Proceedings of the World Congress on Engineering and Computer Science 2012 Vol II
WCECS 2012, October 24-26, 2012, San Francisco, USA

Study on Coordination of Supply Chain with Combined Contracts

Shahrokh Hematyar, Kamal Chahrsooghi, Ahoo Malekafzali

***Abstract*—This paper investigates coordination of supply chain consisting of one manufacturer and one retailer facing consumer return and stochastic demand that is sensitive to both sales effort and retail price. When demand is influenced by both retail price and retail sales effort, coordination is challenging traditional contracts can coordinate the supply chain. To resolve this issue, we study a variety of combined contract types including: buyback contract, joint buyback with sales rebate and penalty (SRP) and buyback with revenue sharing, buy back with sales rebate and buyback with quantity discount. We find that only the properly designed buyback with SRP contract and buyback with quantity discount contract are able to achieve channel coordination and lead to a Pareto improving win-win situation for supply members.**

***Index Terms*—consumer return, coordination, price and effort dependent demand, contract**

I. INTRODUCTION

RETURNS of product from customers to retailers are a common feature of competitive markets. The volume of returns in North America is significant and growing: Stalk reported that returned goods are estimated to exceed $100 billion per year in the united states and in many categories, the number of returns is growing at better than 50% a year[1]. Returns rates are also high for example typical returns rate ranged from 1% to 5% for business products, to as high as 25% to 40% for high-fashion apparel [2]. In retail industries, a returned item is differently handled, depending on the status of the product and the relationship between retailers and manufacturers. If the item is not apparently damaged, it will go back to the shelf. However, if the manufacture desires to keep a high standard, the item will not go back to the shelf until the manufacturer inspected the product. For example, welding equipment HP and Bosch follow this policy [2].

The presence of product return adds one dimension to the relationship between manufacturers and retailers underscores the importance of coordination. To improve the efficiency of a decentralized supply chain, the supply chain requires the collaboration of the players who independently maximize their own profit. Supply chain coordination may be achieved by modifying the structure of these relationships. Contract is an effective tool to allocate the channel profit between the players. Another important function of contract is that it facilitates a long-term partnership and makes the terms more explicit.

Manuscript received July 2, 2012; revised July 27, 2012.

Shahrokh Hematyar is PhD student, Department of Industrial Engineering, P.N. University, Tehran, Iran. His principle research interests focus on supply chain coordination. His publications have appeared in IEEEXplore database. (E-mail: hematyar@mapna.com).

Kamal Chaharsooghi is with the Department of industrial engineering, Tarbiat Modaress University, Tehran, Iran (e-mail: skch@modares.ac.ir).

Ahoo Malekafzali graduated in Architecture and planning at the University of Buffalo, New York, USA. (E-mail: ahoo@yahoo.com).

Apart from the retail price, in most situations, retailer's sales effort is also important in influencing demand. A retailer can increase a product's demand by hiring more sales people, improving their training, increasing advertising and guiding consumer purchases with sales personnel. All of those activities are costly. There is some literature that considers supply chain coordination with effort dependent demand.

As both retail pricing and sales effort are important factors that determine the success of a supply chain, one major objectives of this paper is to study supply chain coordination when the retailer has to choose retail price and exert costly effort to increase sales in addition to his stoking quantity. Our major research questions are: can the buyback contract coordinate the supply chain that faces consumer return and stochastic effort and price dependent demand? If the buyback contract can't coordinate such a supply chain, how about combined contact such as joint buyback with revenue sharing, buyback with sales rebate and penalty, buyback with quantity discount and buyback with sales rebate? Who should bears the cost of effort, retailer, manufacturer or both of them for coordinating supply chain? How to decide the optimal contracts parameters to achieve supply chain coordination?

The rest of this paper is organized as follows. In the next section, we review the related literature. Section 3 introduces the model assumptions and notations and centralized channel as benchmark case. In section 4 we analysis four combined contracts. Section 5 summarizes the results.

II. RELATED RESEARCH

This paper is closely related to supply chain coordination management, buyback contract and consumer returns policy.

