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Abstract:
Although the development of e-commerce can expand market for manufacturers, it requires more fairness. With the rising of consumers' awareness, an enterprise who does not concern fairness will loss reputation and customers immediately, especially in e-supply chain system. Based on this great significance, the paper introduces fairness concern into e-supply chain, constructs two dominant models in Stackelberg game and discusses the decision-making processes respectively. Results show that: (1) The profit of network platform increases with the growth of commission, as well as the service level, but the profit of manufacturer decreases. Therefore, manufacturer does not prefer a higher commission when she dominates. (2) In a certain range, the service level and sales price both reach the highest point with a dominant network platform who concerns fairness, at the same time, they have positive correlation with fairness degree. (3) Fairness concern is beneficial for poaching consumers, so dominant enterprises should concern it forwardly even though sacrifice profit.

Keyword:
E-supply chain; Fairness concern; Dominant model

1 Introduction

With the rapid development of e-business, a huge number of traditional manufacturers began to explore a new way for sale, online to offline, obtaining more chances and consumers (Kumar and Ruan 2006). When the manufacturing enterprises sell products through a network platform, a more efficient system forms, e-supply chain (E-SC). Nowadays, more consumers prefer to shop at home, compared with the traditional way. A survey conducted by iResearch pointed out the online market transaction amount reached 5 trillion yuan in China in 2016. Moreover, if platform could be more reliable in providing information, this development tendency is bound to continue. As to network platform, he provides information and service neutrally for both consumers and enterprises who can get more useful information when buying or selling.

From the consumers' perspective, they grow the awareness of self-protection and attach more importance to fairness along with the network technique innovation (Fehr and Schmidt, 1999). Therefore, fairness concern became a crucial factor in supply chain system gradually (Colin et al., 2003). Ruffle (1998) investigated that all the enterprises in supply chain, no matter dominate or dominated, should decide fairly when they cooperate or compete. Especially in E-SC, fairness has much greater influence on network platform. Building trust makes platform more attractive. Based on the similar production and service, consumers are more willing to choose the one who concerns fairness.

The extant researches of E-SC have mainly examined the contribution of e-procurement, challenges of traditional retailer faced when an online channel introduced (Thomas and Rainer, 2005; Liu and Zhang, 2006). One step further, building a proper e-channel has advantages on both manufacturer and retailer (Cattani et al, 2006). Lots of scholars investigated pricing, operating and service strategy in dual-channel, conventional and e-channels (Lu and Liu, 2013). Based on it, a sort of studies aimed at the changes of enterprises' profits when they structured a e-channel, compared single- and dual-channel systems in two-echelon supply chain and helped enterprises to make decisions (Lu and Liu, 2015). The advantages of E-SC management in improving efficiency and profits was indicated by an example, as well as the disadvantages of traditional channel was improved by e-channel (Raul and Raafat, 2015; Kiselicki et al, 2015).

In Stackelberg game model with a monopolistic manufacturer and network platform, the profits of enterprises and supply chain are influenced by dominant modes significantly. In recent decades, this topic was discussed frequently. In traditional supply chain, the popular issues of dominant retailer related to its rights and coordinating mechanism (Draganska et al, 2008; Chen and Zhang, 2011). As to manufacturer, Zhao et al. (2014) focused on the optimal pricing decisions and analyzed effects of competitive strategies under different dominant modes. Then Altug (2016) proved that different revenue sharing contracts could make different costs in the process of executing contracts. When the e-channel is inefficient, manufacturer would loss profit when sell products through a dual-channel, but she can gain more profit form strong retailers when selling online (Lu and Liu, 2015; Wang et al, 2016).
As mentioned before, fairness concern can improve the enterprises' reputations and competitiveness, cementing its place in business management and academic research. The price incentive contract can coordinate the E-SC when retailers are concerned about fairness (Cui et al, 2007). Closer to our models, lots of researches embedded fairness concerns into utility functions, finding that fairness concern may lead to supply chain performance anomalies under wholesale contract (Fei et al, 2016). Furthermore, Choi and Messinger (2016) presented an experimental study to confirm fairness's significant role in competitive supply chain.

