MAIL-IN-REBATES VS. COMBINED REBATE MECHANISM: WHICH OF THEM IS MORE EFFECTIVE FOR SUPPLY CHAIN COORDINATION?

Vijayender Reddy Nalla
Jack van der Veen
Venu Venugopal
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Vijayender Reddy Nalla
Prof.dr. Jack van der Veen
Prof.dr. Venu Venugopal

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Abstract
This paper considers a business setting, where a Supplier sells a fashion product to a Buyer, who in turn sells the product to the end consumers. Both the Supplier and the Buyer set their own selling price. The end consumer demand is assumed to be a linearly decreasing function of the final selling price (retail price). First, this paper compares the performance of mail-in-rebate mechanism and the no-rebate scenario. This comparative analysis shows that whatever the rebate value is, the Buyer always benefits from the mail-in-rebate mechanism. The Supplier benefits from mail-in-rebate when the rebate value is set within a specific range. The rebate value that optimizes the Supply Chain does not provide any additional profit for the Supplier. Secondly, we design a new rebate mechanism known as the combined rebate mechanism (Buyer provides a rebate to the end consumer and the Supplier provides a wholesale price rebate to the Buyer) and compare its performance with that of the mail-in-rebate mechanism. The comparative analysis shows that the combined rebate mechanism can coordinate the Supply Chain by retaining the maximum Suppliers profit as in the mail-in-rebate mechanism and provides a higher profit for the Buyer when compared to the mail-in-rebate mechanism. Moreover, the combined rebate mechanism is easy to implement and less costly to administer. A final conclusion is that Consumers receive greater surplus with the combined rebate and demand a greater quantity.

Keywords: Coordination, win-win, Mail-in-rebates, Combined rebate mechanism.

Address for correspondence
Drs. Vijayender Reddy Nalla
Email: r.vijayender@nyenrode.nl
Phone: (+31) 346-291257

Prof.dr. Venu Venugopal
Email: v.venugopal@nyenrode.nl
Phone: (+31) 346-291262

Prof.dr. Jack van der Veen
Email: j.vdveen@nyenrode.nl
Phone: (+31)346-291256

Nyenrode Business Universiteit
Straatweg 25, 3621 BG Breukelen, The Netherlands
1. Introduction

Companies in the past usually perceived themselves as a stand-alone entity in the business environment. Times have changed. Today companies begin to perceive themselves as a part of a chain network of entities. The reason is simple: without deep co-operation and collaboration, no single company can survive and prosper on its own. This has lead to considerable interest among both practitioners and academics in the field of Supply Chain Management (SCM). SCM can be defined as “Management activities focused on the (voluntary) co-ordination of several entities in the Supply Chain in order to optimise the entire Supply Chain as it were one unit, rather than optimising each entity separately.” Basically, the concept of SCM emphasises the need for co-ordination and collaboration within and between the firms to achieve a win-win situation for all the firms involved. A Supply Chain is said to be coordinated if we can create a situation such that when each player optimize their own performance it should automatically lead to the maximum Supply Chain profit. Win-win is said to be achieved when each player improve their performance compared to the decentralized (so called Solitaire) scenario. The win-win situation in a co-ordinated Supply Chain results from various sources such as co-ordinated order process and delivery process (Clarck & Hammond, 1997) and co-ordinated product introductions and promotional activities (Buzell et al., 1990). The present paper tests the effectiveness of different promotion mechanisms in Channel coordination and win-win.

