Hindawi Publishing Corporation
Mathematical Problems in Engineering
Volume 2012, Article ID 908408, 19 pages
doi:10.1155/2012/908408

Research Article

Sales Rebate Contracts in Fashion Supply Chains

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Received 26 July 2012; Accepted 1 September 2012

Academic Editor: Pui-Sze Chow

We explore in this paper the performance of sales rebate contracts in fashion supply chains. We conduct both analytical and numerical analyses via a mean-variance framework with reference to real empirical data. To be specific, we evaluate the expected profits and variance of profits (risk) of the fashion supply chains, fashion retailers, and manufacturers under (1) the currently implemented sales rebate practices, (2) the case without sales rebate, and (3) the theoretical coordination situation (if target sales rebate is adopted). In addition, we analyze how sales effort affects the performances of the supply chain and its agents. Our analysis indicates that the rebate contracts may hurt the retailer and the manufacturer of a fashion supply chain when it is inappropriately set. Moreover, a properly designed sales rebate contract not only can coordinate the supply chain (with retail sales effort) but can also improve expected profits and lower the levels of risk for both the manufacturer and the retailer.

1. Introduction

Varying consumer tastes, trends, technology and shorter product life cycle resulted in a turbulent market for fashion products (Frings [1]). Given the product and market characteristics, demand for fashion products is difficult to forecast regardless of whether it is on item level or aggregate level (Christopher et al. [2]). The above-mentioned nature of the fashion industry indicates effective supply chain management becomes increasingly strategically important for supply chain entities, especially in terms of coordination (Wensley [3]). The fashion company and its supply chain partners strive hard to coordinate their internal and external activities so as to achieve the goal of delivering the product to the right

place at the right time in the right shape in an efficient and effective manner (Fernie [4]). Supply chain coordination (SCC) is an important criterion for measuring the performance of supply chains (Anupindi and Bassok [5]). A coordinated supply chain is one in which the profitability of the entire supply chain is maximized (Taylor [6]). If there exist multiple decision makers (agents) in the supply chain, a lack of coordination usually occurs as the agents tend to have different incentives and objectives, and the presence of double marginalization (Spengler [7]), generally describes the situation that each firm only considers its own profit margin in making its decision but does not consider the supply chain's profit.

In order to achieve SCC, supply chain contracts are commonly employed as a mechanism that provides incentives to channel agents to behave in a way which can optimize the supply chain (i.e., coordinate supply chain) (Wang [8]). Some popular supply chain contracts commonly observed include returns contracts (Pasternack [9]), revenue sharing contracts (Yao et al. [10]), quantity flexibility contracts (Barnes-Schuster et al. [11]), quantity discount contracts (Wang et al. [12]), markdown money contract (Ning et al. [13] and Shen et al. [14]), and rebate contracts (Aydin and Porteus [15], Taylor [6], Arcelus and Srinivasan [16], Chiu et al. [17], and Chiu et al. [18]). There are two kinds of rebate, namely, the consumer rebate and the sales rebate. Consumer rebate is a kind of payments from manufacturer to consumer upon consumer's purchases of manufacturer's product (Aydin and Porteus [15]). Sales rebate is also called "channel rebate" (Chiu et al. [18] and Kurata and Yue [19]) and it is a payment from the manufacturer to the retailer based on the items sold from the retailer to the end consumers. This paper focuses on the latter one, that is, the sales rebate.

It is commonly known that the amount of sales rebate that can be granted heavily depends on the retailer's performance and the magnitude of salespush the manufacturer wants to achieve. Notice that when sales rebate is exercised based on actual sales performance measured by retail scanner POS data with using online technology, it is called "scanback rebate" (Arcelus and Srinivasan [16] and Kurata and Yue [19]). In fashion companies, it is also known as "push money" or "push price promotions" (Aydin and Porteus [15]). Linear and target sales rebates are two common types of sales rebate. The former one is a kind of rebate in which manufacturer pays retailer a fixed rebate for each unit sold irrespective of quantity sold (Taylor [6]). The latter one, the target sales rebate, is a kind of rebate which is paid for each unit sold beyond a prespecified target sales level. The amount of rebate is hence a function of the retailer's specific sales performance with respect to the sales volume levels (Zhang et al. [20]). As a remark, as reported in Taylor [6], the linear rebate contract fails to achieve SCC but conversely a properly designed target sales rebate alone can achieve SCC and a win-win outcome under a quantity decision only model. When demand is affected by sales effort, SCC and win-win outcome can be achieved with properly designed target rebate with returns. Moreover, Taylor [6] ascertains that reducing the retailer's risk by sales rebate can strengthen the incentives offered for lifting the retailer's sales effort since the associated risk is partially transferred from retailer to manufacturer. For more empirical details of sales rebates industrial practices, see the cases reported in Chiu et al. [18].

Sales rebate contracts are regarded as a powerful incentive instrument for pushing the retailer to sell better. Taylor [6] ascertains that there is often a mismatch between quantity ordered by retailer and consumers' demand and he analytically proves that sales rebates can enhance supply chain performance. In order to avoid significant markdown and end-of-season clearance loss, understocking may be found in many fashion retailers (Wang [8]). For instance, matching demand and supply is particularly difficult for fashion brands such as Nike, the world's leading athletic footwear and sportswear company, because they have to deal with many product varieties, for example, sizes and colors (Sridharan et al. [21]).

As a result, to encourage the retailer to order and stock more, the manufacturer employs the sales rebate contracts to enhance the retailer's incentives to do so. It is also believed that the retailer will exert more sales effort to sell products and order more from manufacturer in the presence of sales rebate (Taylor [6] and Chiu et al. [17]). Moreover, Wang et al. [12] finds that sales rebate increases the retailer's effective income per sale. Sales rebate can also help to achieve supply chain coordination and win-win situation in a decentralized supply chain system (see Taylor [6], Cachon [22], Krishnan et al. [23], and Lu et al. [24]).