Coordination among suppliers and retailers is a very important strategic issue in supply chain management [3]. The concept of coordination may guide supply chain members to work coherently to identify inter-dependencies between each other, to mutually define goals and to fairly share risks and reward [4]. Whang has classified the coordination from an organizational perspective in terms of single-person, team-based and nexus-of-contract approach

ISBN: 978-988-19252-4-4
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

[5]. Sahin and Robinson proposed price, non-price, buyback, quantity flexibility, allocation rules, information sharing and flow coordination as major categories of coordination mechanisms [6]. The classification can therefore be summarized as flow coordination and contract-based coordination.

Supply chain contract is a set of many clauses that offers suitable information and incentive mechanism to guarantee all supply chain members to achieve coordination and optimize the supply chain performance. generally, the contract analysis offers guidance in negotiating the terms of relationship between supplier and buyer. The contracts are designed to sort out conflicts that may crop up in future. Various types of contracts have been established to coordinate chain members and allow individual decisions to be aligned with the whole system's objective through an agreement reached by the supply chain members. These contracts include the quantity discount pricing scheme, the wholesale price contract, the buy-back contract, the two-part tariff, the quantity flexible contract, the backup agreement, the revenue sharing contract and the sales rebate contract.

Cachon performed a detailed survey on the coordination with contracts and kinds of contracts' effect on the supply chain coordination for a wide range of supply chain models. [7]. Buyback is one of an important coordination contracts which may help to achieve pareto improvement in supply chain. Pasternack shows that a supply chain may be coordinated when the supplier commit to buyback all unsold unit at partial credit [8]. However, Emmons and Gilbert incorporate retailer's pricing decision and show that channel coordinating using buyback contract may no longer be feasible, unless the retailer can commit the selling price prior to the selling season; otherwise, the retailer has an incentive to set price too high [9]. Padmanbhan and Pang analyze the interaction between manufacturer returns policy and retail competition [10]. Krishan et al demonstrated that the buyback contract adversely affected supply chain profits and higher buyback prices induced low profits. Also, buyback contracts could not coordinate the supply chain without promotional cost-sharing agreements, unilateral markdown allowances or additional constraints on the buyback [11]. Taylor incorporates a buyback contract with a target sales rebate contract to coordinate the supply chain when the demand is sensitive to the sales effort of retailer [12]. Chen incorporate buyback contract with consumer return policy in a decentralized supply chain where retailer simultaneously determine retail price and order quantity and faces dependent stochastic demand [2].

Our model is similar in some sense to the one studied by Taylor and Chen. However, in Taylor's model the retail price is assumed to be exogenous. We extend Taylor's model by allowing the price to become a decision variable for the retailer. Besides the return policy considered in Taylor, we also consider consumer return policy in the model and use combined contract that inherit the advantages of buyback. In Chen's model is assumed price dependent stochastic demand. In this study, we also extend the Chen's model [2]. Besides the return policy considered in Chen, we also consider combined contracts and use another approach for modeling price and effort sensitive random demand for the newsvendor problem with consumer return policy.

III. THE MODEL ASSUMPTION AND CENTRALIZED SUPPLY CHAIN

A. Model Assumption

Consider a supply chain where a supplier produces a product and sells it through a retailer. The supplier produces the product at a constant unit cost of $\$c$ and sells it w . Market demand for the product during a selling season, is sensitive to both sales effort and retail price. The supplier, knowing the characteristics of demand, need to decide contract format and parameters to achieve the best performance so entire supply chain. Let x be a random variable representing customer demand. $f(x|p,e)$ is probability density and $F(x|p,e)$ is cumulative distribution of demand random variable that is differentiable, invertible, and strictly increasing in effort and decreasing in price. We use $g(e)$ as retailer's cost of exerting a effort level e, where $g(0)=0$, $g'(0)>0$, $g''(0)>0$

Before the start of the selling season, the supplier produces Q units of the product and delivers them to the retailer who then rises to sell them to the market at the retail price p during the selling season. Retailer offers a refund amount $r<p$ to consumers when the product is returned. The retailer incurs a handling cost I_r per unit return of consumer. The manufacture incurs the inspection and disposition of the returned units by consumers at an average handling cost of I_m per unit. Define $I=I_m+I_r$ as the total unit cost for the channel when the product is returned. $\beta=\frac{I_m}{I}$ as the share of the channel cost that is incurred by the manufacture. Consumers return the products with probability G_1 . At the end of the selling season, the product that has not been sold has a unit salvage values v .

