We deeply appreciate the time and effort you have spent in reviewing our manuscript (sustainability-633009). Your comments are really thoughtful and helpful, we have carefully taken your kind advices and referee's detailed suggestions into consideration in revising our manuscript. Enclosure is our point-point answer to the referee’s comments. We sincerely hope this revised manuscript will be finally acceptable to be published on Sustainability. Thank you very much for all your helps and looking forward to hearing from you soon.

Abstract: Recycling is not important only for saving energy. This is a narrow vision. Which kind of game analysis technology? Authors need to be more explicit. Regarding optimal decisions and optimal selections, there is a lack of context and traceability.

Thank you for your suggestion. To be more precise, we replace “Recycling is not important only for saving energy” with “recycling has become one of an important activity to save energy. And we also make it clear in the abstract that the game analysis technology is Stackelberg game and explain it in the Introduction. Also, in this paper, we unify the expression of optimal decisions.

Keywords: Although they are included into the abstract, they are no emphasized in it.

Thank you for your insightful suggestion. We emphasize the keywords in the abstract. The details are as follows.

Abstract: Green and sustainable consumption are more popular among consumers, and recycling has become one of an important activity to save energy. In a closed-loop supply chain (CLSC), the right alliance can help manufacturers better manufacture green products and make more profits. Therefore, choosing the most suitable alliance partner is critical for manufacturers. This paper considers product greenness and recycling competition, deals with alliance decision in a CLSC that is comprised of a dominant manufacturer, a retailer and a third-party recycler. The Stackelberg game is employed to analyze the optimal decision-making of this supply chain under four different models. Then, after making the optimal alliance decision from the perspective of CLSC profit maximization, we distribute the revenue to the members in the SC to ensure their enthusiasm to participate in the alliance. This further proves that the profit maximization of the CLSC is also the manufacturer's profit maximization. The results show that manufacturer's optimal alliance decisions is related to the degree of recycling competition. When less than the threshold, C alliance is optimal, otherwise, MR alliance is more beneficial for the manufacturer.

Introduction: When authors write "With the rapid development of the economy and the increasing rate of resource consumption", they must be more specific giving an historical and geographical context. Which kind of countries have implemented policies? Developed, developing, underdeveloped countries?

Thank you for your suggestion. According to your suggestions, we add some specific events to the background of rapid economic development of the economy and the increasing rate of resource consumption and cite relevant literature. Second, we point out that many developing and developed countries have implemented some policies and give examples respectively. The details are as
follows.

With the rapid development of the economy and the increasing rate of resource consumption, environmental pollution issues are receiving extensive attention, many companies (such as General Electric, BODY SHOP, Midea) put a lot of effort into product innovation to protect the environment [1,2]. Actually, many years ago, many developing and developed countries have implemented some policies to achieve sustainable development of resources. For example, in 1989, China promulgated the “environmental protection law of China”, which plays an active role in improving and protecting the environment [3]; The German government enacted the “Packaging Regulations” in 1991, which is the first regulation in the world that requires product manufacturers and commodity packaging manufacturers to undertake the classification and recycling of used packaging containers [4].

When do more and more consumers tend to buy organic products? There is a lack of dates, more data and references.

Thank you for your insightful suggestion. In the part of introduction, we point out the time when people tend to buy green products and cite relevant literatures for confirmation. The details are as follows.

At the same time, with the increasing awareness of resource conservation and the advance of government policies, more and more consumers tend to buy green products for the environment and health reasons after the 20th century [5,7].

To protect brand image and enhance brand value to some extent is not related (is more than it) with saving the costs indicated into the abstract.

Thank you for your suggestion. I’m sorry that my expression is not accurate enough. What I want to express is that it can not only save costs and increase profits, but also protect brand image and enhance brand value. So I modify it as “The recycling and green consumption is of great significance to resource conservation and environmental protection. It can not only help save costs, make more profits but also protect brand image and enhance brand value to some extent.”

It is necessary to refer Kiehl references. Problems in recycling market, such as the fierce competition, must be stressed and referred.

Thank you for your insightful suggestion. According to your suggestion, I make the modification. The details are as follows.