In this paper, we explore the applications and performance of sales rebate contracts in fashion supply chains with reference to real company empirical data. With the help of mathematical models, the performances of the supply chains under the currently implemented rebate practices (the current practices), the case without sales rebate (the no rebate case), and the theoretical coordination situation (SCC) if target sales rebate is adopted are explored. After that, we extend the analysis to include saleseffort and then explore how sales effort affects the supply chain performance. In addition, we employ the mean-variance (MV) approach to analyze the payoffs (expected profits) and levels of risk (variance of profits) of the supply chain and its agents. Notice that the use of MV approach is in line with the recent supply chain literature (see Choi et al. [25–27] for more discussions; for a complete review and historical development, refer to Choi and Chiu [28]). To the best of our knowledge, our paper is the first which employs real company data to examine sales rebate contracts from the perspective of supply chain management under the MV framework. Our analysis interestingly indicates that the rebate contracts may hurt the performances of both the retailer and the manufacturer of a fashion supply chain when they are inappropriately set. Moreover, a properly designed sales rebate contract not only can achieve SCC (with sales effort) but can also improve expected profits and lower the levels of risk for both the manufacturer and the retailer. The rest of this paper is organized as follows. Section 2 describes the analytical models, which include the no sales-effort model and sales-effort model. Section 3 presents the detailed numerical analysis. Section 4 concludes the paper with a discussion on managerial insights.

2. Analytical Models

We consider that a fashion supply chain with one manufacturer (which can be a fashion brand) and one fashion retailer selling a fashionable product in a newsvendor setting in which there is only a single selling season with a single ordering and pricing opportunity; at the end of the selling season, the fashion retailer sells the leftover with a big discount price. Let $p > 0$ be the unit retail price, $w > 0$ the unit wholesale price, $c > 0$ the unit production cost, $s > 0$ the unit net end of season value of the unsold quantity (per unit), $u > 0$ the unit sales rebate, and $T > 0$ the target sales level (under the target sales rebate contract; $T = 0$ for the linear rebate contract). In particular, if the target sales rebate policy is adopted, then the retailer can receive a rebate u from the manufacturer for each unit sold beyond T. We assume that p, c, and s are exogenous and w, u, and T are endogenous. Moreover, we assume that $p > w > c > s$. Under the target sales rebate contracts, the manufacturer specifies w, u and T to the retailer. In turn, the retailer determines the order quantity $q \geq 0$. The fashion retailer faces an uncertain market demand. Two demand models developed by Taylor [6] and Chiu et al. [17], namely, the no-sales-effort and the sales-effort models, are basically employed for the analysis in this paper. For any risk-sensitive supply chain agent, in addition to expected profit, the level of risk is also considered in making decisions. In this paper, we apply the MV

approach for investigating the risk-profit tradeoffs under the sales rebate contracts. In the MV approach, the level of risk that a party bears is quantified by the variance of profit. Denoted by $V(\cdot)$ the variance of its argument.

2.1. No-Sales-Effort Model

For the no-sales-effort model, the market demand x follows a probability distribution function $f(x)$ and a cumulative function $F(x)$. Let $\overline{F}(\cdot) = 1 - F(\cdot)$ and denote the expectation of an argument by $E(\cdot)$. Moreover, let R, M, and SC represent the retailer, the manufacturer, and the supply chain, respectively. For any given $q \geq 0$, for the no rebate case under the no-sales-effort model, the profits of the retailer ($\Pi_{R,1}$), the manufacturer ($\Pi_{M,1}$), and the supply chain ($\Pi_{SC,1}$) are given as follows:

$$\begin{aligned} \Pi_{R,1} &= (p-w)q + (p-s)\min(x-q,0), \\ \Pi_{M,1} &= (w-c)q, \\ \Pi_{SC,1} &= (p-c)q + (p-s)\min(x-q,0). \end{aligned} \tag{2.1}$$

Taking expectation and variance, we yield the following:

$$\begin{aligned} E[\Pi_{M,1}] &= (w-c)q, \\ E[\Pi_{R,1}] &= (p-w)q + (p-s)\int_0^q F(x)dx, \\ E[\Pi_{SC,1}] &= (p-c)q - (p-s)\int_0^q F(x)dx, \\ V[\Pi_{R,1}] &= (p-s)^2\xi(0,q), \\ V[\Pi_{M,1}] &= 0, \\ V[\Pi_{SC,1}] &= (p-s)^2\xi(0,q), \end{aligned} \tag{2.2}$$

where $\xi(y,z) = 2\int_y^z (z-x)F(x)dx - [\int_y^z F(x)dx]^2$ for $0 \leq y < z$. For the target sales rebate contracts under the no-sales-effort model, the profits of the retailer ($\Pi_{R,2}$), the manufacturer ($\Pi_{M,2}$), and the supply chain ($\Pi_{SC,2}$) are given by

$$\begin{aligned} \Pi_{R,2} &= (p-w)q + (p-s)\min(x-q,0) + u(q-T+\max(\min(x-q,0),T-q)), \\ \Pi_{M,2} &= (w-c)q + u(T-q-\max(\min(x-q,0),T-q)), \\ \Pi_{SC,2} &= \Pi_{SC,1}, \end{aligned} \tag{2.3}$$

respectively. The associated expected values and variances for $q > T$ (no rebate would be given for any $q \leq T$) are expressed below:

$$\begin{aligned} E[\Pi_{R,2}] &= (p-w)q - (p-s)\int_0^q F(x)dx + u\int_T^q \overline{F}(x)dx, \\ E[\Pi_{M,2}] &= (w-c)q - u\int_T^q \overline{F}(x)dx, \\ V[\Pi_{R,2}] &= (p-s)^2\xi(0,q) + u^2\xi(T,q) + 2u(p-s)\xi_C(T,q), \\ V[\Pi_{M,2}] &= u^2\xi(T,q), \end{aligned} \tag{2.4}$$

where $\xi_C(y,z) = \int_0^y F(x)dx + 2\int_y^z (z-x)F(x)dx - \int_y^z F(x)dx \int_y^z F(x)dx$, for $0 \leq y < z$.