The expected sales and expected left over are respectively

$$S(Q,P,e)=Q-\int_0^Q F(x|p,e)d_x \quad (1)$$

We use notation $S(Q)$ instead of $S(Q,P,e)$ for simplicity

$$I(Q,P,e)=Q-S(Q,p,e) \quad (2)$$

B. Centralized channel

For centralized channel, the decision is to simultaneously choose the selling price p and the quantity Q and e with the objective to maximize the expected channel profit which can be written as:

$$\pi_T(Q,p,e)=[p-v+(v-r-I)G_1]S(Q)-(c-v)Q-g(e) \quad (3)$$

Therefore, the problem faced by the integrated supply chain is: *Maximize* $\pi_T(Q,P,e)$ (4)

$$s.t. \quad Q\ge 0\ and \quad p\ge 0 and \quad e\ge 0$$

The partial derivatives of $\pi_T(P,Q,e)$ are as follows:

$$\frac{\partial \pi_T(Q,p,e)}{\partial Q}=[(p-v)+(v-r-I)G_1]\frac{\partial S(Q)}{\partial Q}-(c-v) \quad (5)$$

$$\frac{\partial \pi_T(Q,p,e)}{\partial p}=S(Q)+[(p-v)+(v-r-I)G_1]\frac{\partial S(Q)}{\partial p} \quad (6)$$

$$\frac{\partial \pi_T(Q,p,e)}{\partial e}=[(p-v)+(v-r-I)G_1]\frac{\partial S(Q)}{\partial e}-g'(e) \quad (7)$$

We also see that

ISBN: 978-988-19252-4-4
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

$$\frac{\partial^2 \pi_T(Q,p,e)}{\partial Q^2} = -(p-v)f(x|p,e) - (v-r-I_t)G_1 f(x|p,e) \tag{8}$$

Because $p \succ v$, $r \succ v$ so $\frac{\partial^2 \pi_T(Q,p,e)}{\partial Q^2} \prec 0$ therefore $\frac{\partial^2 \pi_T(Q,p,e)}{\partial Q^2}$ is concave in Q for a given p and e. Thus, the optimal $\frac{\partial^2 \pi_T(Q,p,e)}{\partial Q^2}$ should satisfy

$$F(Q^*|(p,e)) = \frac{p-c+(v-r-I)G_1}{p-v+(v-r-I)G_1} \tag{9}$$

Although we don't need to assume that the integrated supply chain's profit function is concave or unimodal in three decision variables, we need to assume there exists a finite optimal quantity-effort- price, $\{Q^*, p^*, e^*\}$. Then the following first-order conditions are necessary for coordination (but not necessarily sufficient):

$$\frac{\partial \pi_T(Q^*,p^*,e^*)}{\partial Q} = \frac{\partial \pi_T(Q^*,p^*,e^*)}{\partial p} = \frac{\partial \pi_T(Q^*,p^*,e^*)}{\partial e} = 0 \tag{10}$$

A contract designed by supplier is said to coordinate the supply chain if it is able to satisfy the first-order conditions at Q^*, p^* and e^*.

IV. THE DECENTRALIZED SUPPLY CHAIN UNDER CONTRACT

A supply chain involves managing various resources such as inventory, money and information between disparate but dependent chain members. The conflicting objectives and lack of coordination between supply chains may often cause uncertainties in supply chain. The centralized control of supply chain assures coordination but it may not be realistic, whereas in decentralized control, supply chain members optimize local decisions without considering the impact of their decisions on the other member's performance and overall performance of supply chain. Hence, some coordination mechanism is necessary utilizing which may motivate the members to achieve coordination.

Unfortunately, when allowing the retailer to exert costly effort and use retail price to influence demand, coordination is challenging. Furthermore, coordination is complicated by the fact that incentives to align the retailer's order quantity decision may distort the retailer's effort and price decision. In the rest of this part, we model problem with different kind of contracts. In our model supplier bears α share of effort cost and the retailer $(1-\alpha)$ share of effort cost.