Throughout this paper, we analyze a simple Supply Chain consisting of two entities (firms) namely a Supplier and a Buyer. This model is similar to the one that was used by (Sprengler, 1950, Van der Veen & Venugopal, 2000). The Supplier sells a product with a short life cycle (e.g. a fashion product) to a Buyer who in turn sells the product to the consumers (see Figure 1). Both the Supplier and the Buyer are free to set the price they charge their customer(s).
We start by analysing the above model under the *Solitaire (Decentralized) scenario*, where the Supplier and the Buyer do not collaborate and no rebates are offered. They set their price to maximise their own profit. We show that in the solitaire scenario the Buyer charges a higher price and orders a lower quantity than what is optimal for the Supply Chain. To coordinate such a Supply Chain, supplier provides a price reduction, directly to the end customer upon the purchase of the merchandise and redemption of rebate coupons immediately or at a later stage (e.g., Anderson & Song, 2004; Arcelus & Srinivasan, 2003; McGuiness, 2003; Nevo & Wolfram, 2002). In practice, companies like Nikon and Sharp to name a few have started to provide the discounts directly to the end consumer (Simchi Levi et.al., 2003, p.251). Such discount mechanisms are referred to as the mail-in-rebate mechanism as the consumer can get back the discount amount after he mails back a coupon which he obtains with the purchase of the product. To start with we design the mail-in-rebate mechanism and compare its performance with that of the no rebate case. Later, we design a new mechanism known as combined rebate in which the Buyer provides a rebate to the end consumer and the Supplier provides a wholesale price rebate to the Buyer. Then we compare the performance of both the mail-in-rebate and the combined rebate from the perspective of each of the player (Buyer and Supplier) and Supply Chain.

To start with, we introduce the model and analyse its performance under the Solitaire scenario (no rebate case). Then we analyse the performance of the mail-in-rebate with two different rebate values; one which is optimal for the Supplier and the other which is optimal for the Supply Chain and compare its performance with that of the no rebate case. We continue our analysis with the combined rebate mechanism and compare the performance of the mail-in-rebate and combined rebate mechanism for the players and the Supply Chain.
also look into the benefit each of these mechanisms provide to the end consumer. At the end we conclude our study.

2. Model Description & Solitaire Scenario Analysis

Consider the situation in which the Supplier offers a quantity of products to the Buyer at a price of $W$ per unit. It is assumed that the product has a short life cycle, so that there is only a one-time order placed by the Buyer (i.e. reordering is not possible and there is no stock from previous periods). The Supplier incurs manufacturing and transportation cost of $C$ per unit and is free to set the price $W$ at which he will sell the product to the Buyer. It is also assumed that the Buyer and the Supplier have full information over the entire Supply Chain. Furthermore, it is assumed that final customer demand $D$ for the product depends linearly on the price $P$ set by the Buyer:

$$D(P) = \alpha - \beta P$$

(1)

with $\alpha, \beta > 0$. Once the Buyer has set the price $P$, he can determine the demand $D$ and places an order of size $Q = D(P)$ on the Supplier. The Buyer does not have any cost associated with his operation other than the purchasing cost $WQ$. Throughout, we will make the realistic assumptions:

$$0 \leq C < P \leq \alpha / \beta; \quad (2a)$$

$$C \leq W \leq P. \quad (2b)$$

In the above setting, the Supplier has cost-information $C$ and can set $W$ such that his profit

$$S := (W - C)Q$$

(3)
is maximised. The Buyer is facing final customer demand, and is faced with the Supplier’s price \( W \). He can set the price \( P \) such that his profit

\[
B := (P - W)Q
\]

is maximised. The total Supply Chain profit \( T \) is determined by

\[
T := S + B = (P - C)Q.
\]

The above model has been discussed in many papers. Its origin can be traced back to (Sprengler, 1950). In the Solitaire-scenario, firstly the Supplier sets his price \( W \). Then, the Buyer facing price \( W \) and demand function \( D(P) \) determines his optimal price \( P \), i.e. the price that maximises profit \( B \). Then, an order of size \( Q = D(P) \) is placed to the Supplier. In the Solitaire-scenario the Supplier sets a price \( W \). Obviously, the Buyer likes to maximise his profit, i.e. he chooses \( P \) such that

\[
B = (P - W)(\alpha - \beta P) = -\beta P^2 + (\alpha + \beta W)P - \alpha W
\]

is maximised. It is easy to see that the optimal price is given by

\[
P_1 := \frac{\alpha + \beta W}{2\beta}.
\]

(7)

It follows from (1) that the optimal order size is

\[
Q_1 := \frac{1}{\beta}(\alpha - \beta W).
\]

(8)
Assuming the optimal price $P_1$ and order quantity $Q_1$ are used, the following profits can be derived from (2)-(4):

\[
B_1(w) := \frac{1}{4} \left( \frac{\alpha^2}{\beta} - 2 \alpha W + \beta W^2 \right) = \frac{(\alpha - \beta W)^2}{4 \beta} \tag{9}
\]

for the Buyer,

\[
S_1(w) := \frac{1}{2} \left( - \alpha C + (\alpha + \beta C) W - \beta W^2 \right) \tag{10}
\]

for the Supplier and

\[
T_1(w) := \frac{1}{4} \left( \frac{\alpha^2}{\beta} - 2 \alpha C + 2 \beta CW - \beta W^2 \right) \tag{11}
\]

for the total Supply Chain.