2.2. Sales-Effort Model

In the no-sales-effort model we proposed above, how sales effort affects the retail demand is not considered. Now, for the more general sales-effort model, we assume that the market demand can be increased by exerting sales effort by the retailer. Actions which increase the sales effort can take various forms. For putting and displaying the products into the more prominent places in the retail store, asking the sales associates to promote the products more often (e.g., during checkout or when the customers enter the store), preparing advertisement/promotion leaflet and banner are all popular measures for increasing "sales effort." We consider the case where the retailer is wholly responsible for the cost of the sales effort, and the retailer would make the decision on whether or not to exert sales effort. Obviously, a sales rebate contract provides monetary incentive to lead the retailer to exert higher sales effort. To be specific, the market demand for the sales-effort model is given by $y = x + \delta$, where $\delta \geq 0$ is the demand increased when sales effort is exerted by the retailer. Denoted by e the retailer's cost for exerting sales effort. We note that y follows the probability distribution function $f(y-\delta)$ and the cumulative function $F(y-\delta)$. Moreover, if the demand without sales effort has mean μ and standard deviation σ, then by exerting sales effort, the market demand has mean $\mu + \delta$ and standard deviation σ.

For the no rebate case under the sales-effort model, for any given $q \geq 0$, the profits of the retailer ($\Pi_{R,3}$), the manufacturer ($\Pi_{M,3}$), and the supply chain ($\Pi_{SC,3}$) are given by

$$\begin{aligned} \Pi_{R,3} &= (p-w)q + (p-s)\min(x+\delta-q,0) - e, \\ \Pi_{M,3} &= (w-c)q, \\ \Pi_{SC,3} &= (p-c)q + (p-s)\min(x+\delta-q,0) - e. \end{aligned} \tag{2.5}$$

The associated expected values and variances are

$$\begin{aligned}
E[\Pi_{M,3}] &= (w-c)q,\\
E[\Pi_{R,3}] &= (p-w)q + (p-s)\int_0^{q-\delta} F(x)dx - e,\\
E[\Pi_{SC,3}] &= (p-c)q - (p-s)\int_0^{q-\delta} F(x)dx - e,\\
V[\Pi_{R,3}] &= (p-s)^2\xi(0,q-\delta),\\
V[\Pi_{M,3}] &= 0,\\
V[\Pi_{SC,3}] &= (p-s)^2\xi(0,q-\delta).
\end{aligned} \tag{2.6}$$

For the case with target sales rebate under the sales-effort model, the profits of the retailer ($\Pi_{R,4}$), the manufacturer ($\Pi_{M,4}$), and the supply chain ($\Pi_{SC,4}$) can be derived as follows:

$$\begin{aligned}
\Pi_{R,4} &= (p-w)q + (p-s)\min(x+\delta-q,0) + u(q-T+\max(\min(x+\delta-q,0),T-q)) - e,\\
\Pi_{M,4} &= (w-c)q + u(T-q-\max(\min(x+\delta-q,0),T-q)),\\
\Pi_{SC,4} &= \Pi_{SC,3}.
\end{aligned} \tag{2.7}$$

The associated expected values and variances for $q > T$ (no rebate would be given for any $q \le T$) can be found in the following:

$$\begin{aligned}
E[\Pi_{R,4}] &= (p-w)q - (p-s)\int_0^{q-\delta} F(x)dx + u\int_{T-\delta}^{q-\delta} \overline{F}(x)dx - e,\\
E[\Pi_{M,4}] &= (w-c)q - u\int_{T-\delta}^{q-\delta} \overline{F}(x)dx,\\
V[\Pi_{R,4}] &= (p-s)^2\xi(0,q-\delta) + u^2\xi(T-\delta,q-\delta) + 2u(p-s)\xi_C(T-\delta,q-\delta),\\
V[\Pi_{M,4}] &= u^2\xi(T-\delta,q-\delta).
\end{aligned} \tag{2.8}$$

For $i = M, R, SC$ and $j = 1,2,3,4$, denoted by $q_{i,j}^*$ the optimal order quantity that maximizes $E[\Pi_{i,j}]$, and let $E^*[\Pi_{i,j}]$ be the associated maximum attainable value of $E[\Pi_{i,j}]$, for example, $E^*[\Pi_{R,4}]$ is the maximum attainable expected profit of the retailer under target sales rebate contract in the sales-effort model. We have Lemma 2.1.

Lemma 2.1. *For any given $\delta > 0$ and $e > 0$, exerting sales effort is preferable to not exerting sales effort for the supply chain if and only if $E^*[\Pi_{SC,3}] > E^*[\Pi_{SC,1}]$, which implies that*

$$(p-c)q^*_{SC,3} - (p-s)\int_0^{q^*_{SC,3}-\delta} F(x)dx - e > (p-c)q^*_{SC,1} - (p-s)\int_0^{q^*_{SC,1}} F(x)dx. \tag{2.9}$$

Lemma 2.1 is intuitive and condition (2.9) gives important hint at when exerting sales effort outperforms the case of not exerting effort. By considering the first- and second-order optimality conditions, we observe that $q^*_{SC,1}$ and $q^*_{SC,3}$ are unique and $q^*_{SC,1} = q^*_{SC,3} - \delta - F^{-1}((p-c)/(p-s))$. Then (2.9) implies that $e/\delta < p-c$. In other words, we have Lemma 2.2.

