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Abstract

This paper analyzes coordination of a manufacturer-distributer-retailer supply chain, where the manufacturer exhibits corporate social responsibility (CSR). In manufacturer-Stackelberg game setting, the paper proposes a contract-bargaining process to resolve channel conflict and to distribute surplus profit among the channel members. The contract-bargaining process consists of two wholesale price discount-Nash bargaining. One between the distributer and the retailer based on the outcome of that between the distributer and the manufacturer. Although the contract-bargaining process cuts out channel conflict and distributes surplus profit, the wholesale prices are quite different from that of a pure profit maximizing supply chain. The wholesale price of the manufacturer is less than it's marginal production cost above a threshold of CSR. Even it is negative for the manufacturer's heavy CSR practice. So, the manufacturer's profit may be negative. The behaviour of the wholesale price of the distributer is same as that of the manufacturer but for higher threshold of CSR.

Key words: Corporate social responsibility, channel coordination, wholesale price discount, bargaining.

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1. Introduction

Coordination through cooperation is imperative for improving channel wide performance because it offers the potential to realize substantial profit benefit. To coordinate a supply chain, contracts are designed among the decentralized decision makers such that the difference between outcome of a centralized decision and a decentralized decision can be neutralized. The basic objective behind designing a coordination contract is to incentimize decentralized channel members to act coherently with one another. A variety of side-payment contracts (eg. quantity discount (Li and Liu, 2006), two-part tariff (Goering, 2012; Modak et al. 2015c), revenue sharing (Panda, 2013a, 2014a), sales rebate (Wong et al., 2009), buy back (Ding and Chen,2008), credit option (Du et al., 2013), commitment to purchase quantity (Zhang et al., 2011), mail-in-rebate (Saha et al., 2015), etc have been used in supply chains as the ways of cutting out channel conflict. These contracts differ by the contractual clauses among the channel members and are

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primarily concerned with quantity, time, quality and price.[1]

CSR is a form of corporate self regulation that currently does not has unique definition. Broadly CSR can be defined as a doctrine that promotes expanded social stewardship by businesses and organizations. CSR suggests that corporations embrace responsibilities toward a broader group of stakeholders (customers, employees and the community at large) in addition to their customary financial obligations to stockholders. In the current global business environment CSR is now a determining factor in consumer and client choice, which companies cannot afford to ignore. According to the results of a global survey in 2002 by Ernst & Young, 94% of companies believe the development of a CSR strategy can deliver real business benefits, however only 11 per cent have made significant progress in implementing the strategy in their organization. Senior executives from 147 companies in a range of industry sectors across Europe, North America and Australasia have been interviewed for the survey. The survey has concluded that CEOs are failing to recognize the benefits of implementing CSR strategies, despite increased pressure to include ethical, social and environmental issues into their decision-making processes. For example, on social issue, largest apparel retailer GAP admits to charge of its substandard working conditions in as many as 3000 factories worldwide (Merrick, 2004). Nike is often accused for inhuman labour and business practices in Asian manufacturing factories (Amaeshi et al., 2008). For environmental issues, in 2009 a group of 186 institutional investors having assets of 13 trillion US dollars have signed a statement. It suggests directions to deal with global warming and greenhouse gases (Economist, 2009). The research has found that company CSR programs influence 70% of all consumer purchasing decisions, with many investors and employees also being swayed in their choice of companies. Recent empirical evidence shows that customers are willing to pay a higher price for products with CSR attributes (Auger et al., 2003). Modern theoretical and empirical analysis indicate that firms can strategically engage in socially responsible activities to increase private profits. Given that the firms stakeholders may value the firms social efforts, the firm can obtain additional benefits from enhancing the firms reputation and the ability to generate profits by differentiating its product. As a result many leading international brands like WalMart, Nike, Adidas, GAP have been impelled to incorporate CSR in their complex supply chains by a code of conducts (Amaeshi et al., 2008).

This paper intends to merge two research areas, CSR and channel coordination in a three-echelon supply chain that consists of a manufacturer, a distributer and a retailer. Beside pure profit motive the manufac-

[1] For detail discussion on channel coordination the reader may consult the survey papers of Cachon (2003) and Sarmah et al. (2007).

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turer has the intend to swell stakeholder's welfare by exhibiting CSR. In manufacturer-Stackelberg game setting the paper proposes a contract-bargaining process to resolve channel conflict and to distribute surplus profit among the channel members. In the contract-bargaining process the manufacturer first provides wholesale price discount to the distributer and bargains with the distributer for profit share. Based on the intermediate profit, the distributer provides wholesale price discount and bargains with the retailer for profit share. While formulating the model instead of considering the manufacturer's CSR activities the paper considers the effect of CSR in the form of consumer surplus in the manufacturer's profit. So, the socially responsible manufacturer maximizes it's pure profit plus a share of consumer surplus that it accrues from it's stakeholders. (Lambertini and Tampieri (2010), Goering (2007, 2008), Kopel and Brand (2012)). The underlying principle of the paper is based on the classic paper of Vickers (1985) and hence the result supports the result of Vickers that non-profit maximizing firm may earn higher profits than would profit-maximizers. Here the objective of the manufactuer is to engage in CSR and to find the effects that CSR tends to bring about. The outcome of the paper indicates that when the manufacturer concentrates more on CSR than profit, it's total profit is always higher than pure profit. On the other hand, the channel behaves more competitively than a pure profit maximizing supply chain by exhibiting CSR because it generates higher output by setting lower price. That is, wholesale price of the manufacturer behaves differently from that of a pure profit maximizing supply chain. The CSR has considerable impact on the wholesale price it may be less than marginal production cost or even negative for heavy CSR activity. Although total profit of the channel member increase, the pure profits may be zero of less, which is not desirable. Thus, for acceptable pure profit and for exhibition of social responsibility there must be a limit of CSR up to which a firm can practice CSR.

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2. Literature review

Although use of coordination contract to cut out double marginalization in two-echelon supply chain has been explored extensively, models dealt with resolving channel conflict in three-echelon supply chain are notably fewer. In practice it is more difficult to resolve channel conflict in a three-tire supply chain by applying coordination contract than a two-tire supply chain. When the number of echelon increases, self cost minimizing/profit maximizing objectives increase. As a result, dimension of the solution space increases and the channel coordination using contract becomes more complex. Also, many difficulties remain when it comes to carry out any coordination contract for channel members. For example geographical constraints, administrative problems, performance measurement and incentives at individual forms based on local perspective, dynamically interchanging products and the like (Kanda and Desh-

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mukh 2008). Focusing on multi-echelon supply chain Munason and Rosenblatt (2001) have developed a supplier-manufacturer-retailer chain and have explored channel coordination using quantity discount. Jaber et al. (2006) have extended Munason and Rosenblatt's model by assuming profit function, discount dependent demand and profit sharing. Jaber et al. (2010) have studied a three-echelon supply chain with learning based continious improvement. Saha et al. (2013) have considered a three-echelon supply chain coordination problem, where demand is linear in price. They have used mail-in-rebate and downward-direct-discount for channel coordination. Jaber and Goyal (2008) have investigated the coordination of order quantities in a three-tire supply chain, where they have allowed more than one member at each echelon. Ding and Chen (2008) have used flexible buy back contract to coordinate a three-level supply chain, where the profit is divided among the channel members freely. Panda et al. (2014) have used disposal cost sharing as the coordination contract for a manufacturer-distributer-retailer chain that deals with perishable product. They have assumed that the manufacturer and the distributer form a coalition and the coalition shares the retailer's disposal cost. Modak et al. (2015a) have considered a three-tire supply chain, where in the downstream two retailers play Cournot, Collusion and Stackelberg games. They have used two-part tariff and franchise for channel coordination and have performed a preference analysis for the channel members' preference of game behaviour.

