, we know that under a consignment contract, the manufacturer always prefers to control sales promotion and the retailer shares the same preference except when $\alpha < \frac{e}{e-1}$, $\beta < \beta^*$, and $L > L_r^{MC-RC}$. Compared with Mode RC, the manufacturer benefits from full control of market under Mode MC, and this may also benefit the retailer who is free from any investment burden and enjoys a high demand under Mode MC. However, when $\alpha < \frac{e}{e-1}$, $\beta < \beta^*$, and $L > L_r^{MC-RC}$, the market is less price-sensitive and promotion-sensitive, and so the interaction of price and sales promotion is weakened (per unit change of one variable has weak impact on the other variable's marginal effect on demand). Thus, for a firm, the advantage of fully controlling the market demand is weakened. On the other hand, from the equilibrium results, we find that by owning the decision right of sales promotion, the retailer has a larger revenue share rate under Mode RC than MC. Therefore, the firms may fight for owning the sales promotion right. Although sales promotion brings cost for the retailer, the retailer has enough capital ($L > L_r^{MC-RC}$).

Such a finding (fight) seems to collaborate with the industry evidence. In 2005, Gome attempted to take over the sales promotion decision right from her manufacturers, which was immediately boycotted by her manufacturers. A plausible explanation is that Gome had accumulated enough capital due to its fast growth and thus tried to switch from Mode MC to RC; however, its manufacturers then would become worse off. More interestingly, it was reported that some manufacturers were willing to give up the promotion decision right if Gome could simultaneously switch from a consignment to a wholesale price contract (Shi, 2008). From Proposition 2, when $L_m^{RC-RP} < L < L_r^{RC-RP}$, under the retailer-controlled sales promotion, the manufacturer prefers a wholesale price contract to a consignment contract (the opposite is true for the retailer). Therefore, our findings are consistent with the industry observations and may help us understand the driving forces behind firms' behaviors in practices.

We emphasize a couple of observations from Propositions 1 to 4 on the interaction between the contract type and sales promotion decision right. We show that only the chain business mode of a consignment contract with the manufacturer's right of sales

promotion or a wholesale price contract with the retailer's right of sales promotion is better for both members. This result has not been revealed in the literature. When the manufacturer is already endowed with one of the two market-related decisions (p or s), generally it is better for both chain members if the manufacturer also takes control of the other decision. While when the retailer is endowed with one decision, whether she should also control the other decision depends on her available capital. This is because the decision power is not free: To own the retail pricing decision, the retailer has to purchase the product from the manufacturer; similarly, sales promotion also require capital investment. Therefore, with the capital constraint, it might be better for both members to share the market controlling right, i.e., one firm invests in the product (sets a retail price) and the other invests in sales promotion. To summarize, with a pre-determined contract type or owner of the sales promotion decision right, both members would prefer to delegate the market related decisions (p and s) to a single member, unless the retailer's capital is not enough.

5. Market equilibrium

Based on the analysis given in the previous section, we proceed to study a situation in which the chain members can choose the contract type and the owner of the promotion decision right. The main purpose of this section is to characterize the market equilibrium and understand how various parameters affect the firms' strategic choices. To this end, we consider three different bargaining power structures for the chain. In the first power structure, the manufacturer has dominant bargaining power and thus makes both decisions for the chain; in the second, the two firms share the two decisions; and finally, in the third structure, it is the retailer who makes both decisions. One may easily relate these three structures to our motivational examples: As the retailers (e.g., Gome) grew over time, the consumer electronics distribution channels have experienced the three power structures in the exact order.

5.1. Single firm controlling strategic decisions

In this subsection we analyze the first and the third power structures, in which the market equilibria are characterized in the following theorem.

Theorem 1.