A. Buyback

The buyer is allowed to return any leftover units to the supplier at the end of period at a fraction of purchase price. Let the return credit for each unsold unit be b where $b \in (v,w)$. Then Under the buyback contract, the retailer's profit function is

$$\pi_R(P,Q,e) = [p-b+(b-r-(1-\beta)I)G_1]S(Q) - (w-b)Q - (1-\alpha)g(e) \tag{11}$$

Then,

$$\frac{\partial \pi_T(Q,p,e)}{\partial Q} = [(p-b)+(b-r-(1-\beta)I)G_1]\frac{\partial S(Q)}{\partial Q} - (w-b) \tag{12}$$

$$\frac{\partial \pi_T(Q,p,e)}{\partial p} = S(Q) + [(p-b)+(b-r-(1-\beta)I)G_1]\frac{\partial S(Q)}{\partial p} \tag{13}$$

$$\frac{\partial \pi_T(Q,p,e)}{\partial e} = [p-b+(b-r-(1-\beta)I)G_1]\frac{\partial S(Q)}{\partial e} - (1-\alpha)g'(e) \tag{14}$$

By Comparing (13) with (6) we find that p^* that is retailer's optimal price level if

$$b = v + \frac{IG_1\beta}{1-G_1} \tag{15}$$

By comparing (14) with (7) at $b = v + \frac{IG_1\beta}{1-G_1}$ we find e^* can be the retailer's optimal effort only if

$$\alpha = 0 \tag{16}$$

Therefore retailer bears effort cost by himself until buyback contract can coordinate supply chain.

By comparing (12) with (9) under above condition we find that w amount is required to coordinate the retailer's order quantity.

$$w = c + \frac{IG_1\beta}{1-G_1} \tag{17}$$

Under consumer return policy and contract parameters in (15-17), an arbitrary allocation of the optimal supply chain profit can't be achieved. Because by substituting (15-17) into (11), we get the retailer's expected profit function:

$$\pi_R(P,Q,e) = \pi_T(p,Q,e)) \tag{18}$$

Using (18), the supplier's expected profit is zero.

So buy back contract with reasonable parameter cannot coordinate the supply chain.

B. Buyback +Revenue Sharing

The before section show that buyback contract fail to coordinate the retailer's action. Here we combine the advantage buyback contract with revenue sharing. With a revenue sharing contract, the supplier charges a low wholesale price to the retailer and shares a fraction of the revenue generated by the retailer. Let $0<\rho<1$ be the fraction of supply chain revenue earned by the supplier, so $(1-\rho)$ is the fraction of revenue kept by the retailer.

Under the revenue sharing contract, the retailer's profit function is

$$\pi_R(P,Q,e) = [(1-\rho)p-b+(b-r-(1-\beta)I)G_1]S(Q) - (w-b)Q - (1-\alpha)g(e) \tag{18}$$

Then,

$$\frac{\partial \pi_R(Q,p,e)}{\partial Q} = \{(1-\rho)p-b+[b-r-(1-\beta)I]G_1\}\frac{\partial S(Q)}{\partial Q} - (w-b) \tag{19}$$

$$\frac{\partial \pi_R(Q,p,e)}{\partial p} = (1-\rho)S(Q) + \{(1-\rho)p-b+[b-r-(1-\beta)I]G_1\}\frac{\partial S(Q)}{\partial p} \tag{20}$$

$$\frac{\partial \pi_R(Q,p,e)}{\partial e} = \{(1-\rho)p-b+[b-r-(1-\beta)I]G_1\}\frac{\partial S(Q)}{\partial e} - (1-\alpha)g'(e) \tag{21}$$

Comparing (21) with (7), we find that e^* can be the retailer's optimal effort level only

$$b = \frac{-\rho p}{1-G_1} + \frac{IG_1\beta}{1-G_1} + v \tag{22}$$

$$\alpha = 0 \tag{23}$$

Therefore retailer bears effort cost by himself until this combined contract can coordinate supply chain. by comparing (19) with (9) at above condition we can find Q^* to coordinate the retailer's order quantity if

$$w = c + \frac{IG_1\beta - \rho p}{1 - G_1} \quad (24)$$

Then buyback with revenue sharing contract can coordinate the supply chain when demand is only influenced by the effort cost. However, by comparing (20) with (6) we find that p^* can never satisfy $\frac{\partial \pi_R(Q,p,e)}{\partial p} = 0$ given $0 < \rho$. Hence, when demand is also influenced by retail price, supply chain can't be coordinated through joint buyback and revenue sharing contract.