Note that all the profits under the Solitaire-scenario depend on the Supplier’s price $W$. The Supplier would be interested in choosing a value of $W$ which will optimize his profit in equation 10, which is given by

\[
W_1 := \frac{\alpha + \beta C}{2 \beta}. \tag{12}
\]

As a result, the price charged by the Buyer is given by,

\[
P_1 = \frac{3\alpha + \beta C}{4 \beta} \tag{13}
\]

By defining

\[
k := \frac{(\alpha - \beta C)^2}{16 \beta}, \tag{14}
\]
And using price $W$, and substituting this in (9)-(11), we obtain $B_1(W) = K; S_1(W) = 2K$ and $T_1(W) = 3K$. At first glance it may seem somewhat surprising that in this situation the profit for the Supplier is twice as large as the profit of the Buyer. An intuitive explanation would be that the Supplier’s advantage stems from the fact that here it is assumed that the Supplier has full information ($\alpha, \beta$ and $C$).

Consider the relation given in (2b). Let us assume that the Supplier had chosen the value of $W$ as $W = C$, i.e. the Supplier decides to sell the products to the Buyer at cost. Substituting $W$ in (9)-(11) gives $B_1(W) = 4K, S_1(W) = 0$ and $T_1(W) = 4K$. Note that when compared to the previous situation the total Supply Chain profit is larger ($4K$ instead of $3K$). It can be easily shown that in fact $W = C$ maximises the total Supply Chain profit function given in (11). It is obvious that this situation is very profitable for the Buyer but not for the Supplier. In other words, there is absolutely no incentive for the Supplier to optimise the Supply Chain profit: the more profit for the total Supply Chain, the less profit for the Supplier! The results in this section are summarised in Figure 2.

Throughout this paper we will use the following example. Let $D(P) = 100-2P$, i.e. $\alpha = 100$ and $\beta = 2$. Furthermore, let $C = 30$. The profit function for the Buyer is $B = (P-W)(100-2P) = 100P - 100W + 2WP - 2P^2$. The profit function for the Supplier is $S = (W-30)(100-2P) = 100W - 3000 + 60P - 2WP$. The total Supply Chain profit is equal to $T = 160P - 3000 - 2P^2$. 
3. Supply Chain Coordination Mechanisms

*Mail-in rebate contract mechanism*

With the mail-in rebate mechanism, the Supplier is obliged to credit the end-consumer with an amount equal to the value of the rebate coupon. All that end-consumer has to do is to purchase the product at the Buyer and mail the rebate coupon back to the Supplier. In this way the Supplier directly influences end-consumer demand and thus motivate the Buyer to increase his order quantity. By introducing the rebate, the effective price paid by the end-consumer is reduced and hence the Buyer faces a higher demand. Since we assume information symmetry between the Buyer and the Supplier, the Buyer is fully aware of the rebate provided to the end consumer, which will enable him to adjust his order quantity appropriately. (Simchi Levi et. al 2003, p. 251) has provided a brief description of the mail-in-rebate mechanisms. (Gerstner and Hess, 1991, 1995) has designed and analyzed mail-in-rebate mechanisms which they referred to as pull pricing in a setting in which two different consumer segments make up the market. Mail-in-rebate mechanisms designed in this paper are similar to the pull pricing strategy, but in a different setting.

*Figure 2: Profits for Supplier (S), Buyer (B) and total supply chain (T) for various prices W under the Solitaire-scenario.*

![Graph showing profits for Supplier (S), Buyer (B) and total supply chain (T) for various prices W under the Solitaire-scenario.](image URL)
With this mechanism the Supplier fixes the wholesale price and the Buyer the final selling price as in the solitaire scenario. The final selling price fixed by the Buyer is obtained from equation 13. as,

\[ P_1 = \frac{3\alpha + \beta C}{4\beta} \]

i.e.