Lemma 2.2. *Exerting sales effort is preferable to not exerting sales effort for the supply chain if and only if the marginal cost of the sales effort is less than the supply chain's product profit margin (i.e., $e/\delta < p-c$).*

Lemma 2.2 gives a very neat analytical result indicating how the product's profit margin in the supply chain affects whether exerting sales effort is preferable or not. In particular, for high profit margin items, exerting sales effort outperforms the case of not exerting sales effort. In real industrial setting, this (i.e., the one with high supply chain profit margin) is applied to the highly fashionable brands as well as the higher-end luxury and designer fashion labels.

3. Numerical Analysis

3.1. No-Sales-Effort Model: Expected Profit Analysis

Data collected from current practices of the sales rebate contract from five companies (the following fictitious names MRS, MH, RX, SS, and LS are used in this paper to represent the real companies surveyed. The data sets are contributed by the managers of the respective companies with our survey conducted in 2009. All these companies have their offices in Hong Kong and they are well-established fashion companies) (see Table 1) would be analyzed amongst three scenarios: SCC (For the SCC case, all five companies are assumed to adopt target sales rebate to achieve SCC. We follow Chiu et al. [17] to obtain the target sales rebate contract parameters for achieving SCC), the current practices, and the no rebate case, under the no-sales-effort model. Note that the no rebate case has a zero target level and a zero rebate. Since demand information is not given from the cases, we assume that the demand for all cases follows a normal distribution with mean 1000 and standard deviation 300 (notice that our own analysis reveals that the specific set of parameters does not affect our general conclusion and insights. For example, see the appendix for some results with different demand sizes).

Table 2 (similar results are observed when we consider different demand settings. Please refer to Table 9 for the expected profits under SCC, the current practices, and the no rebate case for the no-sales-effort model. Tables 10, 11, and 12 show the comparisons among SCC, the current practices, and the no rebate case) summarizes the expected profits under SCC, the current practices, and the no rebate case for the no-sales-effort model. Table 2 shows that, for the current practices, among the five supply chains under exploration, some manufacturers and some retailers have less expected profits compared to the no rebate case.

Table 1: Summary of current sales rebate practices*.

	Companies				
	MRS	MH	RX	SS	LS
Business types	Sportswear	Children wear	Luxury watches	Cosmetic	Jeanswear
Rebate forms	Target	Target	Linear	Target	Linear
Rebate rates (% of p per unit)	1.5%	3%	15%	10%	2%
T	2% of expected demand	5% of expected demand	0%	10% of expected demand	0%
c	120	15	9000	50	66
w	218	35	16000	100	195
s	58	7.25	4350	24.2	32
S	499	80	37600	190	390

*Notice that RX and LS are implementing linear rebate contracts with a zero target level. MRS, MH, and SS are implementing target sales rebate.

Table 2: Expected profits under SCC, current practices, and no rebate case for the no-sales-effort model.

	Companies				
	MRS	MH	RX	SS	LS
			SCC		
E[R's profit]	232350.15	36930.36	17970881.83	70889.52	154416.22
E[M's profit]	117118.79	24059.38	8410536.48	57216.39	151394.49
E[SC's profit]	349468.94	60989.74	26381418.30	128105.91	305810.71
Order quantity	1323.30	1373.56	1324.30	1303.59	1392.78
u	697.06	187.74	50053.76	320.97	1354.69
u % (of p)	139.69%	234.68%	133.12%	168.93%	347.36%
T	1066.53	1049.81	1068.86	1052.17	1036.62
			No rebate		
E[R's profit]	231372.28	36680.45	17903826.88	70266.49	152409.02
E[M's profit]	108318.02	21810.15	7807041.98	51609.09	133329.75
E[SC's profit]	339690.30	58490.60	25710868.86	121875.58	285738.77
Order quantity	1105.29	1090.51	1115.29	1032.18	1033.56
			Current practices		
E[R's profit]	231645.43	36724.47	23186337.56	69889.61	159413.89
E[M's profit]	108514.33	21954.56	2785164.79	53639.01	127261.25
E[SC's profit]	340159.76	58679.03	25971502.34	123528.62	286675.13
Order quantity	1110.14	1100.14	1157.70	1068.05	1040.92
u	7.49	2.4	5640	19	7.8
T	1020	1050	0	1100	0

On the other hand, under SCC, all manufacturers, all retailers, and all supply chains have higher expected profits compared to the no rebate case. It implies that sales rebate contracts could be a trap for the retailer and/or the manufacturer if the sales rebate contract is not well designed (just like in many of the current practices).

For MRS, MS, and SS, among the three scenarios, namely, SCC, the current practices, and the no rebate case, SCC is the most preferable for all parties because the largest expected

Table 3: Expected profits under SCC, current practices, and no rebate case for sales-effort model.

	Companies				
	MRS	MH	RX	SS	LS
SCC					
E[R's profit]	232487.15	36975.36	17974681.83	70959.52	154588.22
E[M's profit]	118351.79	24464.38	8444736.48	57846.39	152942.49
E[SC's profit]	350838.94	61439.74	26419418.30	128805.91	307530.71
Order quantity	1353.30	1403.56	1354.30	1333.59	1422.78
u	697.06	187.74	50053.76	320.97	1354.69
u % (of p)	139.69%	234.68%	133.12%	168.93%	347.36%
T	1089.23	1077.02	1088.33	1074.88	1062.42
No rebate					
E[R's profit]	229802.28	36530.45	17731826.88	69466.49	150259.02
E[M's profit]	111258.02	22410.15	8017041.98	53109.09	137199.75
E[SC's profit]	341060.30	58940.60	25748868.86	122575.58	287458.77
Order quantity	1135.29	1120.51	1145.29	1062.18	1063.56
Current practices					
E[R's profit]	230186.22	36607.12	23183476.66	69311.06	157497.80
E[M's profit]	111343.54	22521.91	2826025.68	54917.56	130897.33
E[SC's profit]	341529.76	59129.03	26009502.34	124228.62	288395.13
Order quantity	1140.14	1130.14	1187.70	1098.05	1070.92
u	7.49	2.40	5640	19	7.80
T	1020	1050	0	1100	0
Difference between the sales-effort model and the no-sales-effort model (sales-effort model minus no-sales-effort model)					
SCC					
E[R's profit]	127.85	45	3800	70	172
E[M's profit]	1233	405	34200	630	1548
E[SC's profit]	1370	450	38000	700	1720
T	22.7	27.21	19.47	22.71	25.8
No rebate					
E[R's profit]	−1570	−150	−172000	−800	−2150
E[M's profit]	2940	600	210000	1500	3870
E[SC's profit]	1370	450	38000	700	1720
Current practices					
E[R's profit]	−1459.21	−117.35	−2860.9	−578.55	−1916.09
E[M's profit]	2829.21	567.35	40860.89	1278.55	3636.08
E[SC's profit]	1370	450	38000	700	1720