Although there is a rich content on CSR consideration in individual firm in a supply chain, application of CSR in the entire supply chain has emerged in the last two decades. Murphy and Poist (2002) have considered a CSR supply chain and have suggested a total responsibility approach by adding social issues to traditional economy. Through a case study and survey research Carter and Jennings (2002) have explained the necessity of CSR consideration in supply chain decision making. Using French sample data Ageron et al. (2012) have found several conditions, which lead to a successful sustainable supply chain management. For an environmentally responsible supply chain network Cruz (2008) has traced equilibrium condition by using multi-criteria decision making approach. Cruz and Wakolbinger (2008) have extended the model to multi-period setting for measuring long-term effects of CSR. Hsueh and Chang (2008) have considered a socially responsible supply chain network and have demonstrated that social responsibility sharing through monetary transfer leads to channel optimization. Panda et al. (2014) have developed a two-echelon supply chain , where either the manufacturer or the retailer practices CSR and have used quantity discount to coordinate the chain. Savaskan et al. (2004) have focused on identifying a socially responsible close loop supply chain that is involved in product manufacturing and remanufacturing. Cruz (2009) has developed a decision support system framework for modelling and analysis of a CSR supply chain network. Ni et al. (2010) have developed a two-tire CSR supply chain by

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assuming that the dominant upstream channel member's CSR cost is shared by the downstream channel member through wholesale price contract. Ni et al. (2012) have developed a two-echelon supply chain by assuming that each channel member has individual CSR cost. They have examined the effects of strategic interactions between the channel members under game theoretic setting. Hsueh (2014) has used a new revenue sharing contract to coordinate a CSR supply chain. Considering French sample data Crifo et al. (2015) have analyzed how different combinations of CSR affect economic performance and have compared the result based on quality of CSR and quantity of CSR. In this direction the works of Modak et al (2015b), Chen and Slotnick (2015), Ding et al. (2015), Subramanian and Gunasekaran (2015) are worth mentioning.

Bargaining refers to situations where two or more players, who have the opportunity to collaborate from mutual benefit in more than one way. There are two streams, axiomatic approach and strategic approach, of research and application of bargaining theory. The axiomatic approach requires the resulting solution should possess a set of axioms, whereas in the strategic approach the outcome is predicted by the concept of subgame perfect equilibrium. Bargaining in practice is the relationship that involves bargaining over the term of trade such as bargaining for compensation, wholesale price etc. Gurnani and Shi (2006) have used a generalized Nash bargaining model to study a business-to-business supply chain. Kohli and Park (1989) have first applied bargaining in supply chain, in which a buyer and seller negotiate the terms of a quantity discount contract in an EOQ setting by applying the approach of Kalai and Smordinsky (1975). Kalai and Smordinsky (1975) model suggests that both parties equally share system surplus to achieve channel coordination. Sheu (2011) has used Nash bargaining framework for a green supply chain to investigate the problem of negotiations between producers and reverse-logistics suppliers for cooperative agreements under government intervention. Gan, sethi, Yan (2011) have examined coordination contract in three different cases for a supply chain with risk averse agent. They have explored that their contract yield the Nash bargaining solution for the case, where the supplier as well as the retailer maximizes their own expected utility. Summary of cooperative bargaining models in supply chain can be found in review article of Nagrajan and Sosic (2008). In this direction the works of Panda (2013a,b, 2014b), Eartrogal and Wu (2001) are worth mentioning.

The objectives of the paper differ significantly from the prior works as follows. First, previous researches have explored CSR, effects of CSR on supply chain and channel coordination discretely. In contrast the present paper examines the double marginalization issues in a socially responsible supply chain. Although Hsueh and Chang (2008) have used exogenous monetary transfer to coordinate a socially

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responsible supply chain network, this paper uses an endogenous procedure not only to coordinate the channel but also to distribute the surplus profit among the channel members. Second, in Ni et al. (2010) the supplier performs CSR and the downstream firm shares the CSR cost through wholesale price contract though channel coordination is not examined. Assuming each channel member has CSR cost Ni et al. (2012) have found win-win profits through strategic interaction. The present paper assumes that the upstream channel member has CSR cost and demonstrates a procedure that finds optimal channel profit through coordination. Third, in almost all the papers in traditional supply chain management the double marginalization is resolved by using variety of side payment contract. However, in these settings, ex post to coordination, the question of how the shares are determined is left unaddressed (Nagrajan and Sosic, 2008). Besides channel coordination the present paper uses Nash bargaining product to distribute surplus profit among the channel members.

3. Model description and basic analysis

Notations

The following notations are used in developing the model.

p unit selling price of the retailer

w_d unit wholesale price of the distributer

w_m unit wholesale price of the manufacturer

p_c unit selling price of the supply chain in centralized decision making

c marginal production cost of the manufacturer

q order quantity of the product

PP_c pure profit of centralized channel

CS_c consumer surplus of centralized channel

PP_{ds} pure profit of decentralized channel

π_c profit function of centralized channel

π_r profit function of the retailer in decentralized decision making

π_d profit function of the distributer in decentralized decision making

π_m profit function of the manufacturer in decentralized decision making

μ discount on wholesale price that the manufacturer provides to the distributer

$\overline{\mu}$ maximum discount on wholesale price that the manufacturer provides to the distributer

$\underline{\mu}$ minimum discount on wholesale price that the manufacturer provides to the distributer

μ^b bargaining discount on wholesale price that the manufacturer provides to the distributer

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ρ discount on wholesale price that the distributer provides to the retailer

$\overline{\rho}$ maximum discount on wholesale price that the distributer provides to the retailer

$\overline{\rho}$ minimum discount on wholesale price that the distributer provides to the retailer

ρ^b bargaining discount on wholesale price that the distributer provides to the retailer

Consider a three-layer supply chain that consists of a manufacturer, a distributer and a retailer. The manufacturer produces the products at a unit cost c and supplies it to the distributer at a wholesale price w_m in a single lot. The distributer supplies the product to the retailer at a wholesale price w_d. Finally, the retailer satisfies the customers' demand by selling the product at a retail price p.

Assume that the demand at the retailer's end is linear in retail price and is of the form $D(p) = a - bp$, where $a > 0$ is the market potential and $b > 0$ is the customers price sensitivity. For the non-negativity of the demand function assume $p \in (0, a/b)$. This demand function is fairly common in the literature. Shortages are not allowed at any stage of the channel. The lead time between the manufacturer and the distributer, and between the distributer and the retailer are zero because the demand is deterministic. The manufacturer follows lot-for-lot production policy. This simple channel structure allows us to analyze the effect of CSR on the channel members profits. Also, assume that the manufacturer is the leader of the channel and takes decision independently. Other channel members make decision based on the decision of the manufacturer.

