Response to Reviewer 1 Comments

Thank you for the reviewer's comments concerning our manuscript entitled "A game theoretic approach for production decisions and social welfare maximization in the CSR emergency medical supply chain with government subsidies during COVID-19 situation" (ID: sustainability-1545783). Those comments are all valuable and very helpful for revising and improving our paper, as well as the important guiding significance to our researches. We have studied comments carefully and have made corrections which we hope to meet with approval. Revised portions are marked in red in the paper and use the "Track Changes" function in Microsoft Word. The main corrections in the paper and the responses to the reviewer's comments are as follows:

Point 1: The literature research part is also well documented, although it seems to need more references from other parts of the world.

Response 1: Considering the reviewer's suggestion, we have added about eight pieces of literature from other parts of the world into the instruction part involved in lines **34-127.**

Point 2: In first page you mention that "economic growth rate has dropped by 1.5% ". You probably mean by 1.5 pp.

Response 2: Thank you for pointing this out, we have modified the data into 1.5 pp in **line 39.**

Point 3: In what it concerns the empirical research part your research still has a significant way to undergo. You do not mention any database that you use to verify your mathematical formulas (without the empirical research how can you prove that your mathematical findings check into the real economy?).

Also, you have to double-check your results using a set of listed companies, as the response of the stock exchange markets to any improvement solution is the most realistic one in the real world.

You mention that section 5 is dedicated to the calculation examples and parameter sensitivity analysis. However, you do not mention any (relevant) database for any given company/companies, which reduces the value of your research. In lack of any other given objective landmark the financial markets are still the best factor for proving/disproving any given theoretical assumption. If you do not check the validity of your sound theoretical findings for a dataset from real economy it can remain an unvalidated theory.

These said I recommend improving your research starting with Section 5 to fully or partially validate your theory with a dataset from real economy (preferably listed companies).

Otherwise it can be the object a relevant academic debate but not so much a validated research with data from real economy and financial markets.

Response 3: It is really true as the reviewer suggested that we need fully or partially validate our theory with a dataset from the real economy. Therefore, I have checked the relevant literature data and the market average of the real product-related parameters, adjusted the data to make it in line with the actual situation, and added the source quotation of the data, and added managerial implications in the sixth part to make it more verifiable in lines **722-781** in 5.1. Numerical Analysis of Equilibrium Results.

To further display the above results and verify the validity of the joint contract model, our paper implements sensitivity analysis on some important parameters using numerical simulation. The parameters are summarized in the form of two datasets in Table 3. Because of the limited access to real market data, the first datasets are set in accordance with those in previous studies [41,66]. The second datasets applied in this study have been selected as a control group.

Table 3. Values of parameters under two datasets.

Parameters	a	μ	λ	c	ε
First example	100	1	0.5	10	1
Second example	10000	12	10	200	16

Table 4. Impact of retailer's CSR level β on equilibrium results.

	Decision variables					**Profits and social welfare**						
	β	P_m	P_r	e	φ_m	π_m	π_r	U_r	π_{sc}	CS	GS	SW
First example	0.1	60.81	84.87	23.22	0.424	1203.3	643.51	679.26	1846.8	357.50	228.76	163.40
	0.2	61.11	83.83	24.45	0.42	1277.8	645.07	725.71	1922.9	403.17	250.74	192.87
	0.3	61.45	82.64	25.82	0.41	1362.0	641.27	778.68	2003.3	458.05	275.78	229.82
	0.4	61.83	81.27	27.33	0.407	1457.8	629.70	839.60	2087.5	524.75	276.72	304.40
	0.5	62.26	79.68	29.03	0.40	1567.7	606.87	910.30	2174.6	606.87	337.15	337.15
	0.6	62.73	77.80	30.94	0.39	1695.1	567.56	993.22	2262.6	709.45	374.63	416.26
	0.7	63.28	75.57	33.10	0.38	1844.1	503.83	1091.6	2348.0	839.71	417.37	521.71
	0.8	63.89	72.87	35.55	0.37	2020.8	403.31	1210.0	2424.1	1008.3	465.64	665.19
	0.9	64.59	69.55	38.35	0.35	2233.1	246.25	1354.4	2479.3	1231.3	518.97	864.94
Second example	0.1	615.60	812.47	237.45	0.42	831210	516740	545450	1347900	287080	19135	683.40
	0.3	628.69	805.21	268.86	0.41	958250	534160	648620	1492400	381540	23929	997.04
	0.5	645.60	794.14	309.44	0.40	1128900	529500	794250	1658400	529500	30642	1532.1
	0.7	668.16	776.20	363.59	0.38	1368500	466880	1011600	1835400	778140	40288	2518.0
	0.9	699.38	744.77	438.50	0.35	1725100	247310	1360200	1972400	1236600	54292	4524.3

Table 5. Impact of manufacturer's technological innovation difficulty coefficient ε on equilibrium results ($\beta = 0.25$).