However, these researches do not consider E-SC and fairness concern simultaneously, bring the e-channel characteristics into dominant mode and figure out the relationship between manufacturer and network platform. By analyzing how fairness concern interacts with dominant enterprises in E-SC, out model unifies the literatures on E-SC, fairness concern and dominant modes. The main contribution is that figure out the impact of fairness concern on the operation in E-SC with different dominant modes. Section 2 presents the models. Sections 3 and 4 analyze different dominant modes. Section 5 shows the comparison. Section 6 has numerical illustration. Section 7 concludes.

2 Model and assumption

As shown in Fig 1, this E-SC consists of a single manufacturer (she) and a single network platform (he) with a short life cycle of products. There is no retailer. Therefore, the manufacturer not only produces, but also releases the sales information and sells products through the network platform. Meanwhile, she need to pay commission, which is decided by the total amount of production sold through platform and service level provided by him, for network platform to sell the products.

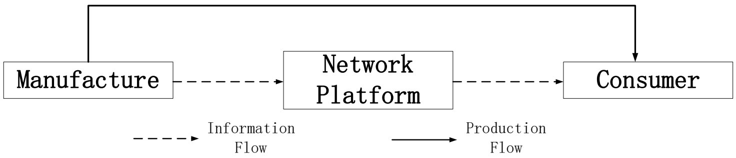

Fig 1: E-SC structure

To simplify the problems and analysis, the following assumptions are made:

(1) Assume manufacturer's margin cost for production and unit sales price are c and p. And s denotes the service level provided by platform. The higher the service-level, the higher the service cost. Simplify the platform's cost function as $C(s) = ks^2/2$. $k(k > 0)$ is an nonnegative elasticity coefficient of service level.

(2) ρ denotes the commission which is charged by platform when he provides service. To simplify the situation, we assume that manufacturer pays commission for the unit sales.

(3) The products are one-period, single and necessary, and the sales price is linearly related to the demand. There is no finished-goods inventory. Market demand of products is q. Also, network platform service-level will affect it. The higher the level, the greater the sales. According to Cai et al. (2009), demand function can be expressed as $q = \alpha - \beta p + rs$. α, β, r respectively indicate market saturation, price's influence coefficient, service-level's influence coefficient. Assuming $0 \le r \le \beta \le \alpha$, meaning that consumers' sensitivity to price is greater than sensitivity to service.

In this E-SC, there are two different kinds dominant modes: one is dominated by the manufacturer and the other is network platform. In order to improve their reputation and ensure coordination in the supply chain, the dominant enterprises will consider the fairness concern. According to whether the dominant enterprises consider the fairness concern, the E-SC presents four decision-making models, as shown in Fig 2.

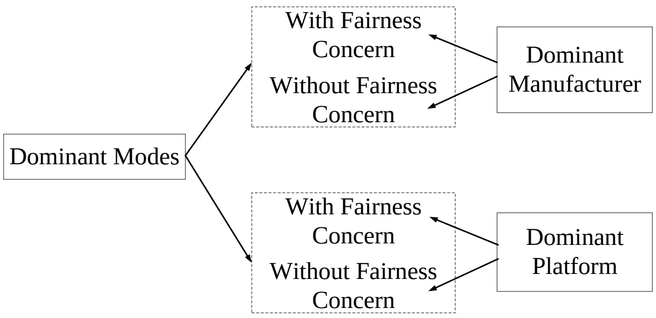

Fig 2: Decision models with different dominant models

3 E-SC dominated by manufacturer

If the manufacturer has the dominant power and become the leader enterprise in the E-SC, she can make decision before the non-dominant enterprises. When she dominates, there are two decision-making modes: one is she does not consider the fairness concern, the other is she does.

3.1 Without fairness concern

When the manufacturer is dominant without the fairness concern, E-SC members make decisions in an order: Manufacturer gives the sales price firstly. Then, the network platform provides the corresponding service-level according to the price. At this time, they constitute the Stackelberg game (Harrison and New, 2002), led by manufacturer and followed by network platform.