profits are obtained. This is also called the "win-win situation" because both the retailers and the manufacturers are better off. However, for RX and LS, the retailers prefer the current practices to SCC but the supply chains and the manufacturers prefer SCC to current practices (i.e., not win-win). The current linear rebate practices somehow reduce the retailers' willingness to move from the current practices towards SCC because SCC could not bring the expected profits to be as high as the current linear rebate practices to the retailers. The above

Table 4: Optimal policies of the manufacturers, the retailers, and the supply chain.

	Companies				
	MRS	MH	RX	SS	LS
Retailer	SCC and exerting sales effort	SCC and exerting sales effort	*Current practice and no sales effort*	SCC and exerting sales effort	*Current practice and no sales effort*
Manufacturer	SCC and exerting sales effort	SCC and exerting sales effort	SCC and exerting sales effort	SCC and exerting sales effort	SCC and exerting sales effort
Supply chain	SCC and exerting sales effort	SCC and exerting sales effort	SCC and exerting sales effort	SCC and exerting sales effort	SCC and exerting sales effort

Table 5: Summary of SDP in no-sales-effort model.

	Companies				
	MRS	MH	RX	SS	LS
			SCC		
R	340041.38	92729.12	24867637.01	144908.18	655581.16
M	91952.91	2864.05	6584910.07	43356.19	218807.93
			No rebate		
R	91862.74	14817.15	7028698.44	30576.09	66276.40
M	0	0	0	0	0
			Current practices		
R	93346.54	15180.48	11926525.62	31893.56	74040.80
M	318.77	57.65	1270359.79	280.48	1472.62

result reveals the importance of selecting a right form and well-designed rebate policy for attaining win-win situation for individual agents as well as optimizing the fashion supply chain. Notice from Table 2 that a big u is needed in order to achieve SCC. Intuitively, as the manufacturer needs to pay more to the retailer as a rebate with a bigger u, it is very natural for the manufacturer to avoid offering a big u to the retailer. However, the results in Table 2 show that a big u can indeed benefit the manufacturer because of a much higher retailer's order quantity. Therefore, by setting the contract parameters properly, the manufacturer can gain more expected profit, even with a big u.

3.2. Sales-Effort Model: Expected Profit Analysis

For the sales effort case, since quantifiable data on "sales effort" is impossible to be collected from the industry, we employ an artificial (while reasonable) set of values for it. To be specific, we assume that the demand distribution will still be normal with the mean = $1000 + \delta$, and standard deviation = 300, where $\delta = 30$, which is the effect brought by the sale effort. With this set of supplementary data, we conduct numerical analysis and the result is summarized in Table 3.

From Table 3, we can see that the increases in order quantities are obvious by exerting sales effort, because the retailers order more to accommodate the increases of demand upon increases of sales effort. Table 3 (Tables 13, 14, and 15 show the comparison among SCC,

Table 6: Summary of SDP in sales-effort model.

	Companies				
	MRS	MH	RX	SS	LS
			SCC		
R	308943.95	89400.20	22324003.38	137745.13	639412.09
M	82900.33	27550.43	5861303.22	40964.35	212875.05
			No rebate		
R	82379.73	13452.38	6304370.74	28170.95	60614.31
M	0	0	0	0	0
			Current practices		
R	84229.52	13909.44	11834794.74	29949.46	69758.43
M	421.32	91.51	1270618.52	1.03	1473.03

Table 7: Summary of the expected profits and the profit variances of RX and LS.

		Companies			
		RX		LS	
		Models			
		No-sales-effort	Sales-effort	No-sales-effort	Sales-effort
			SCC		
R	E[profit]	17970881.83	17981681.83	154416.22	152409.02
	s.d.	24867637.01	22324003.38	655581.16	639412.09
M	E[profit]	8410536.48	8507736.48	151394.49	156121.69
	s.d.	6584910.07	5861303.22	218807.93	212875.05
			No-rebate		
R	E[profit]	17903826.88	17801826.88	152409.02	151259.02
	s.d.	7028698.44	6304370.74	66276.40	60614.31
M	E[profit]	7807041.98	8017041.98	133329.75	137199.75
	s.d.	0	0	0	0
			Current practices		
R	E[profit]	23186337.56	23253476.66	159413.89	158497.80
	s.d.	11926525.62	11834794.74	74040.80	69758.43
M	E[profit]	2785164.79	2826025.68	127261.25	130897.33
	s.d.	1270359.79	1270618.52	1472.62	1473.03

current practices, and the no rebate case) also shows that, for the current practices scenario, some manufacturers and some retailers have lower expected profits compared to the no rebate case. On the other hand, for the scenario under SCC, all manufacturers, retailers, and supply chains have higher expected profits compared to the no rebate case. It further ascertains that sales rebate contracts, for both the no-sales-effort and sales-effort models, could be a trap for the retailer and/or the manufacturer if the contract is not well designed. Moreover, Table 3 shows that manufacturers' and supply chains' expected profits under the sales-effort model are always (for SCC, the current practices, and the no rebate case) bigger than those of under the no-sales-effort model. However, retailers' expected profits under the sales-effort model are smaller than the respective cases of the no-sales-effort model under "the SCC and the no rebate" scenarios only. Therefore, the retailers would prefer not to exert sales effort under the current practices. For the retailer, sales effort should be employed only

Table 8: Summary of the expected profits and the profit variances of MRS, MH and SS.