For example, Kiehl's has made a contribution to environmental protection by recycling cosmetic bottles and adding green elements to make new products [8]. Starting from the brand itself, all Kiehl's counter KCR (Kiehl's customer service representative) have been gradually wearing special work clothes made of green textile technology since 2014. Every 10 plastic bottles can be made into a KCR work clothes, and it not only solves the problem of handling the empty bottles, but also reduces the production cost of the work clothes [http://blog.sina.com.cn/u/2112530335]. However, there are still some problems in recycling market, such as the fierce competition (competition among enterprises, manufacturers, recyclers, etc), the high cost of recycling and
producing green products [9-10].

The introduction section must bring out the problem to be solved with the research, but authors do not do it.

Thank you for your suggestion. According to your suggestion, I bring out the problem to be solved with the research in the introduction section. The details are as follows.

The main purpose of this article is to determine the optimal alliance partner for manufacturers in the context of competitive recycling, so that their alliance can make the most profits for the CLSC and the manufactures can get more profit. To do this, we establish four different alliances, and compare the profits of each agent and CLSC under the two conditions of alliance and non-alliance. In the manufacture–Stackelberg game (As the leader of the supply chain, the manufacturer makes the decision first, and retailer and third-party recycler make the decision according to the manufacturer's decision), we analyze effects of degree of recycling competition on the profits of the channel members and the CLSC. In particular, this paper is designed to address the following questions. First, what impact will the manufacturer's participation in the recycling activities have on the third-party recycler? Second, in the supply chain that targets the best profit, should the manufacturer be alliance? If so, with who? And how to determine the profit of each member in the alliance so as to ensure their initiative.

To mention the 19th century with the cite of Sambasivan and Nget,2010?. These sentences must be better expressed. Resource heterogeneity, flexibility, supplier cost and return rate are cited, but without any kind of prioritization nor context. Later, authors refer to obtain much more profits, which is different to save costs...authors must be homogeneous.

Thank you for your insightful suggestion. According to your suggestion, I correct these details and the main purpose of this paper is obtain more profits, so I make a unity for this statement. The details are as follows.

As early as the 19th century, some scholars put forward several different concept about alliance, and they only studied it from a qualitative perspective, such as the driving and influencing factors of alliance formation or the value of alliance [12]. By combing the existing literatures, we summarize the following major factors that affect strategic alliances: resource heterogeneity, flexibility, supplier cost and return rate, etc. [13-15]. These factors will be considered when making alliance decisions. Later, to obtain much more profits, some manufacturers are willing to establish an alliance with other members, so some scholars tried to introduce alliance into the SC [16].

Coordination mechanisms in the SC alliance to reduce or even eliminate conflicts among SC members are referred, but authors do not explain the context (sector, kind of company, countries, etc.)

Thank you for your suggestion. According to your suggestion, we cited the examples of ford and GM. The details are as follows.

In order to do this, they designed a lot of coordination mechanisms in the SC alliance to reduce or even eliminate conflicts among SC members, such as feedback and punishment mechanisms, revenue sharing mechanism, and cooperative game theory mechanism [23-25]. Reducing supply chain conflicts through alliances has been a success story in the automotive industry. For example, Ford and GM, the big American car manufacturers, have been working with professional third-party
recycling companies for years to recycle their products [26].

During the introduction, authors make a lot of statements, but very few references. They do not demonstrate nor justify nor refer many sentences. Assert-justify means you have to justify after the assertion.

Thank you for your suggestion. According to your suggestion, we added some literature i to reduce the subjectivity of expression. The additional literature is as follows.