	Decision variables					Profits and social welfare						
	ε	P_m	P_r	e	φ_m	π_m	π_r	U_r	π_{sc}	CS	GS	SW
First example	0.4	74.85	102.65	79.41	0.417	1667.6	1030	1201.7	2697.7	686.69	1051.0	840.83
	0.6	66.54	90.77	46.15	0.417	1453.8	782.84	913.31	2236.7	521.89	532.54	426.04
	0.8	63.13	85.90	32.53	0.417	1366.3	691.36	806.59	2057.6	460.91	352.74	282.19
	1	61.28	83.26	25.12	0.417	1318.6	643.97	751.30	1962.6	429.31	262.85	210.28
	1.2	60.11	81.59	20.45	0.417	1288.6	615.03	717.53	1903.7	410.02	209.19	167.36
	1.4	59.31	80.45	17.25	0.417	1268.1	595.54	694.79	1863.6	397.03	173.63	138.90
	1.6	58.73	79.61	14.92	0.417	1253.0	581.52	678.44	1834.6	387.68	148.35	118.68
Second example	12	679.90	885.57	391.75	0.417	1042100	676800	789600	1718900	451200	38368	1534.7
	14	646.98	838.55	312.76	0.417	970590	587150	685000	1557700	391430	28530	1141.2
	16	625.11	807.31	260.27	0.417	923110	531100	619620	1454200	354070	22581	903.23
	18	609.53	785.04	222.87	0.417	889270	492880	575020	1382100	328590	18627	745.09
	20	597.86	768.38	194.87	0.417	863930	465190	542730	1329100	310130	15823	632.92

Besides, we also have added **6.2 Managerial Implications from lines 932 to 971** in the latest version as follows:

Based on the above analyses, our paper reveals some managerial implications:

(1) For the government: The government plays a vital role in the emergency medical supply chain during the COVID-19 pandemic situation. How to establish an effective incentive mechanism and encourage enterprises to assume social responsibility is a particularly important issue. From the perspective of the manufacturer, the government should provide different incentives, such as production or cost subsidies and various support policies, alleviating the uncertainty of manufacturing enterprises during the epidemic. compared with no government subsidies, the utility of supply chain members under government subsidies has improved. Therefore, proper government subsidies not only help to maintain the balance of emergency medical supply chain enterprises but also to achieve unified management and save expenses. In terms of coordination models, government subsidy is positively correlated with the level of retailer's CSR implementation β, indicating that the government should focus on raising enterprises' CSR awareness.

(2) For the manufacturer. It is necessary to promote technological innovation level in terms of product quality, production efficiency, and material supply during the COVID-19 pandemic situation. However, because technology investment will increase production costs and decrease the enterprise utility and the enthusiasm for social responsibility. In the process of fulfilling technological innovation to assume CSR, the manufacturer should pay attention to cost and the government needs to subsidize the manufacturer's technological innovation costs to reduce the burden and allow the manufacturer to assume more social responsibilities during the epidemic. Therefore, the manufacturer's technological innovation difficulty coefficient ε should be relatively small to enhance awareness of social responsibility and obtain more profit.

(3) For the retailer: The retailer should enhance the CSR awareness and capability for cost-sharing ω for the manufacturer's technological innovation under the guidance of the government. Although the higher the CSR awareness and capability for cost-sharing ω, the higher the profit of the retailer. However, the level of CSR implementation has a negative impact on government subsidies and directly affects the manufacturer's production investment decision. In addition, when the retailer has a range of cost-sharing capabilities ($0.17 \leq \omega \leq 0.45$) instead of a random range, the retailer will get more profits. Therefore, the retailer should

not only pursue its economic interest but also should undertake some CSR responsibilities by actively cooperating with its supply chain partners, so as to maintain a certain level of supply chain CSR. Meanwhile, from Corollary 5, we can observe that centralized decision-making is the best cooperation state. Therefore, emergency medical supply chain enterprises should balance technological innovation investments and CSR investments rather than blindly invest, and strive to achieve the level of centralized decision-making.

Point 4: In the fourth and fifth parts of your paper you have to mention how your findings relate to previous studies (they are in-line, different or they present a totally new approach).

Response 4: As the reviewer suggested that the fourth and fifth parts need some relations(they are in-line, different or they present a totally new approach), we have added some contents from lines **708 to 721** at the end of the fourth parts:

Finally, we will compare our work with previous studies. Our findings confirm that when the government subsidizes manufacturer's technological innovation effort, the profits of supply chain members and social welfare have increased. When the government's subsidy for the manufacturer's technological innovation effort reach a certain value, the utilities of supply chain members after contract coordination are higher than that of decentralized decision-making and reach the level of centralized decision-making [11]. We also extend this research by considering CSR. Our research also con-firms that appropriate effort of undertaking CSR can increase the profits of supply chain members and social welfare [13]. Besides, our work also confirms that revenue sharing-cost sharing can lead to perfect coordination [55]. However, our work discuss-es the manufacturer's cost-sharing, not the retailer's cost-sharing. In general, we utilize the game model to extend this research in view of government subsidy, CSR, social welfare, and COVID-19 and enrich emergency medical supply chain operation decisions under the pandemic.

Regarding the relation between Table or Figure and Corollary: we have added the relations as follows and the relations are reflected in the corresponding position of the paper as follows:

corollary 3 is supported by the results of Table 3. in line **748**
The results of Table 4 are the same as those in Corollary 2. in line **768**
The results of Table 5 are the same as those in equation (62). in line **780**
The results of Figure 1 are the same as those in Corollary 3. in line **813**
The results of Figure 2 are the same as those in Corollary 3. in line **829**

We appreciate for reviewer's warm work earnestly and hope that the correction will meet with approval. Once again, thank you very much for your comments and suggestions.