		Companies					
		MRS		MH		SS	
		Models					
		No-sales-effort	Sales-effort	No-sales-effort	Sales-effort	No-sales-effort	Sales-effort
SCC							
R	E[profit]	232350.15	232487.15	36930.36	36975.36	71009.45	71129.45
	s.d.	340041.38	308943.95	92729.12	89400.20	144908.18	137745.13
M	E[profit]	117118.79	118351.79	24059.38	24464.38	57371.71	58451.71
	s.d.	91952.91	82900.33	28645.05	27550.43	43356.19	40964.35
No-rebate							
R	E[profit]	231372.28	229802.28	36680.45	36530.45	70380.68	70080.68
	s.d.	91862.74	82379.73	14817.15	13452.38	30576.09	28170.95
M	E[profit]	108318.02	111258.02	21810.15	22410.15	51712.78	53212.78
	s.d.	0	0	0	0	0	0
Current practices							
R	E[profit]	231645.43	230186.22	36724.47	36607.12	70020.76	69942.21
	s.d.	93346.54	84229.52	15180.48	13909.44	31893.56	29949.46
M	E[profit]	108514.33	111343.54	21954.56	22521.91	53726.10	55004.66
	s.d.	318.77	421.32	57.65	91.51	280.48	1.03

when the extra revenue gained from exerting sales effort is more than the cost of exerting it because the retailer bears wholly the sales effort cost, whereas the manufacturer does not bear the sales effort cost. As the retailer would order more from the manufacturer when sales effort is exerted to increase the demand, the manufacturer always enjoys a higher expected profit from a higher order quantity. Therefore, the manufacturer always welcomes the retailer to exert sales effort. The above argument further reveals that if the manufacturer would like to increase the retailer's order quantity, it is also important to understand how to motivate the retailer to exert sales effort. It is in fact challenging for the manufacturer to optimally set the sales rebate contract for stimulating the retailer to exert sales effort. Table 4 shows that, for MRS, MS, and SS, the retailers prefer the SCC scenario with exerting sales effort, which is consistent with the optimal goals of the manufacturers and the supply chains. However, for RX and LS, the retailers would prefer the current practices (the linear rebate contracts for these two companies) without exerting sales effort but the manufacturers and the supply chains would prefer the SCC case with sales effort (the target sales rebate contracts). Therefore, there is a difference between the retailers, the manufacturers, and the supply chains. The above result proposes that the current linear rebate practices may not only reduce the retailers' willingness to move from the current practices towards SCC, they also prevent the retailers from exerting sales effort. Moreover, the above result shows that the retailers sometimes may obtain higher expected profits from the current practices and prefer not to exert sales effort. As a consequence, the SCC scenario and exerting sales effort would become unattractive for the retailers. The above result again shows the importance of selecting a right form and well-designed rebate contract for attaining win-win situation and expected profit maximization of the supply chain. In particular, the setting of sales rebate contracts could motivate retailers to exert sales effort.

Table 9: Summary of profits in no-sales-effort model (with different demand). Demand sizes: small (mean $\mu = 100$, standard deviation $\sigma = 30$), medium ($\mu = 1000$, $\sigma = 300$), and large ($\mu = 10000$, $\sigma = 3000$).

(a)

	Companies								
	MRS			MH			RX		
	Demand sizes								
	Medium	Large	Small	Medium	Large	Small	Medium	Large	Small
SCC									
E[R's profit]	232350.15	2323501.45	23235.01	36930.36	369303.61	3693.04	17970881.83	179708818.26	1797088.18
E[M's profit]	117118.79	1171187.94	11711.88	24059.38	240593.76	2405.94	8410536.48	84105364.76	841053.65
E[SC's profit]	349468.94	3494689.40	34946.89	60989.74	609897.38	6098.97	26381418.30	263814183.03	2638141.83
Order quantity	1323.30	13233.02	132.33	1373.56	13735.60	137.36	1324.30	13242.99	132.43
U	697.06	697.06	697.06	187.74	187.74	187.74	50053.76	50053.76	50053.76
u% (of p)	139.69%	139.69%	139.69%	234.68%	234.68%	234.68%	133.12%	133.12%	133.12%
T	1066.53	10665.32	106.65	1049.81	10498.14	104.98	1068.86	10688.63	106.89
No rebate									
E[R's profit]	231372.28	2313722.81	23137.23	36680.45	366804.48	3668.04	17903826.88	179038268.82	1790382.69
E[M's profit]	108318.02	1083180.19	10831.80	21810.15	218101.54	2181.02	7807041.98	78070419.82	780704.20
E[SC's profit]	339690.30	3396903.01	33969.03	58490.60	584906.02	5849.06	25710868.86	257108688.64	2571086.89
Order quantity	1105.29	11052.86	110.53	1090.51	10905.08	109.05	1115.29	11152.92	111.53
Current practices									
E[R's profit]	231645.43	2316454.33	23164.54	36724.47	367244.66	3672.45	23186337.56	231863375.55	2318633.76
E[M's profit]	108514.33	1085143.26	10851.43	21954.56	219545.64	2195.46	2785164.79	27851647.86	278516.48
E[SC's profit]	340159.76	3401597.59	34015.98	58679.03	586790.31	5867.90	25971502.34	259715023.42	2597150.23
Order quantity	1110.14	11101.43	111.01	1100.14	11001.43	110.01	1157.70	11576.97	115.77
U	7.485	7.485	7.485	2.4	2.4	2.4	5640	5640	5640
T	1020	10200	102	1050	10500	105	0	0	0

(b)