- (1) $\pi_m^{MC} > \max \{ \pi_m^{RP}(L), \pi_m^{MP}(L), \pi_m^{RC}(L) \}$ for any available capital L .
- (2) If $\beta > \beta^*$ then there is unique threshold L_r^{MC-RP} such that
 - $\pi_r^{MC} > \max \{ \pi_r^{RP}(L), \pi_r^{MP}(L), \pi_r^{RC}(L) \}$ for $L < L_r^{MC-RP}$ and
 - $\pi_r^{RP}(L) > \max \{ \pi_r^{MC}, \pi_r^{MP}(L), \pi_r^{RC}(L) \}$ for $L > L_r^{MC-RP}$. Otherwise,
 - $\pi_r^{MC} > \max \{ \pi_r^{RP}(L), \pi_r^{MP}(L), \pi_r^{RC}(L) \}$ for $L < L_r^{MC-RC}$, $\pi_r^{RC}(L) > \max \{ \pi_r^{MC}, \pi_r^{MP}(L), \pi_r^{RP}(L) \}$ for $L_r^{MC-RC} < L < L_r^{RC-RP}$, and
 - $\pi_r^{RP}(L) > \max \{ \pi_r^{MC}, \pi_r^{MP}(L), \pi_r^{RC}(L) \}$ for $L > L_r^{RC-RP}$.

From part (1) of Theorem 1, if the manufacturer is the dominant player, then he will choose the MC mode, where he takes the full responsibility to make both market related decisions. When the retailer has more bargaining power, her favorite mode depends on her available capital, as shown in part (2) of Theorem 1. Specifically, if the retailer has sufficient capital, then she also prefers to gain full control of the market demand (Mode RP); Otherwise, when the capital constraint becomes tight, the retailer would like to delegate part of control (i.e., pricing) or even full marketing control to her partner (Mode RC or MC). This is because fully controlling market requires significant investment in the product and

sales promotion. Whether Mode RC dominates the other three modes depends on values of the parameters. Fig. 4 depicts two examples where $D_0 = 10$ and $c = 1$.

Hence, when the manufacturer (or the retailer with enough capital) has dominant bargaining power, he (she) prefers to fully control the market demand while let his (her) partner move first. However, with a tight capital constraint, the retailer will give up the pricing control or even both the pricing control and sales promotion right to the manufacturer to save costs. This result shows that both chain members would be willing to gain full market control at the expense of being a second-mover in the game unless there is a tight capital constraint. Furthermore, Theorem 1 shows that Mode RC can be the retailer's favorite mode when she has medium capital ($L_r^{MC-RC} < L < L_r^{RC-RP}$), however, under an important precondition that the retailer has dominant power and the market is less price- and promotion-sensitive. The Chinese consumer electronics industry is a price and promotion sensitive one which can be exemplified from the industry practice. There is much price competition among retailers and demand often surges during sales seasons. For example, during the sales season in 2006, the sales of Five Star (another consumer electronics retailer in China) was double of that of last year.² Thus, Mode RC is not the best choice for the retailer. Taking the Gome example, our result means that Gome's "zero sales promotion program" proposed in 2005 was simply the first step towards the adoption of Mode RP. This has been confirmed by the subsequent strategies undertaken by Gome, i.e., she first signed wholesale price contracts with her manufacturers and then tried to end their sales promotions.

5.2. Separately controlled strategic decisions

We now turn our attention to study separately controlled strategic decisions; that is, each firm makes one of the two strategic decisions: contract type choice and assignment of the decision right of sales promotion. Then, the two firms engage in a strategic game.

There are two types of strategic games. The first type is that the manufacturer determines who invests in sales promotion and the retailer chooses a contract type. This strategic game is natural for a couple of reasons. On one hand, the manufacturer has better understanding on his product, has his own purpose on investing in sales promotion, and gets the right to control market. In Gome and Suning, their appliance manufacturers employed sales persons. On the other hand, the retailer directly faces customers and so has advantages on demand information. For example, in order to increase diversity of products, the retailer may introduce some new products. Then, the retailer may use consignment contracts to reduce risk associated with the new products. But for some best-selling products, the retailer may be willing to choose wholesale price contracts because she can control retail price and then obtain a larger profit. This strategic game is shown in Table 2, where the manufacturer chooses M or R to invest in sales promotion and the retailer chooses P or C as the contract type. The four possible combinations are exactly the four modes studied previously. So, the four possible outcomes of the game are exactly both members' profits in the corresponding modes.