Manufacturer, network platform and E-SC's profit function are expressed as

$$\max\ \pi_m = (p-\rho-c)q \tag{1}$$

$$\text{s.t. } \pi_e = \rho q - ks^2/2 \tag{2}$$

$$\pi_s = (p-c)q - ks^2/2 \tag{3}$$

According to the backward induction method, the steps are as follows:

Firstly, according to $\frac{\partial^2 \pi_e}{\partial s^2} = -k < 0$, π_e is a strictly concave function about s. By $\frac{\partial \pi_e}{\partial s} = 0$, the response function of service-level is:

$$s^* = \rho\gamma/k \tag{4}$$

Secondly, taking (4) into π_m, according to $\frac{\partial^2 \pi_m}{\partial p^2} = -2\beta < 0$, π_m is a strictly concave function about p. By $\frac{\partial \pi_m}{\partial p} = 0$, optimal sales price and service-level are as follows:

$$p^{*M} = \frac{\alpha+\beta(c+\rho)}{2\beta} + \frac{\rho\gamma^2}{2\beta k} \tag{5}$$

$$s^{*M} = \frac{\rho\gamma}{k} \tag{6}$$

Lastly, manufacturer and network platform's optimal profit could be expressed as follows:

$$\pi_m^{*M} = \frac{[\rho r^2+\alpha k-\beta k(c+\rho)]^2}{4\beta k^2} \tag{7}$$

$$\pi_e^{*M} = \frac{\rho[\alpha-\beta(c+\rho)]}{2} \tag{8}$$

3.2 With fairness concern

In the E-SC, manufacturers are mainly responsible for providing products. Increasing their reputation is necessary for sustained development. To achieve this aim, she must consider the fairness, even though it will reduce profit. According to Nie and Du (2016), this section utilizes a simplified fairness utility function. Assuming that sensitivity of network platform facing loss and profit is the same, the utility function can be expressed as:

$$\max\ u_m = \pi_m - \lambda(\pi_m - \pi_e) \tag{9}$$

$\lambda(0 \le \lambda < 1)$ is the fairness concern coefficient. The closer it gets to 0, the lower the manufacturer's degree of fairness concern. On the contrary, the closer it gets to 1, the higher the degree. In reality, the fairness concern's degree is almost less than $0.5(\lambda < 0.5)$.

When the manufacturer dominates with fairness concern, E-SC members make decisions in an order: Manufacturer gives the sales price firstly. Then, network platform provides the corresponding service-level. At this time, they constitute the Stackelberg game, led by manufacturer who concerns fairness and followed by network platform.

According to the backward induction method, the steps are the same as section 3.1:
Firstly, the response function of service-level is:

$$s^* = \rho r/k \tag{10}$$

Secondly, taking (10) into u_m, according to $\frac{\partial^2 u_m}{\partial p^2} = -2\beta(1-\lambda) < 0$, u_m is a strictly concave function about p. By $\frac{\partial u_m}{\partial p} = 0$, optimal sales price and service-level are as follows:

$$p^{*\lambda M} = \frac{k(\alpha+c\beta)(1-\lambda)+\rho r^2(1-\lambda)+k\beta\rho(1-2\lambda)}{2k\beta(1-\lambda)} \tag{11}$$

$$s^{*\lambda M} = \frac{\rho r}{k} \tag{12}$$

Lastly, manufacturer and network platform's optimal profit could be expressed as follows:

$$\pi_m^{*\lambda M} = \frac{r^4(1-\lambda)^2\rho^2+2k\rho r^2(1-\lambda)^2[\alpha-\beta(c+\rho)]+k^2[\alpha(1-\lambda)-\beta(c-c\lambda+\rho-2\lambda\rho)]^2}{4k^2\beta(1-\lambda)} \tag{13}$$

$$\pi_e^{*\lambda M} = \frac{\rho[\alpha(1-\lambda)-\beta(c-c\lambda+\rho-2\lambda\rho)]}{2(1-\lambda)} \tag{14}$$

4 E-SC dominated by network platform

In the E-SC, if the network platform's strength is greater than manufacturer's, the network platform will get the dominant power and become the dominant enterprise. When he is dominant, there also are two decision-making modes: one is that the network platform does not consider the fairness concern and the other is he does.

4.1. Without fairness concern

When the network platform dominates without fairness concern, members in the E-SC make decisions in an order: Network platform provides the service-level first. Then, the manufacturer gives the corresponding sales price according to the service level. At this time, they constitute the Stackelberg game, led by the network platform and followed by the manufacturer.