As indicated, many leading brands face intense pressure for socially responsible supply chain management (Amaeshi et al.(2008)). A commonly noted response to this pressure is the primary firm introduces code of conduct to its partners business practices to be socially responsible (Pedersen and Andersen, 2006). As a result, other members of the channel involve in CSR practice. Also, it is widely observed the main target in supply chain is at the manufacturer's side (Amaeshi et al., 2008). Thus, we assume the manufacturer invests in CSR and aligns its CSR goal with channel performance. The cost associated with the CSR is shared by all the channel members through a transfer pricing (Cruz 2008). In modeling and analysis, we only consider effects of CSR in the form of consumer surplus rather than the CSR activities, which the social responsible channel performs. It is obvious that when a firm practices CSR irrespective of its rival firms, it's goodwill increases because it is widely expresses the intention to enhance the stakeholders welfare. As a result customers will to pay higher price than its base price for the firms produced product. Thus, it is quite reasonable to incorporate consumer surplus in profit maximization sense as the effect of CSR practice. Furthermore, it is well established that a firms CSR is accounted through the consumer

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surplus of it's stakeholders (Lambertini and Tampieri (2010); Goering (2007, 2008), Kopel and Brand (2012); Ni et al (2010)). The consumer surplus is the difference between the maximum price that the consumers are willing to pay for a product and the market price that they actually pay for the product. Thus, the consumer surplus is

$$\int_{p_{min}}^{p_{max}} qdp = \int_{(a-q)/b}^{a/b} (a - bp)dp = \frac{q^2}{2b} \tag{1}$$

If $\theta \in [0, 1]$ is the fraction of CSR that is the socially responsible manufacturers concerned then it incorporates $\theta q^2/2b$ as consumer surplus in its profit. $\theta = 0$ implies the manufacturer is the pure profit maximizer and $\theta = 1$ represents the manufacturer is the perfect welfare maximizer. Since the manufacturer is socially responsible, its profit function consists of pure profit that is receives by supplying the product to the distributer and the consumer surplus through CSR practice. Under this setting we first derive the centralized and decentralized decisions of the channel members.

3.1 Centralized decision

Assume that all the channel members are willing to cooperate and want to implement joint decision. So, there is a single marketing channel in which a product is produced in a single lot and are sold to the customers at a retail price p_c. Also, the channel practices CSR. Thus, some consumer surplus are accumulated from the stakeholders in the channel. The profit function of the channel is

$$\pi_c = (p_c - c)(a - bp_c) + \frac{\theta}{2b}(a - bp_c)^2 \tag{2}$$

Using the necessary condition, $d\pi_c/dp_c = 0$, for the existence of the optimal solution, optimal value of p_c can be found and is depicted in table-1. Also, the optimal order quantity, pure profit, consumer surplus and total profit in the centralized channel are presented in table-1. Moreover, $d^2\pi_c/dp_c^2 = -b(2-\theta) < 0$, i.e., p_c^* provides global optimum to (2).

Note that $d\pi_c^*/d\theta = k/(2-\theta)^2 > 0$, i.e., optimal total profit increases when the manufacturer puts more weight on CSR. $dPP_c/d\theta = -2k\theta/(2-\theta)^3 < 0$ and $dCS_c/d\theta = (2+\theta)/(2-\theta)^3 > 0$, i.e., pure profit of the centralized channel decreases and consumer surplus increases when CSR increases. The increment of consumer surplus is higher than the decrement of pure profit. As a result, total profit of the centralized channel increases with increasing CSR. The pure profit is zero and consumer surplus is maximum in the centralized channel when the manufacturer is the perfect welfare maximizer. Also, $dp_c/d\theta = -(a-bc)/(2-\theta)^2 < 0$ and $dQ_c/d\theta = (a-bc)^2/(2-\theta)^2 > 0$, i.e., retail price of the channel

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decreases and order quantity of the channel increases with increasing CSR of the manufacturer. When the manufacturer acts as the perfect welfare maximizer, the optimal retail price ($p_c|_{\theta=1} = c$) is equal to the marginal production cost of the centralized channel. So, the pure profit of the channel vanishes and the channel accrues maximum consumer surplus k from it's stakeholders. On the other hand, when $\theta = 0$, total profit of the channel is $k/2$, which is less than total profit of the perfect welfare maximizing channel. Thus, the socially responsible supply chain performs more competitively than a pure profit maximizing supply chain. It actually encourages the consumers to purchase more by reducing the retail price.

3.2 Decentralized decision

When the channel members operate independently and optimize their individual goals, it is essentially a non-cooperative decision making process, where the manufacturer is the leader of the channel. The CSR goal is the manufacturer's own. Through a code of conduct the manufacturer induces other members of the channel to involve in CSR practice. We consider the manufacturer-stackelberg game, where the distributer is the manufacturer's immediate follower and the retailer follows the distributer. It is a sequential move game, where the manufacturer enforces its own strategy on the distributer. Based on it the distributer finds its own strategy and enforces it on the retailer. Finally, depending on the optimal strategy of the distributer, the retailer identifies its own strategy. In fact the entire decision making process consists of two stackelberg games. One between the manufacturer and the distributer and the other is between the distributer and the retailer. We use backward induction to find the sub-game perfect solution of the game. The profit functions of the channel members are

$$\pi_m = (w_m - c)(a - bp) \tag{3}$$

$$\pi_d = (w_d - w_m)(a - bp) \tag{4}$$

$$\pi_r = (p - w_d)(a - bp) \tag{5}$$

Total profit of the manufacturer is

$$v_m = \pi_m + \frac{\theta}{2b}(a - bp)^2 \tag{6}$$

Using backward induction the optimal solution can be found and are presented in table-1. Observe that $d\pi_r^*/d\theta = 4k/(8-\theta)^3 > 0$, $d\pi_d^*/d\theta = 8k/(8-\theta)^3 > 0$, $dv_m^*/d\theta = k/(8-\theta)^2 > 0$, but $d\pi_m^*/d\theta = -2\theta k/(8-\theta)^3 < 0$, i.e., the manufacturer's total profit, the distributer's profit and the retailers profit increase but the manufacturer's pure profit decreases with increasing CSR. Also, $dp^*/d\theta = -(a -$

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$bc)/(8-\theta)^2 < 0$, $dQ^*/d\theta = (a-bc)/(8-\theta)^2 > 0$, $dw_d^*/d\theta = -[2(a-bc)+bc]/b(8-\theta)^2 < 0$, $dw_m^*/d\theta = -[4(a-bc)]/b(8-\theta)^2 < 0$. When the manufacturer puts more weight on CSR, it reduces its wholesale price. In response, the distributer also reduces its wholesale price. Finally, the retailer reacts to the upstream channel members' activities by reducing retail price. Since, the retail price of the channel is reduced, customers are encourages to buy more. As a result, the order quantity of the retailer increases. Thus, the CSR attribute of the manufacturer influences all the downstream members of the channel. By exhibiting CSR, the manufacturer acts more competitively than a pure profit maximizing manufacturer. Although it loses some pure profit, it acquires some consumer surplus, which is more than the loss of pure profit. So, it's total profit increases. The pure profit that the manufacturer loses due to CSR is accumulated at the distributer's and the retailer's sides in some proportion. Thus, the profits of the distributer and the retailer increase as the manufacturer's CSR intensity increases.