With the rapid development of the economy and the increasing rate of resource consumption, environmental pollution issues are receiving extensive attention, many companies (such as General electric, Body shop, Midea) put a lot of effort into product innovation to protect the environment [1,2]. Actually, many years ago, many developing and developed countries have implemented some policies to achieve sustainable development of resources. For example, in 1989, China promulgated the “environmental protection law of China”, which plays an active role in improving and protecting the environment [3]; The German government enacted the “Packaging Regulations” in 1991, which is the first regulation in the world that requires product manufacturers and commodity packaging manufacturers to undertake the classification and recycling of used packaging containers [4]. At the same time, with the increasing awareness of resource conservation and the advance of government policies, more and more consumers tend to buy green products for the environment and health reasons after the 20th century [5-7]. The recycling and green consumption is of great significance to resource conservation and environmental protection. It can not only help save costs, make more profits but also protect brand image and enhance brand value to some extent. Some enterprises recycle the packaging of their own product and introduce the concept of green production after recycling, so as to achieve the purpose of saving resources and green production. For example, Kiehl's has made a contribution to environmental protection by recycling cosmetic bottles and adding green elements to make new products [8]. Starting from the brand itself, all Kiehl's counter KCR (Kiehl's customer service representative) have been gradually wearing special work clothes made of green textile technology since 2011. Every 10 plastic bottles can be made into a KCR work clothes, and it not only solves the problem of handling the empty bottles, but also reduces the production cost of the work clothes [http://blog.sina.com.cn/u/2112530335]. However, there are still some problems in recycling market, such as the fierce competition (competition among enterprises, manufacturers, recyclers, etc), the high cost of recycling and producing green products [9-10].

Reducing supply chain conflicts through alliances has been a success story in the automotive industry. For example, Ford and GM, the big American car manufacturers, have been working with professional third-party recycling companies for years to recycle their products [26]. In recent years, with the proposal of sustainable development, green products are deeply loved by the market for their special environmental characteristics [27]. At the same time, many manufacturers save resources by recycling and remanufacturing activities. For example, Nike alliancing with a third-party (a nonprofit structure "National Recycling Coalition"), is responsible for recycling products [28].

In reality, there exists a closed-loop supply chain composed of manufacturers, retailers and third-party recyclers. For example, Kiehl's and its cosmetic bottle recyclers and manufactures. In order to make more profits and increase social welfare, the manufacturers independently recycle the used products and then introduce advanced technology to remanufacture notebooks, clothes,
backpacks and so on, which has higher environmental performance and can meet the environmental protection needs [46-47]. However, green R & D and recycling both require a lot of cost, and if the manufacturer completes these tasks independently, it will inevitably decrease profits significantly. So, in order to maximize the profit of themselves and the CLSC under the premise of guaranteeing product quality, manufacturers need to select an alliance partner to jointly undertake R&D and recycling tasks to determine the optimal product greenness. Through the alliance, it can maintain the stable and sustainable development of the SC [48].

This section should be divided into two groups: introduction and literature review.

Thank you for your suggestion. We modify it according to your suggestion.

Basic models: When authors write "through the alliance, it can maintain the stable and sustainable development of the SC", for example, no references are included. This happens on numerous occasions. Figure 1 is unreadable.

Thank you for your insightful suggestion. We try our best to add references according to your suggestion. And make figure 1 is readable.

The product quantity ordered by retailer positively correlated with greenness must be better explained.

Thank you for your suggestion. We explain why the product quantity ordered by retailer positively correlated with greenness, and the related research literature is added. The details are as follows.

Because consumers tend to buy green products, therefore the higher the product greenness is, the lower the price, and the higher sales volume of products are. In short, the product quantity ordered by retailer is negatively correlated with sales price and positively correlated with greenness. According to the analysis, the market demand function can be written as $D = \alpha - \alpha p + \beta g$ [49].

To assume that R&D costs are quadratic with product greenness (Jiang and Li, 2015) introduces limitation which must be discussed into the discussion section. Idem with the decision-making single period of the CLSC. The section ends and the game analysis is not explained.

Thank you for your suggestion. We discuss the limitation of the assume that R&D costs are quadratic in greenness, and the decision-making single period of the CLSC in the conclusion. Also, we explain the stackelberg game analysis as “the dominant manufacturer has priority decision, retailer and third-party recycler make decisions on the basis manufacture”. The limitation are as follows.