After the Buyer determines his selling price the Supplier would determine the rebate that he would be willing to provide to the end consumers. The actual price paid by the end consumer when the Supplier provides a rebate \( R \) after the Buyer makes a decision on his final selling price (Equation 13) is,

\[ P_2 = \frac{3\alpha + \beta C}{4\beta} - R \]

(15)

The Buyer makes a decision on his order quantity after the Supplier decides on the rebate he would provide to the end consumers. Supplier would be interested in providing a rebate value which would maximise his profit and the result of Suppliers action is summarized in theorem 1.

**Theorem 1** The rebate value \( R_M \) which is optimal for the Supplier does not coordinate the Supply Chain (the Supply Chain profit is not optimal) but leads to win-win situation ( both the Buyer and the Supplier has higher profit than the realized profit under the solitaire scenario).

**Proof.** A rebate value which will optimise the Suppliers profit can be obtained by optimising the Suppliers profit function given in equation 16,

\[ S_z = (W_z - R_M - C)(\alpha - \beta P_z) \]

(16)
By using the first order condition for the Suppliers profit equation it is very easy to arrive at the following rebate value which will maximize his profit:

$$R_M = \frac{1}{8 \beta} [\alpha - \beta C]$$

(17)

When the Supplier decides to provide a rebate which is optimal for him, the profit for the Supplier, Buyer and the Supply Chain can be obtained as follows:

$$S_2 = \frac{9}{64 \beta} (\alpha - \beta C)^2$$

(18)

$$B_2 = \frac{6}{64 \beta} (\alpha - \beta C)^2$$

(19)

$$T_2 = \frac{15}{64 \beta} (\alpha - \beta C)^2$$

(20)

Comparing the profits for the players and the Supply Chain with the mail-in-rebates (Equations 18, 19 & 20) with that of the profits in solitaire scenario gives the following results:

$$B_2 - B_1 = \frac{(\alpha - \beta C)^2}{32 \beta} = \frac{K}{2}$$

(21)

$$S_2 - S_1 = \frac{(\alpha - \beta C)^2}{64 \beta} = \frac{K}{4}$$

(22)

$$T_2 - T_1 = \frac{3(\alpha - \beta C)^2}{64 \beta} = \frac{3K}{4}$$

(23)

Positive values for equations 21, 22 & 23 imply a higher profit for the players and the Supply Chain with the mail-in-rebate mechanism. Next we try to show that rebate value $R_M$ does not coordinate the Supply Chain.
**Optimal rebate value for the Supply Chain**

The profit function for the Supply Chain with price $P_3$ can be obtained as

$$T_3 = (P_3 - R - C)(\alpha - \beta (P_3 - R)) \quad (24)$$

First order condition on the Supply Chain profit with respect to $R$ gives the following rebate value:

$$R_{opt} = \frac{1}{4\beta} [\alpha - \beta C] \quad (25)$$

**Theorem 2** At the optimal rebate value for the Supply Chain $R_{opt}$, the Supplier's profit is same as that of the solitaire scenario. The entire additional profit pie is taken up by the Buyer.

**Proof.** The proof for the above theorem can be obtained by using the $R_{opt}$ values in the profit functions of the players. optimal rebate in equation 26 allocates the following profits for the Supplier and the Buyer,

$$S_3 = \frac{(\alpha - \beta C)^2}{8\beta} = 2K \quad (26)$$

$$B_3 = \frac{(\alpha - \beta C)^2}{8\beta} = 2K \quad (27)$$

$$T_3 = \frac{(\alpha - \beta C)^2}{4\beta} = 4K \quad (28)$$

The additional Supply Chain profit by using the optimal rebate value can obtained by comparing the equations 20 and 28 and can be obtained as,
It is clear from equation 26 that at the optimal rebate for the Supply Chain the Suppliers profit is same as that he has obtained during the solitaire scenario. All the additional profit goes to the Buyer. Another interesting observation which can be made from the above analysis is that the Supplier’s profit is 
same as that of the Buyer. This proves our theorem 2. As the Supplier is the one who makes the decision on the rebate value he would choose the rebate which maximises his profit.

Reviewing our numerical example, the wholesale price set for the Buyer can be obtained as 40. The Buyer will fix the final selling price at 45. If the Supplier provides a rebate $R$ to the end consumer, the profit functions for the Buyer can be obtained as $B_R = 50 + 10R$, For the Supplier it is $S_R = 100 + 10R - 2R^2$, For the Supply Chain it is $T_R = 150 + 20R - 2R^2$. Figure 3 indicates the profit profiles for the players and the Supply Chain at the two different rebate values.