C. Buyback +Sales Rebate

The sales rebate contract is one of the contracts regimes, and channel rebates are widely adopted in the different industries. A channel rebate is a payment from a manufacturer to a retailer based on retailer sales to end consumers. The rebate contract has the effect of motivating retailer to lower prices for increasing sales, so it is a good application for system coordination.

Under the buyback and sales rebate contract, the retailer's profit function is

$$\pi_R(P,Q,e) = \quad (24)$$
$$[\,p - b + (b - r - (1-\beta)I\,)G_1\,]S(Q) - (w - b)Q - (1-\alpha)g(e) + sL(d)$$

s is channel rebate for retailer and S_0 is target threshold for retailer so a rebate s is paid by the supplier to the retailer for each unit sold beyond the threshold S_0. $L(d)$ is expected rebate offered by the supplier.

$$L(d) = E(S(Q) - S_0)^+ = (q - S_0)^+ - \int_{S_0}^{Q} F(x|p,e)\,dx \quad (25)$$

Then

$$\frac{\partial \pi_T(Q,p,e)}{\partial Q} = \quad (26)$$
$$[(p-b) + (b - r - (1-\beta)I)G_1]\frac{\partial S(Q)}{\partial Q} - (w-b) + s(1 - F(Q|p,e))$$

$$\frac{\partial \pi_T(Q,p,e)}{\partial p} = S(Q) + [(p-b) + (b - r - (1-\beta)I)G_1]\frac{\partial S(Q)}{\partial p} \quad (27)$$

$$\frac{\partial \pi_T(Q,p,e)}{\partial e} = [p - b + (b - r - (1-\beta)I)G_1]\frac{\partial S(Q)}{\partial e} - (1-\alpha)g'(e) \quad (28)$$

Compare (27) with (6) we find that p^* satisfies $\frac{\partial \pi_R(Q,p,e)}{\partial p} = 0$ if

$$b = v + \frac{\beta IG_1}{1 - G_1} \quad (29)$$

By comparing (28) with (7), at $b = v + \frac{\beta IG_1}{1 - G_1}$, we know that only when $\alpha = 0$ is, e^* can be the retailer's optimal effort level. We find that amount w is required to coordinate the retailer's order quantity as below

$$s = 0 \quad (30)$$

$$w = c + \frac{\beta IG_1}{1 - G_1} \quad (31)$$

Hence this combined contract can't coordinate the supply chain. However, if $s = 0$, then buyback with sales rebate becomes buyback contract, which can't coordinate the supply chain as shown in section A.

D. Buyback +Sales Rebate and Penalty (SRP)

Before selling season, supplier offers a sales target to the retailer, if the final sale quantity is above the target, the supplier gives the retailer a rebate; otherwise, the retailer gives a payment to the supplier as penalty.

Let T be target for the retailer and τ be rebate amount if retailer sales is beyond the target or a penalty for each unit of product unsold below T. The sales rebate and penalty is required when the market incentives are insufficient [13]. Under the SRP contract considered in the paper, the retailer enjoys rebates from the supplier because of the enhanced sales; in the meantime, he is also under pressure of penalty resulted from low sales.