Generally speaking, the alliance model and profit distribution constructed in this paper help manufacturers make better alliance decisions from the perspective of their own profit and supply chain profit. At the same time, she also enriched the single alliance theory, from the perspective of the supply chain to achieve competition and cooperation. However, there are some limitations in this paper. For example, we assume that green R&D costs are quadratic in greenness, and this is a
reference to the previous literature, but the actual relationship between them in real life may not be the case, and we idealize it for convenience. In addition, we only consider single-phase CLSC decision-making. In fact, CLSC decisions tend to be multi-phase in many cases, these will be one of the directions for this article to study further.

3. Decision analysis considering product greenness and recycling competition: OK. This section is the best of the paper. But it is necessary to underline that only the cost is addressed. Other crucial parameters like delivery, quality, or risk are not treated in this paper, so the decision is biased (at least incomplete).

Thank you for your insightful suggestion. This paper makes the best alliance decision from the perspective of profits (the profit of the manufacturer and the profit of the closed loop supply chain). Your opinion is very good, so I add an explanation in the assume that “Since this paper mainly selects the optimal type of alliance for the manufacturer from the perspective of profit maximization (the profit of manufacture and CLSC), so we assume that the products’ quality, delivery time, risk and other factors in the different models are the same.” At the same time, we add a chapter to distribute the profits after the alliance, ensuring that the manufacturer can get the most profits after choosing this alliance. That is to say, the profit of manufacturer and supply chain can be maximized through the alliance decision. The details are as follows.

6. Revenue distribution after alliance

From the analysis in chapter 5, we can find that when the degree of recycling competition is less than \( \theta^* \left( \theta^* = \frac{5}{4} - \frac{\sqrt{17}}{4} \right) \), both the alliance profit and CLSC profit are bigger than MR model; When the recycling competition is greater than \( \theta^* \), the profits of alliance and CLSC in model MR are bigger than model C. However, this only shows that model C or model MR is the optimal alliance decision from the perspective of CLSC for manufacturer. As a manufacturer, it is also necessary to ensure that the profit of each subject after the alliance is greater than that before the alliance. We assume that manufacturer, retailer or third-party recycler have the same profit sharing proportion under four different alliance models. So with the same sharing proportion, the more profits the system makes, the more profits each subject will receive.

Therefore, in this chapter, we need to conduct profit distribution for model C and model MR, and further determine the conditions for optimal alliance decision. Under this distribution mechanism, each supply chain subject shares the profit of the system in a certain proportion.

6.1 The revenue distribution in model C

Assume that \( \lambda_1, \lambda_2, \lambda_3 \) represent the sharing proportion of CLSC profit distributed by manufacture, retailer and third-party recycler respectively, and \( 0 < \lambda_1 + \lambda_2 + \lambda_3 \leq 1 \). From the view of the profit of CLSC system, when model C is optimal, in order to further ensure that model C is the optimal alliance decision for the manufacture, it must satisfy:
\[ \begin{align*}
\lambda_1 \pi^C \geq \pi^D_m
\lambda_2 \pi^C \geq \pi^D_r
\lambda_1 + \lambda_2 + \lambda_3 &= 1
\lambda_1, \lambda_2, \lambda_3 &> 0
\end{align*} \] (51)

Solve the equation (51), we can get,

\[ A_1 \leq \lambda_1 \leq 1 - (A_2 + A_1); A_2 \leq \lambda_2 \leq 1 - (A_1 + A_2); A_3 \leq \lambda_3 \leq 1 - (A_1 + A_2) \]

Among them, \( A_1 > A_2 > A_3 > 0 \), and

\[ A_1 = \frac{(2 + \theta) \left( 2a c m(\theta + 1) - 2(\Delta - A) \alpha c (\theta - 1)^2 - \beta^2 m(\theta + 1) \right)}{(1 + \theta) \left( 4a c m(\theta + 2) - (\Delta - A) \alpha c (\theta - 1)^2 (\theta + 3) - \beta^2 m(\theta + 2) \right)} \]

\[ A_2 = \frac{2a c m(2 + \theta)^2 \left( 2a c m(\theta + 1) - 2(\Delta - A) \alpha c (\theta - 1)^2 - \beta^2 m(\theta + 1) \right)}{(1 + \theta) \left( 4a c m(\theta + 2) - (\Delta - A) \alpha c (\theta - 1)^2 (\theta + 3) - \beta^2 m(\theta + 2) \right)^2} \]

\[ A_3 = \frac{\alpha c (\Delta - A)^2 (\theta - 1)^2 (\theta + 4\theta^2 + 4\theta - 1) \left( 2a c m(\theta + 1) - 2(\Delta - A) \alpha c (\theta - 1)^2 - \beta^2 m(\theta + 1) \right)}{(1 + \theta) \left( 4a c m(\theta + 2) - (\Delta - A) \alpha c (\theta - 1)^2 (\theta + 3) - \beta^2 m(\theta + 2) \right)^2} \]