Note that $\pi_r^*+\pi_d^*+v_m^* = (14-\theta)k/(8-\theta)^2 < \pi_c^*$, i.e., the channel conflict is not resolved. $d[\pi_c^*-(\pi_r^*+\pi_d^*+v_m^*)]/d\theta = 16(28-17k)/(2-\theta)^2(8-\theta)^3 > 0$, i.e., the difference of centralized total profit and decentralized total profit increases with increasing CSR (see fig-1). This result is quite different from a pure profit maximizing supply chain. In a pure profit maximizing supply chain the double marginalization of the channel decreases when the retailer reduces unit selling price. The channel is coordinated when the selling price is equal to the centralized selling price. But in a socially responsible supply chain though the retail price decreases with the manufacturer's increasing CSR, the double marginalization of the channel increases. Also, $(\pi_r^*+\pi_d^*+v_m^*)|_{\theta=0} = 7k/32 \neq k/2 = \pi_c^*|_{\theta=0}$ and $(\pi_r^*+\pi_d^*+v_m^*)|_{\theta=1} = 13k/49 \neq k = \pi_c^*|_{\theta=1}$. That is, pure profit maximizing channel is not coordinated and the perfect welfare maximizing motive of the manufacturer does not resolve channel conflict.

The pure profit of the centralized channel is $PP_c = 2(1-\theta)k/(2-\theta)^2$ and the pure profit of the decentralized channel is $PP_{ds} = \pi_r^*+\pi_d^*+\pi_m^* = 2(7-\theta)k/(8-\theta)^2$. Now $PP_c - PP_{ds} > 0$ if $\theta^2-8\theta+6 < 0$, i.e., $\theta < 4-\sqrt{10}$ (see fig-1). Thus, the pure profit of the centralized channel is higher when compared with decentralized pure profit if $\theta \in (0, 4-\sqrt{10})$, otherwise the decentralized pure profit is higher. Therefore, we have the following proposition.

Proposition 1: *In a socially responsible supply chain (i) the manufacturer's perfect welfare maximizing motive does not resolve channel conflict, (ii) double marginalization increases when the retailer's unit selling price decreases and (iii) the pure profit of the decentralized channel is higher for* $\theta \in (4-\sqrt{10}, 1)$ *when compared with centralized pure profit.*

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It turns out that, when the channel members do not cooperate the manufacturer should limit its CSR in $(4-\sqrt{10}, 1)$. In such case, the retailer's profit and the distributer's profit are higher but the manufacturer's pure profit is lower compared to centralized profits. But the consumer surplus that the manufacturer accrues from it's stakeholders compensates its loss of pure profit. Otherwise, when the channel members cooperate, the best channel performance can be found through a transfer pricing policy.

3.3 Channel coordination, ranges of win-win opportunities and surplus pure profit distribution.

As a socially responsible channel member, the manufacturer always wants to receive order of larger lot size from the retailer because in that case it can operate more competitively through CSR practice. But the retailer has no reason to order larger lot than the optimal decentralized EOQ because of it's suboptimal profit. The retailer will positively deviate from it's decentralized EOQ only when the manufacturer approaches to the retailer by providing some monetary incentive through the distributer. Assume that as incentive the manufacturer provides a wholesale price discount to the distributer, who is its immediate downstream channel member. In response, by providing a wholesale price discount the distributer impels the retailer to increase the order quantity. The channel members provide and accept the wholesale price discounts under two restrictions. First, the retailer must order channel optimal order quantity. Second, under any form of wholesale price discount the channel members must get at least their decentralized profits.

Generally, in a multi-echelon supply chain a channel member interacts with other members of the channel in one-to-one basis, where it assumes that there is no other member in the channel. The manufacturer can provide wholesale price discount to the distributer until its decentralized total profit is reserved. The retailer accepts the distributer's wholesale price discount and orders centralized quantity as long as its loss of profit is subsidized through the wholesale price discount. In the entire transfer pricing policy, the distributer plays the central role because as an intermediator it maintains the incentive streaming from the manufacturer to the retailer and maintains lot streaming from the retailer to the manufacturer. By doing so it also receives some profit additional to its decentralized profit. Thus, when the wholesale price discount policy is applied aiming at resolving channel conflict the distributer decides (i) the manufacturer's minimum wholesale price discount and (ii) maximum wholesale price discount that it can provide to the retailer. These two are interrelated and one definitely gets different limits when approaches from (a) the manufacturer to the retailer and (b) the retailer to the manufacturer. In the former case, the manufacturer and the distributer jointly decide the minimum and maximum discounts

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on the manufacturer's wholesale price for channel coordination. Within this range they decide a particular discount that effectively divides the surplus profit between them. Based on the decentralized profit and the surplus profit share, the distributer and the retailer find win-win wholesale price discount range and bargain for benefit share. In the later case, first the distributer deals with the retailer and settles benefit share. Based on decentralized profit and benefit share, it deals with the manufacturer. Since the surplus profits at the manufacturer's end and at the retailer's end are different, the results are different in these two cases. However, we consider the approach from the manufacturer to the retailer through the distributer because the manufacturer is the leader of the channel. Also, it is quite common in marketing practice that any discount flows from the manufacturer to the customers through different echelons and the move is initiated at the manufacturer's side. Since, two coordination contracts and two bargainings are involved in the entire process we term it as contract-bargaining process. In this process the channel members operate in the following sequence.

Step 1 The manufacturer and the distributer find the wholesale price discount range for win-win profits subject to the condition that the distributer has to compensate the retailer's loss due to changed order quantity.

Step 2 Within the discount range the manufacturer bargains with the distributer for a particular profit share. The decentralized profit plus the surplus profit is the manufacturer's optimal profit. The decentralized profit plus surplus profit is the distributer's intermediate profit.

Step 3 Depending on the intermediate profit, the distributer and the retailer determines the win-win range of wholesale price discount.

Step 4 The distributer and the retailer determine surplus profit share through bargaining. Decentralized profit plus surplus profit share is the retailer's optimal profit. Intermediate profit plus surplus profit is the distributer's optimal profit.