Similar to Choi (1991), we study the following three structures for the strategic game, each with a different sequence of actions:

- (1) Nash game. The two firms have equal bargaining power and make their strategic choices simultaneously.

² http://www.jmnews.com.cn/c/2006/10/08/09/c_5338101.shtml. Assessed March 5, 2013.

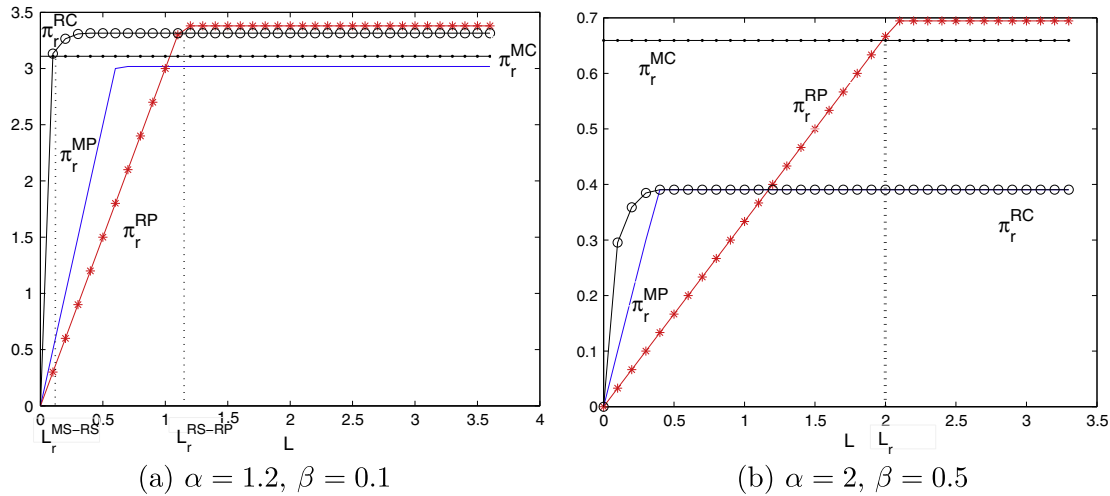


Fig. 4. The retailer's profits under different modes.

Table 2
The strategic game.

	Retailer (P)	Retailer (C)
Manufacturer (M)	(π_m^{MP}, π_r^{MP})	(π_m^{MC}, π_r^{MC})
Manufacturer (R)	(π_m^{RP}, π_r^{RP})	(π_m^{RC}, π_r^{RC})

- (2) Manufacturer Stackelberg game. The manufacturer has more bargaining power and thus determines who owns the promotion decision right; the retailer observes the manufacturer's choice and then chooses a contract type.
- (3) Retailer Stackelberg game. The retailer has more bargaining power and thus acts as the Stackelberg leader. The sequence of actions is reversed of that in the manufacturer Stackelberg game.

We are interested to understand how the game sequence affects the firms' strategic choices. In the two Stackelberg games, one firm acts as the leader due to his (her) stronger bargaining power, however he (she) is not a dominant player and cannot control both strategic decisions as studied in Section 5.1. Based on Propositions 1–4, we obtain the equilibrium results for each game in the following theorem.

Theorem 2.

- (1) In the Nash game, both Modes RP and MC are Nash equilibria if $L > \max \{L_r^{MP-RP}, L_m^{RC-RP}\}$; otherwise, Mode MC is the unique Nash equilibrium.
- (2) In the manufacturer Stackelberg game, Mode MC is the unique subgame perfect equilibrium.
- (3) In the retailer Stackelberg game, the unique subgame perfect equilibrium is Mode MC if $L < \max \{L_r^{MC-RP}, L_m^{MP-RP}\}$, and Mode RP otherwise.