6.2 The revenue distribution in model MR

Like the idea in section 6.1, we assume that \( \rho_1, \rho_2 \) represent the sharing proportion of CLSC profit distributed by manufacture and retailer respectively, and \( 0 < \rho_1 + \rho_2 \leq 1 \). From the view of the profit of CLSC system, when model MR is optimal, in order to further ensure that model MR is the optimal alliance decision for the manufacture, it must satisfy:

\[ \begin{align*}
\rho_1 \pi^{MR_m} &\geq \pi^D_m
\rho_2 \pi^{MR_r} &\geq \pi^D_r
\rho_1 + \rho_2 &= 1
\rho_1, \rho_2 &> 0
\end{align*} \] (52)

Solve the equation (52), we can get,

\[ B_1 \leq \rho_1 \leq 1 - B_2; B_2 \leq \rho_2 \leq 1 - B_1 \]

Among them, \( B_1 > B_2 > 0 \), and

\[ B_1 = \frac{2a c m(\theta + 2) - \alpha c (\Delta - A)^2 (\theta + 3)(\theta - 1)^2 - \beta^2 m(\theta + 2)}{4a c m(\theta + 2) - \alpha c (\Delta - A)^2 (\theta + 3)(\theta - 1)^2 - \beta^2 m(\theta + 2)} \]

\[ B_2 = \frac{4a c m(\theta + 2) - 2\alpha c (\Delta - A)^2 (\theta + 3)(\theta - 1)^2 - 2\beta^2 m(\theta + 2)(\theta + 2)c m}{\left( 4a c m(\theta + 2) - \alpha c (\Delta - A)^2 (\theta + 3)(\theta - 1)^2 - \beta^2 m(\theta + 2) \right)^2} \]
In this chapter, based on the optimal alliance decision from the view of system profit maximization, we try to determine the profit distribution of the alliance subject and the conditions for each subject to participate actively in the alliance are determined. Combined with chapters 5 and 6, we can say when the degree of recycling competition is less than $\theta^*$, model C is the best alliance; otherwise, model MR is optimal.

4. Comparison among the optimal decisions under different modes:
The conclusions, and their implications, of this section should be better explained. What is the translation of these formulas into the real world? Conclusion 1 is divided into 3, 2 into 4, 3 into 4, 4 into 5, 5 into 4, and 6 into 3....totally 23 formulas (conclusions) that need to be better commented.

Thank you for your insightful suggestion. According to your opinion, we rearrange this chapter. The details are as follows.

5. Comparison among the optimal decisions under different modes

By comparing the optimal decisions in different modes, we can obtain the regular of the optimal decisions. The regular can provide a theoretical reference for the subsequent analysis. Therefore, we will compare and analyze the wholesale price, retailer price, greenness and profit in different modes.

Conclusion 1. The optimal wholesale price meets the following conditions.

(1) If $0 < \theta \leq \frac{1}{2}$, then $\omega^{D^*} > \omega^{D^*} > \omega^{MC^*}$;

(2) If $\frac{1}{2} < \theta \leq 1$, then $\omega^{MC^*} > \omega^{D^*}$.