**Figure 3**: Profit for Supplier ($S$), Buyer ($B$) and total Supply Chain ($T$) with mail-in-rebate mechanism

The analysis with the mail-in-rebate mechanism gives us the following interesting insights:
1) At the rebate value which is optimal for the Supply Chain the Supplier’s profit is same as his profit in a solitaire scenario. All the additional profit goes to the Buyer. Interestingly, at the optimal rebate value the Buyer’s profit is same as that of the Supplier.

2) If the Supplier decides to provide a rebate value which will optimize his own profits, Supply Chain coordination is not possible, but win-win can be achieved. As the supplier makes the decision on the rebate value, he would choose the rebate which maximizes his profit.

3) Any rebate value greater than the optimal rebate ($R_{opt}$) has a detrimental effect on the profit for the Supplier and the Supply Chain.

In the next subsection we design and analyze the combined rebate mechanism.

*Combined rebate mechanism*

![Combined rebate mechanism diagram](image)

*Figure 4. Combined rebate mechanisms*

It is a very well known fact which can be verified from figure 2 that any wholesale price rebate provided by the Supplier to the Buyer has a detrimental effect on the supplier’s profit. Close observation of figure 2 reveals the fact that a simple wholesale price rebate provided by the Supplier to the Buyer cannot provide win-win. From the analysis of the mail-in-rebate mechanism we have understood the fact that it can provide win-win but cannot coordinate the Supply Chain (as the supplier will choose the rebate value which will maximize his profit). The limitations of the above mechanisms has encouraged us to design a new
coordination mechanisms. In this new coordination mechanism Buyer provides a rebate to
the end consumer and the Supplier provides a wholesale price rebate to the Buyer. As the
mechanism combines the rebate provided by each of the player to its immediate customer
we call this as a combined rebate mechanism (Figure 4). In our analysis we test if the
combined rebate mechanism has the potential coordinate and provide win-win for the
players and compare its performance with the mail-in-rebate mechanism.

With the combined rebate mechanism we assume the events to take place in the following
sequence:

1) Supplier initially fixes the wholesale price at a level which will maximize his profit (as
in the solitaire scenario).
2) Given the wholesale price the Buyer decides on the final selling price (as in the
solitaire scenario).
3) Buyer decides on the rebate that he will provide to the end consumers
4) Finally, the Supplier decides on the wholesale price discount provided to the Buyer.

The wholesale price which will optimize Supplier’s profit can be obtained from the solitaire
scenario analysis (equation 12) as,

\[ W_1 := \frac{\alpha + \beta C}{2 \beta}. \]

(30)

Given the above wholesale price the Buyer would fix the selling price which would maximize
his profit (as obtained in the solitaire scenario) which is the same as obtained in Equation 13.

\[ p_1 = \frac{3\alpha + \beta C}{4 \beta} \]

(31)

**Theorem 3** In a combined rebate mechanism when the Buyer provides a rebate value which is optimal for
the Supply Chain, win-win can be obtained even when the Supplier fixes the wholesale price rebate such that
his profit is same as the maximum potential profit with the mail-in-rebate mechanism. And interestingly the Buyer makes a greater profit than that is possible with the Suppliers optimal rebate value in the mail-in-rebate mechanism.

**Proof:** Buyer determines the rebate he has to provide to the end consumers. We look at the condition at which he provides the rebate value which is optimal for the Supply Chain. The optimal rebate value for the Supply Chain will be the same as obtained in equation 25 which is,

\[ R_{opt} = \frac{1}{4\beta} [\alpha - \beta C] \]  

(32)

When the Buyer provides the rebate value as obtained in equation 32, the price that the end consumer has to pay to own the product can be obtained as,

\[ P_{effective} = (P_1 - R_{opt}) = \frac{\alpha + \beta C}{2\beta} \]  

(33)

And the optimal Q value can be obtained as,

\[ Q_{effective} = (\alpha - \beta P_1) = \frac{\alpha - \beta C}{2} \]  

(34)