Note that the theorem is also true for the other type of strategic game (the retailer determines who invests in sales promotion and the manufacturer chooses a contract type).

Theorems 1 and 2 demonstrate that the only possible market equilibria are Modes MC and RP. Furthermore, the above analysis reveals how the market equilibrium may shift depending on the firms' bargaining powers. So far in this section we have considered five scenarios of bargaining power structures: (1) the manufacturer

has dominant bargaining power so he has full control of both strategic decisions; (2) the firms split the two strategic decisions but the manufacturer is the Stackelberg leader; (3) the firms split the two strategic decisions and make their choices simultaneously; (4) the firms split the two strategic decisions but the retailer is the Stackelberg leader; and (5) the retailer has dominant bargaining power so she has full control of both strategic decisions. Clearly, the retailer's bargaining power increases in index of the scenarios (the retailer has the least power in Scenario (1) and the most power in Scenario (5)). Our results indicate that without the capital constraint, the market equilibrium depends on the retailer's bargaining power: With very weak bargaining power (in Scenarios (1) and (2)), MC is the unique equilibrium; with a medium level of bargaining power (in Scenario (3)), both MC and RP may arise as an equilibrium; with a very strong bargaining power (in Scenarios (4) and (5)), RP is the unique equilibrium. Pan et al. (2010) find that the manufacturer's and retailer's preferences over contract types rely on the channel power structure. Xia and Gilbert (2007) also find that their equilibrium (combination of sales promotion decision and organizational structure) depends on which, if any, channel partner has the ability to act as the Stackelberg leader. Similarly, our results further show that each member's preference (combination of the contract type and decision right of sales promotion), as well as the equilibrium, depends on the channel power structure.

The retailer's capital constraint also plays a critical role in determining the market equilibrium; that is, the retailer has to give up the control right to the manufacturer if L is lower than a threshold. Therefore, for RP to be an equilibrium, the retailer must have both strong bargaining power and enough capital.

The above results have useful practical implications. Again, we take the consumer electronics industry for example. When the retailers such as Gome and Suning started in their early years, appliance manufacturers (e.g., Haier and Siemens) were much more powerful, so MC was the natural mode. Later, the landscape of the consumer electronics industry changed over time and the retailers have grown to be more powerful relative to manufacturers. For example, thanks to her great power, Suning signed exclusive sales agreements with foreign manufacturers: Whirlpool, Electrolux, and Hitachi. So, the retailers (Gome and Suning) would like to push the mode from the original MC to RP. One prediction from our results is that Mode RP will be widely applied especially at Gome and Suning as long as they continue to grow. Why did Gome's "zero sales promotion program" in 2005 fail? Besides the

reason that a fight for the sales promotion decision right might emerge (from [Proposition 4](#)), Mode RC is never an equilibrium according to the above theorems. Gome learned an important lesson from such a failure: Instead of trying to change only the sales promotion decision right, Gome had to change the contract type as well. Fortunately, Gome quickly recovered from the mistake and then proposed a two-step plan to gradually shift from Modes MC to RP, as described in the introduction.

Why did Best Buy expand so slowly in China and eventually quit the market (It had only nine stores before closing in 2011 while Suning and Gome had over one thousand stores)? Best Buy has been successful with the RP mode in the U.S. market. So she tried to copy the RP mode to the Chinese market. However, given the few Best Buy stores in China, Best Buy's bargaining power was relatively weak compared to the local appliance manufacturers. In this case, the unique equilibrium for Best Buy is Mode MC, not RP.