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Suppose the manufacturer provides μw_m^*, $(\mu > 0)$ discount on wholesale price to the distributer. The manufacturer's total profit under the wholesale price discount is

$$v_m^{wd} = (w_m^* - c)(a - bp_c^*) + \frac{\theta}{2b} Q_c^{*2} - \mu w_m^* Q_c^* \tag{7}$$

The manufacturer can provide the discount on the wholesale price as long its decentralized total profit is reserved, i.e., $v_m^{wd} \geq v_m^*$. If $\overline{\mu}$ is the maximum discount on wholesale price then simplifying the inequality

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$\overline{\mu}$ can be found as

$$\overline{\mu} = 1 - \left[\frac{c}{w_m^*} + \frac{(2-6\theta+\theta^2)(a-bc)}{bw_m^*(2-\theta)(8-\theta)}\right] \tag{8}$$

Therefore, the minimum wholesale price that the manufacturer can offer to the distributer is

$$\underline{w_m} = (1-\overline{\mu})w_m^* = c + \frac{(2-6\theta+\theta^2)(a-bc)}{b(2-\theta)(8-\theta)} \tag{9}$$

Similarly, the distributer can consider the manufacturer's wholesale price discount until its decentralized profit and minimum compensation that it provides to the retailer are reserved. If the distributer demands $\underline{\mu}w_m^*$ minimum discount from the manufacturer then

$$(w_d^* - w_m^*)Q_c^* + \underline{\mu}w_m^*Q_c^* = \pi_d^* + [\pi_r^* - (p_c^* - w_d^*)Q_c^*]$$

Simplifying the above expression, $\underline{\mu}$ can be found as

$$\underline{\mu} = \frac{24(1+\theta)k}{(2-\theta)^2(8-\theta)^2w_m^*Q_c^*} \tag{10}$$

Consequently the manufacturer can demand the maximum wholesale as

$$\overline{w_m} = (1-\underline{\mu})w_m^* = c + \frac{(4-\theta)(a-bc)}{b(8-\theta)} - \frac{12(1+\theta)(a-bc)}{b(2-\theta)(8-\theta)^2} \tag{11}$$

For any $w_m \in (\underline{w_m}, \overline{w_m})$ the manufacturer's profit is win-win and, after providing minimum compensation to the retailer, the distributer's profit is also win-win. Within this range the manufacturer bargains with the distributer for a particular wholesale price that effectively divides the surplus profit between them. The bargaining outcome is based on the symmetric Nash bargaining product. The Nash bargaining model (1950) that has been used in various contexts, is an axiomatic derivation of bargaining solution. The axiomatic derivation leaves out the actual process of negotiations while focusing on the expected outcome based on prespecified solution procedures. Also the axioms does not reflect the rationale of the agents or the process in which the agreement is reached. One of the important characteristics of the Nash solution concept is that the outcome is random because it depends on the participating players negotiation powers. In Nash bargaining model the objective function is the product of the players benefit from cooperation and it must be maximized. Each players benefit is the difference between the negotiated profit and profit under decentralized decision making.[2] The Nash bargaining product of the manufacturer

[2] For detail discussion see Nagarajan and Sosic (2008).

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and the distributer is

$$\max_{\underline{\mu}\leq\mu\leq\overline{\mu}}[(w_m^*-c)(a-bp_c^*)+\frac{\theta}{2b}{Q_c^*}^2-\mu w_m^*Q_c^*-v_m^*][(w_d^*-w_m^*)Q_c^*+\mu w_m^*Q_c^*-(\pi_d^*+(\pi_r^*-(p_c^*-w_d^*)Q_c^*))] \quad (12)$$

From (12) optimal value of μ can be found as

$$\mu^B = \frac{6(10+\theta)k}{(2-\theta)^2(8-\theta)^2 w_m^* Q_c^*} \quad (13)$$

Therefore, the bargaining wholesale price of the manufacturer is

$$w_m^b = (1-\mu^b)w_m^* = c + \frac{(4-\theta)(a-bc)}{b(8-\theta)} - \frac{3(10+\theta)(a-bc)}{b(2-\theta)(8-\theta)^2} \quad (14)$$

After first round of bargaining the distributer's intermediate profit is

$$\pi_d^{ib} = \pi_d^* + \frac{18(6-\theta)k}{(2-\theta)^2(8-\theta)^2} \quad (15)$$

Based on the intermediate profit, the distributer and the retailer determine the range of wholesale price discount. If $\overline{\rho}w_d^*$ is the maximum discount on wholesale price that the distributer can provide to the retailer then

$$\pi_d^{ib} - \overline{\rho}w_d^*Q_c^* = \pi_d^*$$

i.e.,

$$\overline{\rho} = \frac{1}{w_d^*}\left[\frac{9(6-\theta)(a-bc)}{b(2-\theta)(8-\theta)^2}\right] \quad (16)$$

Consequently, the minimum wholesale price of the distributer under wholesale price discount policy is

$$\underline{w_d} = (1-\overline{\rho})w_d^* = c + \frac{(6-\theta)(a-bc)}{b(8-\theta)} - \frac{9(6-\theta)(a-bc)}{b(2-\theta)(8-\theta)^2} \quad (17)$$

If the distributer provides minimum ρw_d^*, $\rho > 0$ discounts on wholesale price then the retailer's profit is

$$\pi_r^{wd} = (p_c^* - w_d^*)Q_c^* + \rho w_d^* Q_c^*$$

From the inequality $\pi_r^{wd} \geq \pi_r^*$, $\underline{\rho}$ can be found as

$$\underline{\rho} = \frac{36(a-bc)}{b(2-\theta)(8-\theta)^2 w_d^*} \quad (18)$$

Thus, the maximum wholesale price that the distributer can demand from the retailer is

$$\overline{w_d} = (1-\underline{\rho})w_d^* = c + \frac{(6-\theta)(a-bc)}{b(8-\theta)} - \frac{36(a-bc)}{b(2-\theta)(8-\theta)^2} \quad (19)$$

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For any $w_d \in (\underline{w_d}, \overline{w_d})$ the distributer's profit and the retailer's profit under the wholesale price discount are win-win. Within the range the distributer and the retailer bargain for particular wholesale price, which effectively divides the surplus profit between them. The Nash bargaining product is

$$\max_{\underline{\rho} \le \mu \le \overline{\rho}} [\pi_d^{ib} - \rho w_d^* Q_c^* - \pi_d^*][(p_c^* - w_d^*)Q_c^* + \rho w_d^* Q_c^* - \pi_r^*] \tag{20}$$

From (20) the optimal value of ρ can be found as

$$\rho^b = \frac{9(10-\theta)(a-bc)}{2b(2-\theta)(8-\theta)^2} \tag{21}$$

Consequently, the distributer's optimal wholesale price in the contract-bargaining process is

$$w_d^b = (1-\rho^b)w_d^* = c + \frac{(6-\theta)(a-bc)}{b(8-\theta)} - \frac{9(10-\theta)(a-bc)}{2b(2-\theta)(8-\theta)^2} \tag{22}$$

Thus, in the contract-bargaining process the optimal profits of the channel members are

$$v_m^b = v_m^* + \frac{18k}{(2-\theta)(8-\theta)^2} \tag{23}$$

$$\pi_d^b = \pi_d^* + \frac{9k}{(2-\theta)(8-\theta)^2} \tag{24}$$

$$\pi_r^b = \pi_r^* + \frac{9k}{(2-\theta)(8-\theta)^2} \tag{25}$$

$$\pi_m^b = \frac{(34-59\theta+14\theta^2-\theta^3)(a-bc)^2}{b(2-\theta)^2(8-\theta)^2} \tag{26}$$

Note that $\pi_r^b + \pi_d^b + v_m^b = k/(2-\theta) = \pi_c^*$, i.e., the channel conflict is resolved. All the channel members' profits are win-win. The manufacturer takes away half of the surplus profit $36k/[(2-\theta)(8-\theta)^2]$ and the remaining is divided between the distributer and the retailer equitably. Thus, we have the following proposition.