Conclusion 1 shows that when the degree of competition is less than 1/2, the wholesale price of the product in model D is greater than that in model MC. In mode MC, as competition intensity increasing, the wholesale price of the manufacturer always keeping growing. When the competition intensity reaches the threshold $\theta^*$, the third-party recycler will withdraw from the recycling market in the model D, and the wholesale price in model D goes down suddenly and then remain unchanged after the threshold $\theta^*$. This is because when the third-party recycler exits the recycling market, the manufacturer will recycle it independently, it avoids the marginal effect of the reverse supply chain, so the wholesale price go down.. The optimal wholesale price in the MC alliance is higher than no alliance in the end. Because of the lower competitive intensity, MC alliance can increase the total recycling volume, so manufacturer can provide the retailer with a lower recycling price. However, when the competition intensity increases to a certain extent, the recycling cost between two parties also increases, so the wholesale price is higher. This shows that the weaker competition intensity is, the more conducive to consumers.

Conclusion 2. The optimal retail price satisfies the following conditions.

(1) If $0 < \theta \leq \frac{5}{4} - \frac{\sqrt{17}}{4}$, then $p^{D^*} > p^{D^*} > p^{MC^*} > p^{MR^*} > p^{MR^*} > p^{C^*}$;
(2) If \( \frac{5}{4} - \frac{\sqrt{17}}{4} < \theta \leq \frac{1}{2} \), then \( p^{D^*} > p^{MC^*} > p^{C^*} > p^{MR^*} \);

(3) If \( \frac{1}{2} < \theta \leq 1 \), then \( p^{MC^*} > p^{D^*} > p^{C^*} > p^{MR^*} \).

It can be found from conclusion 2 that the retail price under MR and C models is always lower than MC and D models. Because manufacturer and retailer together can enhance the market information, better grasp the consumer dynamics. When the third-party recycler exits the recycling market, the retail price under model D and MR will suddenly drop. Because from conclusion 1, we find that when the third-party recycler exits the recycling market, the wholesale price given by the manufacturer to the retailer is reduced, and the retailer's wholesale cost is reduced, so the retail price reduce. In addition, When \( \theta \) is small enough, the retail price in model MR is greater than that in model C; When competition \( \theta \) is high, the retail price in model C is higher than that in model MR. This suggests that the model C is most beneficial to consumers when recycling competition is small, otherwise the model MR is more beneficial. This means that when the competition is low, the cooperation among manufacturer, retailer and third-party recycler will improve the decision-making efficiency of the SC. However, with the increase of recycling competition, the cooperation between manufacturer and third-party will decrease and the contradiction will be aroused, so the decision-making efficiency will be lower than MR model. So you can see that when \( \theta \) is smaller, the more of the alliance member, the higher of the optimal retail price. But when \( \theta \) reach to a certain value, this relationship will no longer exist.

Conclusion 3. The optimal greenness meets the following conditions.

(1) If \( 0 < \theta \leq \frac{5}{4} - \frac{\sqrt{17}}{4} \), then \( g^{C^*} > g^{MR^*} > g^{MC^*} > g^{D^*} > g^{D^*} \);

(2) If \( \frac{5}{4} - \frac{\sqrt{17}}{4} < \theta \leq \frac{1}{2} \), then \( g^{MR^*} > g^{C^*} > g^{MC^*} > g^{D^*} \);

(3) If \( \frac{1}{2} < \theta \leq 1 \), then \( g^{MR^*} > g^{C^*} > g^{D^*} > g^{MC^*} \).

According to the Conclusion 3, when the manufacturer and third-party recycler recycle at the same time, the product greenness in model C is the largest. But when the third party withdraws from the recycling market and the competition intensity increases to the threshold \( \theta^{**} = \frac{5}{4} - \frac{\sqrt{17}}{4} \), the greenness of MR alliance is bigger than that of C alliance. This is because when the degree of competition is low, the more alliance members can reduce the manufacturer's production cost, so that more energy can be invested in the improvement of product greenness. But as competition becomes more and more intense, the MR alliance will weaken the influence of third-party recycler. Therefore, the MR alliance has certain advantages, and the product greenness investment is also the highest.

Secondly, compare the model MC and model D. When the degree of competition is small, the greenness of MC model is greater than that of D model. But when \( \theta > 1/2 \), the greenness is greater
in model D. Because the degree of competition is relatively small, the third-party participates in recycling activities, and the manufacturer and MC alliance can improve the decision-making efficiency, so the degree of greenness is relatively high. When the degree of competition increases to 1/2, competition reduces the decision-making efficiency of MC model.