After the Buyer fixes the final selling price and the rebate value the Supplier has to decide on the wholesale price rebate \((w_d)\) he will provide to the Buyer. The profit for the players and the Supply Chain can be obtained as,

\[ S_s(w_d) = \frac{(\alpha - \beta C)^2}{4\beta} - w_d \frac{(\alpha - \beta C)}{2} \]  

(35)

\[ B_s(w_d) = w_d \frac{(\alpha - \beta C)}{2} \]  

(36)

\[ T_s = \frac{(\alpha - \beta C)^2}{4\beta} \]  

(37)
What is interesting in equation 37 is that the Supply Chain’s profit is optimal and is independent of the wholesale price rebate that the Supplier provides. Now the Supplier has to decide on the wholesale price rebate that is to be provided to the Buyer. It is very logical to assume that the Supplier would be interested in choosing the wholesale price discount value which would yield him the optimal profit that he would obtain with the mail-in-rebates.

\[
\text{i.e. } \quad \frac{(\alpha - \beta C)^2}{4 \beta} - w_x \frac{(\alpha - \beta C)}{2} = \frac{9(\alpha - \beta C)^2}{64 \beta}
\]

\[w_x = \frac{7(\alpha - \beta C)}{32 \beta}\]

\[B_x = \frac{7(\alpha - \beta C)^2}{64 \beta}\]

The profit for the Buyer can be obtained as,

What is interesting from the above analysis is that the Supplier makes a profit which is equal to his optimal profit with the mail-in-rebates (as in equation 18). And the Buyer’s profit is greater than the profit he makes when the Supplier chooses his optimal rebate value in the mail-in-rebates (Equation 19). And the maximum possible Supply Chain’s profit can be obtained (Equation 37). We can conclude that if the combined rebate mechanisms is designed properly both win-win and coordination can be achieved. If implemented correctly it outperforms the mail-in-rebate mechanism as it improves the Buyer and the Supply Chain profit. This completes the proof of theorem 1. Combined rebate mechanism is easier to implement when compared to the mail-in-rebate as each player has to provide the rebate only to his immediate consumer. This mechanism will also be less costly to administer.
Theorem 4 When the combined rebate values are chosen appropriately end consumer pays a lower price and demands a greater quantity when compared with a mail-in-rebate mechanism.

Proof. The difference in the quantity demanded with the wholesale price discount mechanism and the mail-in-rebate mechanism can be obtained as follows:

\[ Q_4 - Q_2 = \frac{1}{8}[\alpha - \beta C] \]  \hspace{1cm} (41)

The positive value in equation 41 indicates that a higher quantity is demanded with the combined rebate mechanisms when compared to the mail-in-rebate mechanism. The difference in the price paid by the end consumers with the above two mechanisms can be obtained as follows:

\[ P_4 - P_2 = -\frac{1}{8\beta}[\alpha - \beta C] \]  \hspace{1cm} (42)

A negative value for the equation 42 indicates that the consumer pays a lower price with the combined rebate mechanism.

3. Conclusions

This paper has analyzed mail-in-rebate and combined rebate mechanism from the perspective of channel coordination and win-win. We have obtained an optimal mail-in-rebate value from Supplier’s and Supply Chain perspective. First, we have compared the performance of mail-in-rebate mechanism and the no-rebate scenario. With this comparative analysis we have shown that whatever the rebate value is, the Buyer always benefits from the mail-in-rebate mechanism. The Supplier benefits from mail-in-rebate when the rebate value is set within a specific range. The rebate value that optimizes the Supply Chain does not provide any additional profit to the Supplier. As the mail-in-rebate value is decided by the Supplier he will provide the rebate which will maximise his profit and at this rebate value
Supply Chain coordination is not possible. Secondly, we have designed a combined rebate mechanism in which the Buyer provides a rebate to the consumer and the Supplier provides a wholesale price rebate to the Buyer. We have obtained conditions under which the combined rebate mechanism can coordinate and provide win-win for the players. In fact, with the combined rebate mechanisms the Supplier can obtain maximum profit that was possible with the mail-in-rebate and the Buyer can make a profit which is greater than that of the mail-in-rebate mechanism. Consumers receive greater surplus with the combined rebate and demand a greater quantity. Combined rebate mechanism is easy to implement as each player has to deal with his immediate customer which makes it more feasible and less costly to administer. However, the most critical step is to choose the rebate values in the combined rebate mechanism appropriately.
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