Proposition 2: *The contract-bargaining process resolves channel conflict and distributes surplus profit among the channel members.*

3.4 Effects of CSR

Using the contract bargaining process it is possible to find win-win total profit for the manufacturer and win-win pure profits for the distributer and the retailer for any $w_m \in (\underline{w_m}, \overline{w_m})$ and for any $w_d \in (\underline{w_d}, \overline{w_d})$. Note that $d\underline{w_m}/d\theta = -[(a-bc)(4\theta^2-28\theta+76)/b(2-\theta)^2(8-\theta)^2] < 0$ and $d\overline{w_m}/d\theta = -[4(a-bc)(116-93\theta+6\theta^2-\theta^3)/b(2-\theta)^2(8-\theta)^3] < 0$ for any $\theta \in (0,1)$, i.e., the wholesale price of

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the manufacturer, when contract bargaining process is used, decreases with increasing CSR. Further, $\underline{w_m} - c = (2 - 6\theta + \theta^2)(a - bc)/b(2 - \theta)(8 - \theta) > 0$ if $2 - 6\theta + \theta^2 > 0$, i.e. if $\theta < 0.3542$. Also, $\overline{w_m} - c = (4-\theta)(a-bc)/b(8-\theta) - 12(1+\theta)(a-bc)/b(2-\theta)(8-\theta)^2 > 0$ if $(2-\theta)(4-\theta)(8-\theta) > 12(1+\theta)$ i.e. if $52 - 68\theta + 14\theta^2 - \theta^3 > 0$, i.e for any $\theta > 0.93144$. Therefore, the discounted wholesale price of the manufacturer is always larger than it's marginal production cost for any $\theta < 0.3542$ and always less than it's marginal production cost for any $\theta > 0.93144$. The discounted wholesale price may be larger or less than it's production cost for $\theta \in (0.3542, 0.93144)$. Also, $\underline{w_m} \geq 0$ if $a\theta^2 - 2(3a + 2bc)\theta + 2(a + 7bc) \geq 0$ i.e, if $\theta \leq [3a + 2bc - \sqrt{7a^2 - 2abc + 4b^2c^2}]/a$ and $\overline{w_m} \geq 0$ if $\theta > \theta_1$, say, where θ_1 is the real root of the equation $a\theta^3 - (14a - 4bc)\theta^2 + 4(17a - 13bc)\theta - 52(a - bc) = 0$. So, the discounted wholesale price of the manufacturer is non-negative for $\theta \in (0, [3a + 2bc - \sqrt{7a^2 - 2abc + 4b^2c^2}]/a)$ and always negative if it performs CSR above the threshold $\theta = \theta_1$ (see fig-2). Thus, we have the following proposition.

Proposition 3: *In the contract bargaining process the CSR manufacturer's wholesale price is always (i) less than its marginal production cost for* $\theta \in (0.93144, 1)$*, (ii) greater than its marginal production cost for* $\theta \in (0, 0.3542)$*, (iii) positive for* $\theta < [3a + 2bc - \sqrt{7a^2 - 2abc + 4b^2c^2}]/a$ *and (iv) negative for* $\theta > \theta_1$*.*

The CSR manufacturer acts quite differently when compared with a pure profit maximizing manufacturer. When it puts more weight on CSR, it reduces its wholesale price to encourage the distributer to supply more units to the retailer by reducing it's wholesale price. The objective of the manufacturer is not to coordinate the channel. Actually, as the leader of the channel and for CSR practice, it encourages all the channel members to sell more units by reducing the selling price. As such, for exhibiting CSR, the manufacturer may supply the product to the distributer below its marginal production cost. Even its wholesale price may be negative for heavy CSR practice. The CSR manufacturer, in such case pays the distributer to sell products additional to the decentralized order quantity.

Interestingly, when the manufacturer's CSR increases, its shareholder's value (pure profit) decreases but its stakeholder's value (consumer surplus) increases. The intuitive reason is straightforward. The wholesale price of the manufacturer in the contract-bargaining process is inversely proportional to its CSR practice. So, when the manufacturer performs CSR heavily, its wholesale price may be below the marginal production cost or negative. As a result the manufacturer's pure profit (shareholder's value) is negative though it's stakeholder's value compensates the loss of pure profit and leads to win-win total profit. This finding is quite consistent with "it pays to be good but not too good" (Mintzberg, 1983). Thus, it is very important for the manufacturer to decide upto what level the CSR activity should be

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extended such that (i) the channel conflict is resolved and (ii) it can balance the shareholder's value and stakeholder's value while practicing CSR.

The range of the optimal wholesale price of the distributer for channel coordination is determined after the second round of contract bargaining process between the distributer and the retailer. Observe that $d\underline{w_d}/d\theta = -(a-bc)[2(8-\theta)(2-\theta)^2 + 9(2-\theta)(4-\theta) + 9(6-\theta)(8-\theta)]/b(8-\theta)^3(2-\theta)^2 < 0$ and $d\overline{w_d}/d\theta = -2(a-bc)[(2-\theta)^2 + 72(4-\theta)]/b(8-\theta)^2(2-\theta)^2 < 0$ i.e, the discounted wholesale price of the distributer is sensitive to the manufacturer's CSR. In fact, the distributer provides more discount on wholesale price when the manufacturer's CSR increases. Further, $\underline{w_d} - c = [(6-\theta)(a-bc)/b(8-\theta)] - [9(6-\theta)(a-bc)/b(2-\theta)(8-\theta)^2] > 0$ if $\theta^2 - 10\theta + 7 > 0$, i.e. if $\theta < 0.75936$. Also, $\overline{w_d} - c = [(6-\theta)(a-bc)/b(8-\theta)] - [36(a-bc)/b(2-\theta)(8-\theta)^2] > 0$ if $(2-\theta)(6-\theta)(8-\theta) \geq 36$, i.e. if $60 - 76\theta + 16\theta^2 - \theta^3 \geq 0$ i.e. if $\theta < 0.97885$. Thus, the wholesale price of the distributer in the contract bargaining process is greater than the manufacturer's marginal production cost for $\theta < 0.75936$ and less than the manufacturer's marginal cost if $\theta > 0.97885$ (see fig-3). Also, note that $\underline{w_d} < 0$ if $\theta > \theta_3$, say, where θ_3 is the real root of the equation $42a + 86bc - (67a + 29bc)\theta - 2(8a + bc)\theta^2 - a\theta^3 = 0$ and $\overline{w_d} < 0$ if $\theta > \theta_4$, say, where θ_4 is the real root of the equation $60a + 68bc - 4(19a + 5bc)\theta + 2(8a + bc)\theta^2 - a\theta^3 = 0$. Thus, we have the following proposition.