Combined with conclusion 2, it can be found that the lower the retail price of the product, the higher the greenness. This shows that manufacturer can achieve higher green degree products at lower price through alliance, which is beneficial to consumers and the environment.

Conclusion 4. When \( \tau_{m}^{C*} \) is equal to \( \tau_{m}^{MR*} \), the optimal decision is \( \theta_{1} \), and when \( \tau_{m}^{C*} \) is equal to \( \tau_{m}^{D*} \), the optimal decision is \( \theta_{2} \). So we can get following results.

(1) If \( 0 < \theta \leq \theta_{1} \), then \( \tau_{m}^{C*} > \tau_{m}^{MR*} > \tau_{m}^{MC*} > \tau_{m}^{D*} \);

(2) If \( \theta_{1} < \theta \leq \theta^{*} \), then \( \tau_{m}^{MR*} > \tau_{m}^{C*} > \tau_{m}^{MC*} > \tau_{m}^{D*} \);

(3) If \( \theta^{*} < \theta \leq \theta_{2} \), then \( \tau_{m}^{MR*} > \tau_{m}^{C*} > \tau_{m}^{D*} > \tau_{m}^{MC*} \);

(4) If \( \theta_{2} < \theta \leq \frac{\alpha c}{3\alpha \beta - \beta^{2}} \), then \( \tau_{m}^{MR*} > \tau_{m}^{D*} > \tau_{m}^{C*} > \tau_{m}^{MC*} \);

(5) If \( \frac{\alpha c}{3\alpha \beta - \beta^{2}} < \theta \leq 1 \), then \( \tau_{m}^{MR*} > \tau_{m}^{D*} > \tau_{m}^{MC*} > \tau_{m}^{C*} \).

According to the conclusion 4, manufacturers’ recycling rate is more complex. However, it shows that if the size of the recycling competition cannot be determined, the advantage of manufacturer and retailer alliance is more obvious. Compared with model C and model MR, when the degree of competition is relatively small, the recycling rate of the manufacturer in model C is greater than that in model MR. This is because when the competition is low, the larger the number of members of the alliance, and the higher the decision-making efficiency. However, with the increase of the degree of competition, the recycling rate of manufacturer in the model MR model is higher than that in the C model, because the higher the competition, the lower the decision-making efficiency. The change of manufacturer recovery rate in model C and model MC is consistent with the change of model C and model MR.

For model C and model D, before the critical point \( \theta_{2} \), the recycling rate of the manufacturer in model C is greater than that in model D, and after that, the recycling rate of the manufacturer in model D is greater than that in model C. This is because the model D is equivalent to decentralized decision-making, with low efficiency. However, with the increase of recycling competition, the competition between manufacturer and third-party is intensified. The more alliance members cause the opinions inconsistent, leading to low decision-making efficiency. The change of manufacturer recovery rate in model MC and model D is consistent with the change of model C and model D.

Conclusion 5. When \( \tau_{c}^{MR*} \) is equal to \( \tau_{c}^{MC*} \), its optimal decision is \( \theta_{3} \), third-party’s recycling rate will meet following conditions.
(1) If \( 0 \leq \theta \leq \theta_1 \), then \( \tau_{c}^{C*} > \tau_{c}^{MR*} > \tau_{c}^{MC*} > \tau_{c}^{D*} \);

(2) If \( \theta_1 < \theta \leq \theta^* \), then \( \tau_{c}^{C*} > \tau_{c}^{MC*} > \tau_{c}^{MR*} > \tau_{c}^{D*} \);

(3) If \( \theta^* < \theta \leq \frac{\alpha c}{3\alpha c - \beta^2} \), then \( \tau_{c}^{C*} > \tau_{c}^{MC*} \);

(4) If \( \frac{\alpha c}{3\alpha c - \beta^2} < \theta \leq 1 \), then \( \tau_{c}^{MC*} > \tau_{c}^{C*} \).

According to conclusion 5, if we select C alliance, after reaching the critical point (third-party doesn’t recycle any more), the third-party recycling rate will no longer be optimal.