Under the SRP contract, the retailer's profit function is

$$\pi_R(P,Q,e) = \quad (32)$$
$$[p - b + \tau + (b - r - (1-\beta)I - \tau)G_1]S(Q) - (w-b)Q - \tau T - (1-\alpha)g(e)$$

Then,

$$\frac{\partial \pi_R(Q,p,e)}{\partial Q} = [p - b + \tau + (b - r - (1-\beta)I - \tau)G_1]\frac{\partial S(Q)}{\partial Q} - w + b \quad (33)$$

$$\frac{\partial \pi_R(Q,p,e)}{\partial p} = S(Q) + [p - b + \tau + (b - r - (1-\beta)I - \tau)G_1]\frac{\partial S(Q)}{\partial p} \quad (34)$$

$$\frac{\partial \pi_R(Q,p,e)}{\partial e} = \quad (35)$$
$$[p - b + \tau + (b - r - (1-\beta)I - \tau)G_1]\frac{\partial S(Q)}{\partial e} - (1-\alpha)g'(e)$$

By Comparing (34) with (6) and (35) with (7) and (33) with (9) we can find p^* and e^* and Q^* if

$$b = w - c + v \quad (36)$$

$$\tau = w - c - \frac{\beta IG_1}{1 - G_1} \quad (37)$$

$$\alpha = 0 \quad (38)$$

Hence the joint buyback and SRP contract can coordinate the supply chain.

Substituting (36-38) into (32), we get the retailer's expected profit function:

$$\pi_R(P,Q,e) = \pi_T(P,Q,e) - (w - c - \frac{\beta IG_1}{1 - G_1})T \quad (39)$$

Under buyback with SRP and contract parameters in (36-38), an arbitrary allocation of the optimal supply chain profit can be achieved by varying T and β.

By using (39), the supplier's expected profit is

$$\pi_S(P,Q,e) = (w - c - \frac{\beta IG_1}{1 - G_1})T \quad (40)$$

So the total supply chain profit can be split as $[\pi_S(P,Q,e), \pi_R(P,Q,e)]$ between the supplier and the retailer. Any profit allocation can be realized by changing T and β. Supplier should adjust T and β such that the retailer gets a profit larger than under a non-coordination contract. If β, share of the channel cost that is incurred by the manufacture be zero, supplier's expected profit increases.

ISBN: 978-988-19252-4-4
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

E. Buyback +Quantity Discount

Quantity discount is widely applied in the industry. Under quantity discount, the seller gives the buyer different proportion preferential benefit in price according to the amount of products the buyer buys, the lower the price is. According to the different discount basis, quantity discount can be divided into two kinds, all-unit discount and incremental quantity discount. In an all-unit discount, when the buyer's quantity exceeds a given threshold, the corresponding price decrease applied to all of the units that he buys. In an incremental discount, when the buyer's quantity exceeds a given threshold, the corresponding price decrease applies to only the additional. Here the quantity discount form which the manufacturer provides to retailer is goal unit' quantity discount. The manufacturer establishes a minimum standard of order L (0<L<Q). Only when the retailer's order quantity is greater than the minimum standard of order L, the manufacturer gives certain price discount for the part of order which exceeds the standard quantity.

The discount rate is as follow:

$$d=\begin{cases}1 & Q\prec L\\ d_1 & Q\ge L\end{cases}\quad \text{where } 1\succ d_1\succ 0 \tag{41}$$

Under this combined contract, the retailer's profit function is

$$\pi_R(P,Q,e)= \tag{42}$$
$$[p-b+(b-r-(1-\beta)I)G_1]S(Q)-(dw-b)Q-Lw(1-d)-(1-\alpha)g(e)$$

Then

$$\frac{\partial\pi_R(Q,p,e)}{\partial Q}=[p-b+(b-r-(1-\beta)I)G_1]\frac{\partial S(Q)}{\partial Q}-(dw-b) \tag{43}$$

$$\frac{\partial\pi_R(Q,p,e)}{\partial p}=S(Q)+[p-b+(b-r-(1-\beta)I)G_1]\frac{\partial S(Q)}{\partial p} \tag{44}$$

$$\frac{\partial\pi_R(Q,p,e)}{\partial e}=[p-b+(b-r-(1-\beta)I)G_1]\frac{\partial S(Q)}{\partial e}-(1-\alpha)g'(e) \tag{45}$$

By Comparing (44) with (6) we find p^* satisfies $\frac{\partial\pi_R(Q,p,e)}{\partial p}=0$ if

$$b=v+\frac{\beta IG_1}{1-G_1} \tag{46}$$

Comparing (25) with (7), at above condition, we know that only when $\alpha=0$ is, we can find e^* to coordinate the retailer's optimal effort level.