Proposition 4 *In the contract bargaining process, the pure profit maximizing distributer's discounted wholesale price is always (i) greater than the manufacturer's marginal production cost for any* $\theta > 0.75736$*, (ii) less than the manufacturer's production cost for any* $\theta > 0.97885$*, (iii) positive for* $\theta < \theta_3$ *and (iv) negative for* $\theta > \theta_4$*.*

It is a common practice, in a socially responsible supply chain that the leader of the channel is mainly responsible for CSR and it introduces code of conduct such that all the other channel members business practices are socially responsible. As such, in response to the manufacturer's reduced wholesale price, the distributer also reduces its wholesale price to encourage the retailer to sell more units by reducing retail price. The distributer's wholesale price is inversely proportional to the manufacturer's CSR intensity. Thus, when the manufacturer's CSR intensity increases, the distributer's wholesale price may be less than the manufacturer's marginal production cost ($\theta > 0.75736$) and it may be negative for the manufacturer's heavy CSR practice ($\theta > \theta_4$). That is, the distributer pays the retailer to sell units additional to decentralized order quantity. In such case, the distributer's business practice is socially responsible and it's pure profit objective is not only reserved but also pure profit is win-win. The in-

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tuitive reason is straightforward. First, the positive wholesale price of the distributer is always larger than that of the manufacturer and both the wholesale prices lie in their corresponding win-win ranges of the contract-bargaining process. As a result the distributer's profit is always win-win. Second, in the contract bargaining for CSR, the manufacturer pays the distributer to sell additional units when $\theta > \theta_2$ and the distributer pays the retailer when $\theta > \theta_4$. Note that $\theta_4 > \theta_2$, i.e, before paying the retailer, the distributer receives some revenues from the manufacturer, which is larger than the subsidy that the distributer provides to the retailer for selling inventories additional to the decentralized order quantity. The distributer's role in a socially responsible supply chain is interesting. Unlike the pure profit maximizing supply chain, the distributer supports the manufacturer, to practice CSR freely, by diminishing it's wholesale price following the intensity of the CSR.

In response to other channel members socially responsible activities, the retailer also performs socially because it reduces the retail price to sell additional units. Since, the objective of the channel is to perform in coordinated way, the retailer fixes its retail price same as the centralized channel. In that case, the retailer's profit is also win-win because the distributer supplies inventories by reducing it's wholesale price or pays the retailer. The discount on the wholesale price that the distributer provides not only nullifies the retailer's loss due to deviation from the decentralized order quantity but also provides some extra profit.

The optimal bargaining wholesale price of the manufacturer decreases with increasing CSR and it is less than the marginal production cost if $\theta^3 - 14\theta^2 + 59\theta - 34 \leq 0$ i.e. if $\theta > 0.6809$. The optimal wholesale price of the manufacturer in the contract bargaining process is negative if $\theta \in (\theta_2, 1)$, where θ_2 is the real root of the equation $34a + 94bc - (59a + 37bc)\theta + (14a + 4bc)\theta^2 - a\theta^3 = 0$ (see fig-4). Since, the optimal wholesale price of the contract bargaining process lies in $(\underline{w_m}, \overline{w_m})$, the limit of CSR intensity for non negative wholesale price is lower than over all non-negative CSR intensity, i.e, θ_2 is always less than θ_1. Similarly, the optimal bargaining wholesale price of the distributer is less than the manufacturer's marginal production cost if $102 - 143\theta + 32\theta^2 - 2\theta^3 \geq 0$ i.e $\theta > 0.87538$. Also the optimal discounted wholesale price of the distributer is negative if $\theta > \theta_5$, say, where θ_5 is the real root of the equation $102a + 154bc - (143a + 49bc)\theta + (32a + 4bc)\theta^2 - 2a\theta^3 = 0$ (see fig-4). Thus, we have the following proposition.

Proposition 5: *(a) The optimal bargaining wholesale price of the manufacturer is less than it's marginal production cost if* $\theta > 0.6809$ *and is negative for* $\theta > \theta_2$.

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(b) The optimal bargaining wholesale price of the distributer is less than the manufacturer's marginal production cost if $\theta > 0.87538$ *and is negative for* $\theta > \theta_5$.

Note that $d\pi_d^b/d\theta = (140-59\theta+8\theta^2)k/(2-\theta)^2(8-\theta)^3 > 0$ and $d\pi_r^b/d\theta = (124-43\theta+4\theta^2)k/(2-\theta)^2(8-\theta)^3 > 0$, i.e., the optimal bargaining profits of the distributer and the retailer increase with increasing CSR practice of the manufacturer. Also, $d\pi_m^b/d\theta = -(164+278\theta-129\theta^2+18\theta^3-\theta^4)/(2-\theta)^3(8-\theta)^3 < 0$ and $dv_m^b/d\theta = (250-90\theta+12\theta^2-\theta^3)k/(2-\theta)^2(8-\theta)^3 > 0$, i.e., optimal bargaining pure profit of the manufacturer decreases but optimal total profit increases with increasing CSR (see fig-5). The pure profit is maximum at $\theta = 0$ and the total profit is maximum when the manufacturer is the perfect profit maximizer. The manufacturer's pure profit is non-negative for $\theta \in (0, 0.6809)$ because in this range it's wholesale price is larger than the marginal production cost. Also, in this range the manufacturer's total profit in win-win. So, CSR is purely a costly endeavour to the manufacturer. Obviously for any $\theta > 0.6809$ the manufacturer's bargaining pure profit is negative. Thus, instead of selling the right of the product to the distributer, the manufacturer encourages the distributer to sell more units by subsidizing the sell units. Even it pays the distributer ($w_m^b < 0$) to sell additional units.

4 Summary and concluding remarks

In this paper we have discussed channel coordination issues in a socially responsible three-echelon supply chain by proposing a contract-bargaining process. It is assumed that the manufacturer, the leader of the channel, practices CSR and encourages it's downstream channel members for CSR through a code of conducts. While formulating the model we have incorporated only the effect of CSR in the form of consumer surplus in the socially responsible firm's profit function rather than the activities, which it performs. A contract-bargaining process, which consists of two wholesale price discounts and two Nash bargaining products is used to coordinate the channel and to distribute the surplus profit among the channel members. The proposed model yields following insights.

First, in decentralized decision making the socially responsible channel member's perfect welfare maximizing motive is not enough for channel coordination. Unlike the pure profit maximizing channel, the double marginalization of the socially responsible channel increases with decreasing retail price of the channel. Moreover, in the perfect welfare maximizing socially responsible centralized channel the retail price is equal to the marginal production cost. So, CSR is cost enhancing by inducing a higher output and lower price and the socially responsible channel behaves more competitively than a pure profit maximizing channel because it accepts less profit to act socially. Second, the contract-bargaining pro-

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cess resolves channel conflict and distributes surplus profit among the channel members. The wholesale prices of the contract-bargaining process are different when compared with the wholesale prices of a traditional supply chain. The wholesale price of the manufacturer is less than its marginal production cost above a threshold of CSR practice. Even it is negative for the manufacturer's heavy CSR activity. As a result the manufacturer's pure profit may be negative, i.e., it pays the distributer to sell additional units that it produces for exhibiting CSR. The behaviour of the distributer's wholesale price is same as that of the manufacturer but for the manufacturer's higher threshold of CSR. As a consequence, the distributer's profit and the retailer's profit are win-win. Third, the manufacturer's pure profit and it's CSR are inversely proportional. Thus, the manufacturer can not maximize the shareholder's value and the stakeholder's value simultaneously. In the contract-bargaining process, if the manufacturer's CSR is above 0.6809 then it's shareholder's value destroys completely. Although the consumer surplus, which the manufacturer accrues, compensates the loss of pure profit, still the manufacturer should identify the intensity of CSR that balances shareholder's value and stakeholder's value.