6. Social welfare

The motivation of our research is to find what is the "best" mode for the Chinese consumer electronics industry. So far we have answered this question from the firms' perspective. But how does the chain performance change under different modes? What about consumer surplus and social welfare? Although consumers are not decision makers in our model, their preference for each mode is very important from a sustainable perspective. This section aims to address these questions and provide additional insights for the government. During recent years, the Chinese government has drawn up various policies to fuel economic development, one of which is by stimulating domestic demand consumption ([General Office of the State Council, 2008](#)). Thus, the demand level D conveys useful information for government since it measures the size of population that enjoys the product. In the following theorem, we check which mode generates the lowest price, the highest sales promotion level, or the highest demand level.

Theorem 3.

- (1) *The lowest price and largest demand are generated by Mode MC.*
- (2) *The highest sales promotion level is generated by Mode MC when $L < L_{s1}$, by Mode RC when $L_{s1} < L < L_{s2}$, and by Mode RP when $L > L_{s2}$, for some thresholds $L_{s1} \leq L_{s2}$. Moreover, $L_{s1} = L_{s2}$ if $\alpha(\alpha - 1)^{\alpha-1}(\alpha + \beta - 1)^{-\alpha} < 1$.*

From [Theorem 3](#), we see that compared with other modes, Mode MC always generates the lowest retail price, the largest demand, and further the highest sales promotion level when the retailer's available capital is not enough. However, when the retailer has enough capital, Mode RP generates the highest sales promotion level. We see that prices are lower in Gome and Suning than in Best Buy. However, Best Buy provides customers with higher quality of service (e.g., purchasing experience and professional shopping guide). [Theorem 3](#) also explains the retailer's preference for Mode RP when she has enough capital. When L is large, Mode RP generates the highest sales promotion level, which shifts the demand curve with respect to retail price. Then, she has the power to obtain larger profit margin. [Theorem 3](#) together with [Theorems 1 and 2](#) implies that when the manufacturer is more powerful or the retailer faces tight budget, more consumers can enjoy a lower retail price. Otherwise, consumers enjoy a higher sales promotion level at the expense of a higher retail price.

We also compare the chain surplus (the total profit of the two firms), consumer surplus, and social welfare (the sum of the chain and consumer surpluses) in the following theorem.

Theorem 4.

- (1) *The highest consumer surplus is generated by Mode MC when $L < L_{cs1}$, by Mode RC when $L_{cs1} < L < L_{cs2}$, and by Mode RP when $L > L_{cs2}$, for some thresholds $L_{cs1} \leq L_{cs2}$. The same result is true for chain surplus for some thresholds $L_{ch1} \leq L_{ch2}$.*
- (2) *The highest social welfare is generated by Mode MC when $L < L_{sw1}$ and by Mode RP when $L > L_{sw2}$ for some thresholds $L_{sw1} \leq L_{sw2}$.*

Numerical study shows that when $L_{sw1} < L < L_{sw2}$, Mode RC generates the highest social welfare.

From [Theorem 4](#), when the retailer has a tight budget, Mode MC is the best mode for the chain, consumers, and social welfare. However, when the retailer gets sufficient capital, Mode RP is the best one. Although under Mode RP, the retail price is not the lowest one, taking the sales promotion level into consideration, Mode RP still generates higher consumer surplus. Compared to Mode MC, Mode RP generates a higher retail price, less demand, but larger profit. [Theorem 4](#) gives an explanation *why Mode MP never exists in the market*: No matter for the chain, consumers, or society, it is always dominated by some other mode.

In the past decades, not only retailers got more capital, but also consumers in China became murgim(„652J/FTfMCID7TD((1Tfcapita)TJ0-

ensure positive values of the decision variables. This restriction implies that the price sensitivity or the cost of sales promotion cannot be too less relative to the sales promotion sensitivity.