Comparing model MR and model MC, for third-party recycler, when he participates in market recycling and the competition is small, due to the manufacturer is in a dominant position, the alliance of the two restrict the recycling of third-party recycler. In this case, if manufacture choose to alliance with retail, the third-party recycler has enough energy to devote itself to the recycling activity, so its recycling rate in MR is higher than MC alliance. However, when going to reach the threshold \( \theta^* \), the third-party need to alliance with manufacture, otherwise will be forced to exit the recycling market. So the recycling rate of the third-party under model MC is higher than that of model MR in the end.

For model C and model MC, no matter how competitive, the third-party will not withdraw from the recycling market. However, as the number of alliance members increases, the interests of each subject become more dispersed, and the manufacturer is in the dominant position. Therefore, finally, the recycling rate of the third-party in model C is the lowest.

Conclusion 6. For alliance profits, we can find the following conclusions.

(1) If \( 0 < \theta \leq \frac{5}{4} \), then \( \pi_{C}^{C*} > \pi_{T}^{MR*} > \pi_{T}^{MC*} \);

(2) If \( \frac{5}{4} < \theta \leq \frac{\sqrt{17}}{4} \), then \( \pi_{T}^{MR*} > \pi_{C}^{C*} > \pi_{T}^{MC*} \).

For the profit of the CLSC system, we can see that

(1) If \( 0 < \theta \leq \frac{5}{4} \), then \( \pi_{C}^{C*} > \pi_{MR*} > \pi_{MC*} > \pi_{D*} \);

(2) If \( \frac{5}{4} < \theta \leq \frac{1}{2} \), then \( \pi_{MR*} > \pi_{C}^{C*} > \pi_{MC*} > \pi_{D*} \);

(3) If \( \frac{1}{2} < \theta \leq 1 \), then \( \pi_{MR*} > \pi_{D*} > \pi_{MC*} \).

According to conclusion 6, when there are two recyclers in the market, the thresholds \( \theta^* = \frac{5}{4} - \frac{1}{4} \sqrt{17} \), and when \( \theta < \theta^* \), the alliance and system profits in the mode C are all optimal,
otherwise the model MR is the best alliance. And when \( \theta > \frac{1}{2} \), the system profit in the mode D is greater than that in mode MC. This also shows that third-party recycler exiting from the recycling market is beneficial to both manufacturers and SC systems.

5. Numerical illustration: Values of \( C_m=6 \) RMB/piece, \( C_r=2 \) RMB/piece and other parameters \( a=75 \), \( \alpha=7 \), \( m=120 \), \( A=2 \), \( c=3 \), \( \beta=3 \) should be better explained. Where do they come from? Figure 2 is almost unreadable. Try to preset it larger and if possible avoid rasterization and pixelation.

Thank you for your insightful suggestion. No specific data can be found for the value, so in order to prove the conclusion of this paper, the value is randomly selected, but even if the value is changed, it will not affect the conclusion of this paper. For the sake of academic accuracy, I have explained in the value section as” To further prove the validity of the conclusion, we assume that take the cost of producing a new uniform and cost of remanufacturing as \( C_m = 6 \) RMB/piece and \( C_r = 2 \) RMB/piece. Other parameters are as shown follows: \( a = 75, \alpha = 7, m = 120, A = 2, c = 3, \beta = 3 \). I Try to preset Figure 2 larger also.

6. Conclusions: Although the mathematical apparatus seems solid it is necessary to emphasize that the vision is biased since other parameters, not directly related to the cost, are not treated, so the mathematical results do not help to make a decision about which is the best option.

Thank you for your insightful suggestion. I do some prove in section 6. In this paper, the alliance decision is mainly made from the perspective of profit maximization. Therefore, when both manufacturer's profit and supply chain's profit can be maximized, it is the best alliance decision for manufacturer. Although the vision is biased since other parameters, not directly related to the cost, are not treated, we try to find the relatively optimal strategy under the various choices as much as possible.

In short, we are very grateful to the reviewer for his/her insightful suggestions, which make the article more complete. In accordance with the comments, we have made major adjustments and rewrites of the article. We hope that this revision can meet the requirements of reviewer.