Although the proposed model provides some insightful results, still it has some limits and may provide an interesting future research direction. First, for simplicity of analysis the demand is assumed as deterministic and linear in price. Models may be developed by considering some stochastic price dependent demand or some other well established deterministic demand. Secondly, in modelling and analysis it is assumed that as the leader of the channel, the manufacturer practices CSR. Instead of this, it may be assumed that only the retailer or both the channel members are involved in CSR and perform it in a proportion. In the former case the CSR is the retailer's own and the manufacturer is independent of that. In the later case the consumer surplus accrued for CSR will be incorporated in the channel members' profits in the same proportion in which they practice CSR. Thirdly, in the contract-bargaining process the manufacturer and the distributer provide wholesale price discount. Instead of this some other transfer pricing policy may be used. Also, instead of using symmetric Nash bargaining product, asymmetric Nash bargaining product may be used to distribute surplus profit among the channel members. Although these extensions make the model robust and dynamic, still in our view the basic result of the proposed model will remain unaltered.

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Table-1 Optimal values in centralized and decentralized decision making ($k = (a - bc)^2/2b$)

Optimal	Decentralized channel			Centralized channel
	Manufacturer	Distributer	Retailer	
Price	$\frac{(4-\theta)a+4bc}{(8-\theta)b}$	$\frac{(6-\theta)a+2bc}{(8-\theta)b}$	$\frac{(7-\theta)a+bc}{b(8-\theta)}$	$\frac{(1-\theta)a+bc}{(2-\theta)b}$
Order quantity	$\frac{a-bc}{(8-\theta)}$	$\frac{a-bc}{(8-\theta)}$	$\frac{a-bc}{(8-\theta)}$	$\frac{a-bc}{(2-\theta)}$
Pure profit(PP)	$\frac{2(4-\theta)k}{(8-\theta)^2}$	$\frac{4k}{(8-\theta)^2}$	$\frac{2k}{(8-\theta)^2}$	$\frac{2(1-\theta)k}{(2-\theta)^2}$
Consumer surplus(CS)	$\frac{\theta k}{(8-\theta)^2}$	-	-	$\frac{\theta k}{(2-\theta)^2}$
Total profit (PP+CS)	$\frac{k}{(8-\theta)}$	$\frac{4k}{(8-\theta)^2}$	$\frac{2k}{(8-\theta)^2}$	$\frac{k}{(2-\theta)}$

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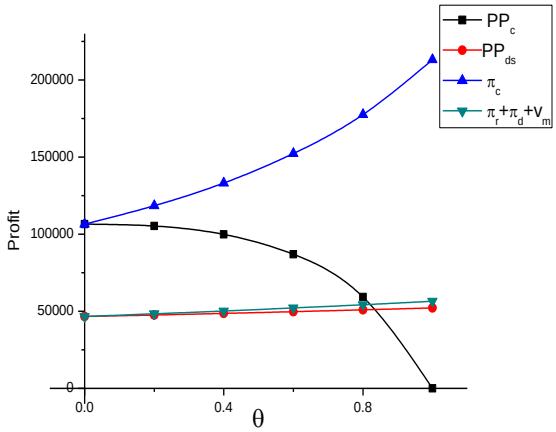

Fig 1: Behaviour of profits in centralized and decentralized channel with respect to CSR

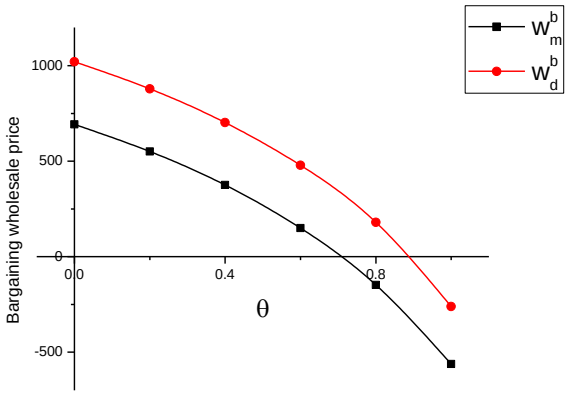

Fig 4: Behaviour of the bargaining wholesale prices with respect to CSR

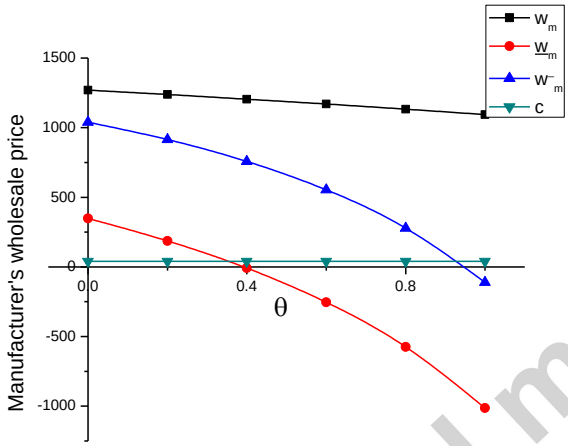

Fig 2: Behaviour of the manufacturer's wholesale price with respect to CSR

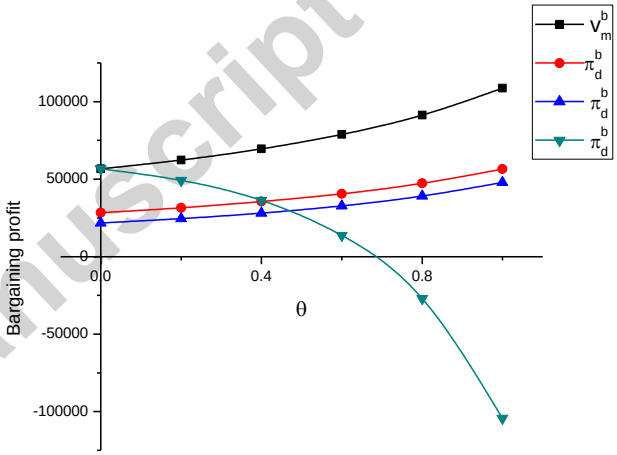

Fig 5: Behaviour of the bargaining profits with respect to CSR

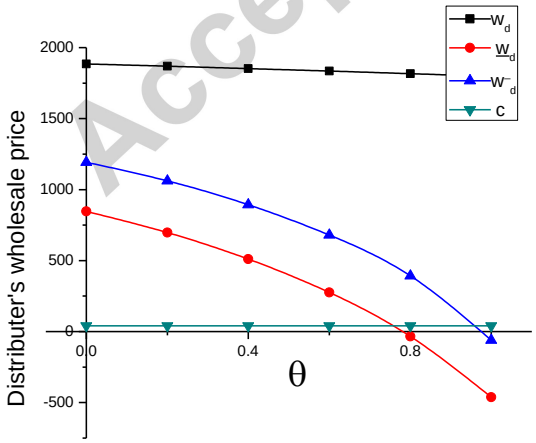

Fig 3: Behaviour of the distributer's wholesale price with respect to CSR

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