According to the backward induction method, the steps are as follows:
Firstly, according to $\frac{\partial^2 \pi_m}{\partial p^2} = -2\beta < 0$, π_m is a strictly concave function. By $\frac{\partial \pi_m}{\partial p} = 0$, so the response function of sales price is:

$$p^* = \frac{\alpha+rs+\beta(c+\rho)}{2\beta} \tag{15}$$

Secondly, taking (15) into π_e, according to $\frac{\partial^2 \pi_e}{\partial s^2} = -k < 0$, π_e is a strictly concave function. By $\frac{\partial \pi_e}{\partial s} = 0$, optimal service-level is as follows:

$$s^{*E} = \frac{\rho r}{2k} \tag{16}$$

Thirdly, optimal sales price can be expressed as follow:

$$p^{*E} = \frac{\rho r^2+2k[\alpha+\beta(c+\rho)]}{4k\beta} \tag{17}$$

Lastly, manufacturer and network platform's optimal profit could be expressed as follows:

$$\pi_m^{*E} = \frac{\{\rho r^2+2k[\alpha-\beta(c+\rho)]\}^2}{16\beta k^2} \tag{18}$$

$$\pi_e^{*E} = \frac{\rho\{\rho r^2+4k[\alpha-\beta(c+\rho)]\}}{8k} \tag{19}$$

4.2. With fairness concern

The network platform in an E-SC is mainly responsible for providing information. In order to increase consumers' trust, he should consider fairness. Therefore, the network platform is willing to give up some profits for forming a fairness effect. In order to simplify the calculation and according to the literature in Nie and Du (2016), this paper assumes the sensitivity of a network platform facing loss and profit is the same, the utility function can be expressed as:

$$\max\ u_e = \pi_e - \lambda(\pi_e - \pi_m) \tag{20}$$

When the network platform is dominant with the fairness concern, the order the E-SC members make decisions is the same as section 4.1. At this time, manufacturer and network platform constitute the Stackelberg game, led by network platform who concerns fairness and followed by manufacturer.

According to the backward induction method:
Firstly, according to section 4.1, the response function of sales price is:

$$p^* = \frac{\alpha+rs+\beta(c+\rho)}{2\beta} \tag{21}$$

Secondly, taking (21) into u_e, according to $\frac{\partial^2 u_e}{\partial s^2} = -k(1-\lambda) < 0$, u_e is a strictly concave function. By $\frac{\partial u_e}{\partial s} = 0$, optimal service-level is as follow:

$$s^{*\lambda E} = \frac{r\{\alpha\lambda-\beta[c\lambda-\rho(1-2\lambda)]\}}{2k\beta(1-\lambda)-\lambda r^2} \tag{22}$$

Thirdly, optimal sales price can be expressed as follow:

$$p^{*\lambda E} = \frac{r^2[2c\lambda-(1-3\lambda)\rho]-2k(1-\lambda)[\alpha+\beta(c+\rho)]}{2\lambda r^2-4k\beta(1-\lambda)} \tag{23}$$

Lastly, manufacturer and network platform's optimal profit could be expressed as follows:

$$\pi_m^{*\lambda E} = \frac{\beta(1-\lambda)^2\{r^2\rho+2k[\alpha-\beta(c+\rho)]\}^2}{4[2k\beta(1-\lambda)-r^2\lambda]^2} \tag{24}$$

$$\pi_e^{*\lambda E} = \frac{(1-\lambda)\{r^2\beta(1-\lambda)\rho^2+2k[\alpha-\beta(c+\rho)][\alpha\lambda-\beta(c\lambda-2\rho+3\lambda\rho)]\}}{4r^2\lambda-8k\beta(1-\lambda)} \tag{25}$$

5 Comparison in models

Comparing the different dominant models, several conclusions are reached:
Property 1 The service level s and sales price p are related to commission's change. The regularities are as follows (Proof in Appendix 1):

(1) $s^{*\lambda E} > s^{*M} = s^{*\lambda M} > s^{*E}$; $\frac{\partial s^{*\lambda E}}{\partial \rho}, \frac{\partial s^{*M}}{\partial \rho}, \frac{\partial s^{*\lambda M}}{\partial \rho}, \frac{\partial s^{*E}}{\partial \rho} > 0$;
(2) $p^{*\lambda E} > p^{*M} > p^{*E} > p^{*\lambda M}$; $\frac{\partial p^{*\lambda E}}{\partial \rho}, \frac{\partial p^{*M}}{\partial \rho}, \frac{\partial p^{*\lambda M}}{\partial \rho}, \frac{\partial p^{*E}}{\partial \rho} > 0$.