We repeat the steps in Sections 3–6 to study the four modes under linear demand. To avoid confusion, each variable x under iso-elastic demand is denoted by \tilde{x} under linear demand (e.g., \tilde{p}^{MC} refers to the retail price for Mode MC under linear demand). Also, to focus on the difference of iso-elastic and linear demands, our analysis is confined to the case where the retailer has sufficient capital. Then, by backward induction, we get the equilibrium results under Modes MP and RP (the details are in the appendix) and find that both the manufacturer and retailer prefer Mode RP to MP, which is consistent with that under iso-elastic demand. However, for Modes MC and RC under linear demand, it is difficult to get analytical equilibrium results and so we conduct numerical studies. Specifically, we normalize the value of the parameter $c = 1$; other parameters are assigned with values $D_0 = 20, 30, 40, \dots, 1000$, $k = \frac{1}{4}, \frac{1}{2}, 1, 5, 10$, and $\alpha = 2, 3, 4, 5, \dots, 10$, similar to that in Wang et al. (2004). All the parameters we test result in reasonable equilibrium decision variables and profits (positiveness and boundness). The main results under iso-elastic demand and linear demand are reported in Table 3.

From Table 3, we conclude three main results under linear demand. First, both the manufacturer and retailer prefer such a contract type under which he or she moves first; that is, the manufacturer prefers a wholesale price contract and the retailer prefers a consignment contract. Second, both members prefer the retailer's right of sales promotion. Therefore, the equilibrium mode is RP or RC, the manufacturer prefers Mode RP, and the retailer prefers Mode RC. Third, Mode RC generates the largest demand and the highest chain surplus, consumer surplus, and social welfare. Thus, these results under linear demand differ from those under iso-elastic demand, which is also shown in Choi (1991) and Lee and Staelin (1997) under other settings.

These differences are caused by the following two aspects. First, as shown in Lee and Staelin (1997), different demand types lead to different vertical strategic interactions. Specifically, the iso-elastic one leads to vertical strategic complementarity under which it is profitable to be a Stackelberg follower, and the linear one leads to vertical strategic substitutability under which being a Stackelberg leader is more profitable. That is why both the manufacturer and retailer have more incentives to be a price leader under linear demand, while both prefer fully controlling the market and being a follower under iso-elastic demand.

Second, under iso-elastic demand, per-unit change of price (or sales promotion level) not only influences demand, but also changes the marginal effect of sales promotion investment (or price) on demand. Due to this strong interaction between price and sales promotion investment, the chain members' preferences over the owner of the sales promotion decision also depend on the contract type. But under linear demand, such interaction disappears and then the benefit of one member fully controlling the market demand is weakened. Therefore, the manufacturer and retailer care more about each member's incentive on investing in sales promotion. We find that the retailer has more incentive to invest in sales promotion due to $\tilde{s}^{RC} > \tilde{s}^{MC}$ and $\tilde{s}^{RP} > \tilde{s}^{MP}$. Thus, both members would like the retailer to carry the sales promotion right, irrespective of the contract type.

However, out of our 4455 numerical experiments, there are 25 cases under which some results are not consistent with those shown in Table 3 (those results underlined). The different results are summarized as follow: When D_0 is very small ($D_0 \leq 30$) and α is very large ($\alpha \geq 7$), instead of Mode RC, the retailer may prefer Mode MC. Also, Mode MC may generate the highest demand, chain surplus, consumer surplus, and social welfare. That is because when the base demand is very low and demand is very sensitive

Table 3
Comparison between iso-elastic demand and linear demand.

	Iso-elastic demand	Linear demand
Preference over contract type	Depends on sales promotion right	Manufacturer: P; retailer: C
Preference over promotion decision right	Depends on contract type	<u>retailer</u>
Preference over four modes	Manufacturer: MC; retailer: RP	Manufacturer: RP; <u>retailer: RC</u>
Market equilibrium mode	MC or RP	RP or RC
Lowest retail price	MC	MC
Largest demand	MC	<u>RC</u>
Highest sales promotion level	RP	RC
Highest chain surplus	RP	<u>RC</u>
Highest consumer surplus	RP	<u>RC</u>
Highest social welfare	RP	<u>RC</u>

to price while not so much sensitive to sales promotion, price plays an important role to stimulate demand. Finally, it should be noted that in these 25 cases, the advantage of Mode MC over RC (the differences of retailer's profit, market demand, chain surplus, consumer surplus, and social welfare between the two modes) is very weak.⁴ Thus, though not very exactly, we claim that the conclusions in Table 3 are true and Mode RC is the best choice for the supply chain and consumers under linear demand.