	Companies					
	SS			LS		
	Demand sizes					
	Medium	Large	Small	Medium	Large	Small
	SCC					
E[R's profit]	70889.52	708895.23	7088.95	154416.22	1544162.18	15441.62
E[M's profit]	57216.39	572163.87	5721.64	151394.49	1513944.94	15139.45
E[SC's profit]	128105.91	1281059.09	12810.59	305810.71	3058107.12	30581.07
Order quantity	1303.59	13035.88	130.36	1392.78	13927.75	139.28
U	320.97	320.97	320.97	1354.69	1354.69	1354.69
u% (of p)	168.93%	168.93%	168.93%	347.36%	347.36%	347.36%
T	1052.17	10521.68	105.22	1036.62	10366.20	103.66
	No rebate					
E[R's profit]	70266.49	702664.89	7026.65	152409.02	1524090.24	15240.90
E[M's profit]	51609.09	516090.86	5160.91	133329.75	1333297.47	13332.97
E[SC's profit]	121875.58	1218755.76	12187.56	285738.77	2857387.71	28573.88
Order quantity	1032.18	10321.82	103.22	1033.56	10335.64	103.36
	Current practices					
E[R's profit]	69889.61	698896.11	6988.96	159413.89	1594138.87	15941.39
E[M's profit]	53639.01	536390.09	5363.90	127261.25	1272612.47	12726.12
E[SC's profit]	123528.62	1235286.20	12352.86	286675.13	2866751.35	28667.51
Order quantity	1068.05	10680.48	106.80	1040.92	10409.22	104.09
U	19	19	19	7.8	7.8	7.8
T	1100	11000	110	0	0	0

Table 10: Summary of improvement on profits (from no-rebate case to SCC) in no-sales-effort model*.

	Companies				
	MRS	MH	RX	SS	LS
Improvement percentage of R profit	0.42	0.68	0.37	0.89	1.32
Improvement percentage of S profit	8.12	10.31	7.73	10.86	13.55
Improvement opercentage of SC profit	2.88	4.27	2.61	5.11	7.02
Improvement percentage of q	19.72	25.96	18.74	26.29	34.75

*Each company has the same improvement percentage of R, S, and SC profits and q with small, medium, and large demand.

Table 11: Summary of improvement on profits (from no-rebate-case to current practice) in no-sales-effort model*.

	Companies				
	MRS	MH	RX	SS	LS
Improvement percentage of R profit	0.12	0.12	29.5	−0.54	4.6
Improvement percentage of S profit	0.18	0.66	−64.32	3.93	−4.55
Improvement opercentage of SC profit	0.14	0.32	1.01	1.36	0.33
Improvement percentage of q	0.44	0.88	3.8	3.47	0.71

*Each company has the same improvement percentage of R, S, and SC profits and q with small, medium, and large demand.

Table 12: Summary of improvement on profits (from current practice to SCC) in no-sales-effort model*.

	Companies				
	MRS	MH	RX	SS	LS
Improvement percentage of R profit	0.3	0.56	−22.49	1.43	−3.14
Improvement percentage of S profit	7.93	9.59	201.98	6.67	18.96
Improvement opercentage of SC profit	2.74	3.94	1.58	3.71	6.68
Improvement percentage of q	19.2	24.85	14.39	22.05	33.8

*Each company has the same improvement percentage of R, S, and SC profits and q with small, medium, and large demand.

Table 13: Summary of improvement on profits (from no-rebate-case to SCC) in sales-effort model*.

	Companies				
	MRS	MH	RX	SS	LS
Improvement percentage of R profit	0.48	0.8	0.4	0.99	1.43
Improvement percentage of S profit	9.26	12.17	8.17	12.09	14.71
Improvement opercentage of SC profit	3.28	5.04	2.76	5.69	7.63
Improvement percentage of q	22.44	28.71	21.43	29.2	37.66

*Each company has the same improvement percentage of R, S, and SC profits and q with small, medium, and large demand.

Table 14: Summary of improvement on profits (from no-rebate-case to current practice) in sales-effort model*.

	Companies				
	MRS	MH	RX	SS	LS
Improvement percentage of R profit	0.12	0.12	29.5	−0.54	4.6
Improvement percentage of S profit	0.18	0.66	−64.32	3.93	−4.55
Improvement opercentage of SC profit	0.14	0.32	1.01	1.36	0.33
Improvement percentage of q	0.44	0.88	3.8	3.47	0.71

*Each company has the same improvement percentage of R, S, and SC profits and q with small, medium, and large demand.

Table 15: Summary of improvement on profits (from current practice to SCC) in sales-effort model*.

	Companies				
	MRS	MH	RX	SS	LS
Improvement percentage of R profit	0.36	0.68	−22.48	1.53	3.03
Improvement percentage of S profit	9.07	11.43	203.2	7.84	20.18
Improvement opercentage of SC profit	3.14	4.7	1.72	4.27	7.27
Improvement percentage of q	21.9	27.58	16.95	24.86	36.68

*Each company has the same improvement percentage of R, S, and SC profits and q with small, medium, and large demand.

3.3. Profit Variance (PV)

In this subsection, the PVs of the retailers, the manufacturers and the supply chains are examined (notice that profit variance (PV) = squared "standard deviation of profit (SDP)"). Moreover, the PVs under the no-sales-effort model and the sales-effort model are also compared. Notice that the manufacturer is risk free under the no rebate case because the manufacturer's profit is deterministic (the supply chain is a make-to-order type). In specific, the manufacturer simply gains from the retailer's order quantity and does not bear any risk coming from demand uncertainty, and the retailer takes up all the demand uncertainty risk under the no rebate case. On the other hand, the manufacturer would bear some of the demand uncertainty risk when the sales rebate contract is adopted. To be specific, as the rebate payment from the manufacturer to the retailer depends on the realized demand, the manufacturer's final profit becomes stochastic and retail demand dependent.