According to property 1, there are three conclusions:
(1) The network platform's service level reached the highest point when the network platform was dominant with fairness concern, but the lowest point when she was dominant without fairness concern. The reason is that when the network platform dominated in the supply chain, providing service was the main cost and it would be reduced forwardly. However, when the network platform was required to consider fairness, it would improve the service level in order to increase product sales.
(2) The sales price reached the highest point when the network platform was dominant with fairness concern, but the lowest point when he was dominant with fairness concern. When the

dominant enterprise did not concern fairness, the sales price with dominant manufacturer was higher than dominant network platform. Without the fairness concern, the manufacturer would increase the price to improve revenue, but a fairness concern could change this situation. A network platform with fairness concern would raise its service level, which could make the price rise. A manufacturer with fairness concern would reduce the price, which could make fairness in the supply chain system.

(3) No matter who dominates in the E-SC, the network platform's service level and sales price both increased with the growth of commission. The direct revenue of network platform was commission, so it was proportional to the service level. The more commission the manufacturer paid, the better service it obtained. However, the commission that the manufacturer paid to the network platform was one of its costs. The increase in commission would directly increase the manufacturer's cost, so it would make the manufacturer raise its price to maintain the balance, ensuring profit did not decline.

Property 2 The profits of manufacturer and network platform, π_m and π_e, are related to the commission's change. The regularities are as follows (Proof in Appendix 2):

(1) $\pi_m^{*M} > \pi_m^{*E}; \pi_m^{*\lambda E} > \pi_m^{*\lambda M}; \pi_m^{*M} > \pi_m^{*\lambda M}; \pi_m^{*\lambda E} > \pi_m^{*E};\ \frac{\partial \pi_m^{*M}}{\partial \rho}, \frac{\partial \pi_m^{*\lambda M}}{\partial \rho}, \frac{\partial \pi_m^{*E}}{\partial \rho}, \frac{\partial \pi_m^{*\lambda E}}{\partial \rho} < 0;$

(2) $\pi_e^{*E} > \pi_e^{*M}; \pi_e^{*\lambda M} > \pi_e^{*\lambda E}; \pi_e^{*\lambda M} > \pi_e^{*M}; \pi_e^{*E} > \pi_e^{*\lambda E};\ \frac{\partial \pi_e^{*M}}{\partial \rho}, \frac{\partial \pi_e^{*\lambda M}}{\partial \rho}, \frac{\partial \pi_e^{*E}}{\partial \rho}, \frac{\partial \pi_e^{*\lambda E}}{\partial \rho} > 0.$

As for the profits of the manufacturer and network platform, two conclusions can be reached:

(1) Without the fairness concern, the dominant enterprise would gain more profit in the supply chain system. However, this situation could change with fairness concern. The dominant enterprise would sacrifice profits to achieve the fairness concern, showing less profit than the non-dominant enterprise. This is because the enterprise with more power was required to consider fairness firstly by the government, consumers or third-party regulator. In order to meet this requirement, the dominant enterprise would reduce profit to achieve the objective. At the same time, consumers' stickiness could rise with the increasing degree of fairness concern, laying a solid foundation on long-term profit growth for the whole supply chain system.

(2) The profit of manufacturer decreased with the growth of commission, while the profit of network platform increased. Actually, commission was one of the manufacturer's costs, as well as the only revenue of network platform. The change of commission could significantly affect their profits.