Now, we get different results under the two types of demand functions. Then, a natural question arises: Which type of demand functions is proper to analyze the Chinese consumer electronics market? Yang, Hu, and Wu (2008) collect retail sale data of 55 months (from 2000 to 2004) from the Chinese domestic color TV category, with the TV products assembled according to 4 specification (screen sizes) and 2 price levels (high and low). They find that the data fits iso-elastic demand. Bijmolt, van Heerde, and Pieters (2005) present a meta-analysis of price elasticity and across a set of 1851 price elasticities based on 81 studies, the average price elasticity is 2.62. Thus, we think that compared with linear demand, the iso-elastic form is more proper for this industry and our results given in the previous sections under iso-elastic demand can be applied to the Chinese consumer electronics industry.

8. Conclusions and discussions

Inspired by practices of Best Buy, Gome, and Suning in China, our first managerial insight is that a consignment contract should match with the manufacturer's right of sales promotion and a wholesale price contract with the retailer's sales promotion right. This interprets why the three firms choose their modes from either MC or RP. Gome's failed "zero sales promotion program" in 2005 is because Mode RC does not satisfy the insight above. The second managerial insight is that the retailer prefers to fully control the market demand when she has more power and at the same time has enough available capital while the manufacturer always prefers to fully control the market demand. This interprets why Best Buy failed in China but Gome and Suning want to copy her mode. Our third managerial insight is that Mode MC is adequate for customers who prefer low price, while RP for those who enjoy high sales promotion. This is also useful for government. To stimulate domestic demand or keep down retail prices, the government should encourage Mode MC. However, when consumers enjoy a high sales promotion level, it is better for the government to encourage Mode RP, e.g., let retailers easily

⁴ All the differences are less than 0.03. Recall that the marginal production cost equals 1 and the base demand is 20 or 30. The advantage of Modes MC over RC is very weak.

achieve loan from banks or somewhere else. *The managerial insights above are consistent with the practice of Chinese consumer electronics industry*, as explained in the paper.

It is noteworthy that although this research is motivated by the consumer electronics industry, the two issues we investigate (the contract type and sales promotion decision right) are also important in other industries. For example, in the automobile industry, manufacturers or dealers perform after-sales services (one kind of sales promotion): holding large inventories of spare parts to facilitate timely repairs, scheduling appointments, shuttle services, etc. (Xia & Gilbert, 2007). For grocery products, before Carrefour entered China in 1995, retail stores in China performed as a selling platform, similar to the early Gome and Suning. Carrefour brought in the hypermarket model (performing wholesale price contracts is one of the features) (Sun, 2010). For the sales promotion issue, these hypermarkets employ some sales persons by themselves and also some by manufacturers. However, with the intensifying competition in the market, Wal-Mart has laid off lots of her own sales persons and relied on her manufacturers' salesforce to reduce costs (Lu, 2013). Other settings include the B2C industry. For example, on 360buy.com, the largest B2C electronic commerce website selling consumer electronics in China, we can see some listing products with the description "delivered by 360buy and after-sale service provided by 360buy", while other products with "delivered by manufacturers and after-sale service provided by manufacturers". This implies that the contract type and sales promotion decision are also important in the B2C industry. Thus, our model setting and derived results are general and may also be applied to these industries.

There are several possible directions for future research. One is to consider stochastic demand under which order quantity should be considered. It is also interesting to consider what will happen with competitive retailers or competitive manufacturers.

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Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.ejor.2014.07.030>.

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