Tables 5 and 6 show that for the five companies under investigation $V[\Pi_R$ for SCC$] > V[\Pi_R$ for current practices$] > V[\Pi_R$ for no rebate$]$ and $V[\Pi_M$ for SCC$] > V[\Pi_M$ for current practices$] > V[\Pi_M$ for no rebate$]$. Therefore, all companies face the highest level of risk under SCC, and all companies would face the smallest risk under the no rebate case, for both the no-sales-effort model and the sales-effort model.

3.4. Decision Making under MV Approach

3.4.1. Linear Rebate Practitioners

In our analysis, both RX and LS are the practitioners of linear rebate. In our discussions above, it has been shown that the retailers prefer the current linear practices to SCC due to the higher expected profits. Conversely, the manufacturers would suffer losses from adopting the current linear rebate practices. Table 7 summarizes the expected profits and the profit variances of RX and LS. The following results are observed. For the retailers $E[\Pi_R$ for current practice$] > E[\Pi_R$ for SCC$] > E[\Pi_R$ for no rebate$]$ and $V[\Pi_R$ for SCC$] > V[\Pi_R$ for current practices$] > V[\Pi_R$ for no rebate$]$. For the manufacturers, $E[\Pi_M$ for SCC$] > E[\Pi_M$ for no rebate$] > E[\Pi_M$ for current practices$]$ and $V[\Pi_M$ for SCC$] > V[\Pi_M$ for current practices$] > V[\Pi_M$ for no rebate$]$. We note that the results are the same under both the no-sales-effort model and the sales-effort model.

For the retailers RX and LS, (a) the current linear rebate practices are better than SCC due to higher expected profits and smaller risks, (b) although the no rebate case brings the lowest expected profits for the retailers, the lowest risks could be found simultaneously. Therefore, the current linear rebate practices and the no rebate case are noninferior in the MV sense, and SCC is inferior to the current practices and the no rebate case for these two retailers.

For the manufacturers of RX and LS, (a) the current practices are dominated by the no rebate case because the manufacturers could have higher expected profits but lower risks under the no rebate case. (b) If the manufacturers attain SCC, the highest expected profits and highest risks could be found. Therefore, SCC and the no rebate case are non-inferior for the manufacturers of RX and LS in the MV sense. In other words, under the MV approach, the manufacturers should only consider the no rebate case and SCC, and do not select the current practices. There is obviously a difference between the optimal decisions for the manufacturers and the retailers in the supply chains of RX and LS.

3.4.2. Target Sales Rebate Practitioners

MRS, MH, and SS adopt the target sales rebate policy. Table 8 summarizes the expected profits and the profit variances of MRS, MH and SS. The following results are observed. For retailers, $E[\Pi_R \text{ for SCC}] > E[\Pi_R \text{ for current practices}] > E[\Pi_R \text{ for no rebate}]$ and $V[\Pi_R \text{ for SCC}] > V[\Pi_R \text{ for current practices}] > V[\Pi_R \text{ for no rebate}]$. For manufacturers, $E[\Pi_M \text{ for SCC}] > E[\Pi_M \text{ for current practices}] > E[\Pi_M \text{ for no rebate}]$ and $V[\Pi_M \text{ for SCC}] > V[\Pi_M \text{ for current practices}] > V[\Pi_M \text{ for no rebate}]$. We note that these results are consistently the same under both the no-sales-effort model and the sales-effort model. The above result reveals that SCC, the no rebate case, and the current practices are noninferior, respectively, for the manufacturers and the retailers. In other words, under the MV approach, the manufacturers and the retailers can choose among the no rebate case, the current practices, and SCC, depending on their own tolerance levels of risk. Moreover, as SCC yields the highest levels of risk and the no rebate case yields the lowest risk, SCC is the most risky and the no rebate case is the least risky for both the manufacturers and the retailers.

4. Conclusions

Sales rebate contract is a kind of instrument to help to achieve supply chain coordination (SCC). It is commonly adopted in the fashion industry. In this paper, we study the performance of sales rebate contracts in fashion supply chains with the use of real empirical data from five companies. In our analysis, we find that SCC is significant to both the retailer and the manufacturer. One interesting point to note is that the risk levels for attaining coordination are also higher for both the retailer and the manufacturer since their respective profit variances under SCC are also larger. The optimal parameters of the sales rebate contracts should hence be determined with a good balance between the benefit (expected profit) and the risk (variance of profit). The supply chain agents should discuss and examine the best contract setting which can achieve the best supply chain performance as well as their own goals with respect to both benefit and risk perspectives. In the no rebate case, the expected profits and risk levels are the lowest. We also find that an inappropriate setting of sales rebate could either hurt the retailer or the manufacturer because the expected profit of the retailer or the expected profit of the manufacturer may decrease with improperly designed sales rebate contracts (when compared with their expected profits in the no rebate case). In this situation, sales rebate becomes a trap for either the retailer or the manufacturer. By employing sales effort, higher expected profits and lower risks for the retailers and the manufacturers can be found. From our findings, we argue that how to set an optimal rebate rate and contract format for the retailers to exert sales effort under coordination is an important decision for the manufacturers. In particular, our analysis reveals that the linear

rebate practices adopted by some companies will lead the retailers to avoid exerting sales effort. This gives a very important hint on real-world implementation of the sales rebate contracts because the linear rebate practice has the drawback of hindering the level of sales effort exerted by the retailers.

The above findings are indicative for fashion supply chains as they provide important insights and better pictures on the performance of sales rebate contracts. For future research, more forms of rebates, such as consumer rebate, could be investigated as they are also popular. By doing so, a more complete picture of how rebate contracts affect fashion supply chains can be revealed.

Appendix

For more details see Tables 9–15.

Acknowledgments

This paper is partially supported by funding provided by RGC(HK)-GRF with account number of PolyU5420/10H, and the "985 project" of Sun Yat-Sen University. The authors sincerely thank the anonymous reviewers for their constructive comments on this paper.

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