By comparing (43) with (9) at $b=v+\frac{\beta IG_1}{1-G_1}$ and $\alpha=0$ we find Q^* satisfies $\frac{\partial\pi_R(Q,p,e)}{\partial Q}=0$ if

$$w=\frac{c}{d}+\frac{\beta IG_1}{d(1-G_1)} \tag{47}$$

Hence the combined contract can coordinate the supply chain.

Substituting (46-47) into (42), we get the retailer's expected profit function:

$$\pi_R(P,Q,e)=\pi_T(P,Q,e)-L(w-c-\frac{\beta IG_1}{1-G_1}) \tag{48}$$

Using (48), the supplier's expected profit is

$$\pi_S(P,Q,e)=L(w-c-\frac{\beta IG_1}{1-G_1}) \tag{49}$$

So the total supply chain profit can be split as $[\pi_S(P,Q,e),\pi_R(P,Q,e)]$ between the supplier and the retailer. Any profit allocation can be realized by changing L and β. Supplier should adjust L and β such that the retailer gets a profit larger than under a non-coordination contract. If $\beta=0$ be, this combined contract the same as joint buyback with SRP.

V. CONCLUSION

In this paper, we study coordination of a two-echelon supply chain that retailer faces both effort and price dependent stochastic demand and so retailer faces consumer return. With the increase of product variety, consumers feel much uncertain about whether specific items fit their needs. If the items don't fit, consumers wish return them. We considered four combined contracts that inherit the advantages of buyback contract. We find combination of buyback with revenue sharing and buyback with sales rebate can't coordinate the supply chain. Whereas we find buyback with sales rebate and penalty and buyback with quantity discount can coordinate supply chain. Furthermore, we find that, only when retailer bears all of effort cost, could combine contracts (joint buyback with SRP and joint buyback with quantity discount) coordinate the supply chain.

REFERENCES

[1] G. Stalk, "Customer returns top10 billion in 2005: most Canadian retailers fail to capitalize on this key customer relationship, Harvard business review," Vol. 80, 2006
[2] J. Chen, P. C. Bell, "Coordinating a decentralized supply chain with customer returns and price-dependent stochastic demand using a buyback policy," European Journal of Operational Research, Vol. 212, 2011
[3] H. Yong. Z. Xuan, Z. Lindu, "Coordinating a study supply chain with effort dependent stochastic demand," Applied Mathematical Modeling, Vol. 33, 2009.
[4] S. Arshinder. A. Kanda, S.G. Deshmukh, "Develop a tool for supply chain coordination using contract," management Research, Vol. 5, 2008.
[5] W. K. Wong, J. Qi, S.Y. Leung, Coordinating supply chains with sales rebate contracts and vendor-managed inventory, Production Economics, Vol. 120, 2009.
[6] F. Sahin, E.P. Robinson, Flow coordination and information sharing in supply chains: Review, implication and directions for future research. Decision Sciences, Vol. 33, 2002
[7] G. Cachon, "Supply chain coordination with contracts," Handbooks in Operation Research and Management Science: Supply chain management, North-Holland, 2003
[8] B. Pasternack, "Optimal pricing and return policies for perishable commodities," Marketing Science, Vol. 14, 1985.
[9] H. Emmons and S Gilbert, "The role of returns policies in pricing and inventory decisions for catalogue goods," Management Science, Vol. 44, 1998
[10] V. Padmanabhan, J.P. Pang, "Manufacturer's returns policies and retail competition," management Science, Vol. 16, 1997.
[11] H. Kirshnan, R. Kapuscinski Dada, "Coordinating contracts for decentralized supply chains with retailer promotional effect," Management Science, Vol. 50, 2004.
[12] T. Taylor, "Supply chain coordination under channel rebates with sales effort effects," Management Science, Vol. 48, 2001.
[13] M. Kolesar, D.L. Weisman, "Accommodative competitive entry policies and telecommunications regulation," Info, Vol.5, 2003.

ISBN: 978-988-19252-4-4
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)