Property 3 The service level s and sales price p are related to the change of fairness concern's degree. The regularities are as follows (Proof in Appendix 3):

(1) $s^{*M} = s^{*\lambda M} > s^{*E}; s^{*\lambda E} > s^{*E}$; when $\lambda < \lambda_1$, $s^{*\lambda E} < s^{*M}$; when $\lambda > \lambda_1$, $s^{*\lambda E} > s^{*M}$; ($\lambda_1 = \frac{\beta k \rho}{\alpha k + \rho r^2 - \beta c k}$);

(2) $\frac{\partial s^{*\lambda E}}{\partial \lambda} > 0$; $\frac{\partial p^{*\lambda M}}{\partial \lambda} < 0$; $\frac{\partial p^{*\lambda E}}{\partial \lambda} > 0$.

According to property 3, there are two conclusions:

(1) With the dominant manufacturer, the network platform's service level did not change with the fairness concern's degree. With the dominant network platform, however, it improved with

the increase in the degree of fairness concern. When the dominant party considered fairness, the sales price was impacted by manufacturer, and service level was impacted by network platform. The higher the fairness concern's degree, the greater effort paid by network platform, leading to a higher service level.
(2) When the network platform was dominant with fairness concern, the sales price would increase with the growth of fairness degree, since that network platform would improve the service level firstly upon considering fairness. As a result, it increased the network platform's cost, making the network platform require a higher commission and lead sales price increase. When the manufacturer was dominant with a fairness concern, growth of the fairness concern's degree would make the price decline. In order to achieve fairness, the manufacturer would sacrifice profit in order to keep the consumers.

Property 4 The profits of manufacturer and network platform, π_m and π_e , are related to the change of fairness concern's degree, the regularities are as follows (Proof in Appendix 4):

(1) $\pi_m^{*M} > \pi_m^{*E}; \pi_m^{*\lambda E} > \pi_m^{*\lambda M}; \pi_m^{*M} > \pi_m^{*\lambda M}; \pi_m^{*\lambda E} > \pi_m^{*E};$
(2) $\frac{\partial \pi_m^{*\lambda M}}{\partial \lambda} < 0;\ \frac{\partial \pi_m^{*\lambda E}}{\partial \lambda} > 0;$
(3) $\pi_e^{*E} > \pi_e^{*M}; \pi_e^{*\lambda M} > \pi_e^{*\lambda E}; \pi_e^{*\lambda M} > \pi_e^{*M}; \pi_e^{*E} > \pi_e^{*\lambda E};$
(4) $\frac{\partial \pi_e^{*\lambda E}}{\partial \lambda} < 0;\ \frac{\partial \pi_e^{*\lambda M}}{\partial \lambda} > 0.$

Regarding the profits of manufacturer and network platform, two conclusions can be obtained:
(1) Manufacturer's profit increased with the growth of fairness concern's degree when network platform dominated, but decreased when the manufacturer dominated. Furthermore, the manufacturer's profit with dominant manufacturer was higher than dominant network platform without fairness concern. On the other hand, when the dominant enterprise started considering fairness, this situation would change. Manufacturer's profit with dominant manufacturer was lower than dominant network platform. In reality, the network platform would sacrifice her profit to achieve fairness concern when she dominated, increasing the manufacturer's profit and the whole supply chain system's. The situation was opposite when the manufacturer dominated, because that fairness concern could increase the supply chain's profit and decrease the dominant enterprise's, thus leading to the non-dominant enterprise getting more profit.
(2) Network platform's profit increased with the growth of fairness concern's degree when the manufacturer dominated, but decreased when the network platform dominated. Without a fairness concern, the network platform could gain more profit when it was dominant in the supply chain. After considering a fairness concern, the network platform could gain more profit when the manufacturer was dominant. This is because the fairness concern could make the dominant party be willing to give up its own profit for fairness. The higher the fairness concern's degree was, the more profit the dominant enterprise gave. After considering fairness, consumers' purchase intentions would enhance and product sales would increase. As a result, the entire supply chain system's profit would increase and the non-dominant enterprise's profit would also increase.

6 Numerical illustrations

In order to prove the correctness of the conclusions, we utilized numerical illustrations for our results analysis. Assume that $\alpha = 100, \beta = 3, r = 1, k = 1, c = 10, \lambda = 0.3$and let ρ be the independent variable. The commission is uniformly distributed between [2,4]. The change rule of service-level, sales price, profits of manufacturer and profits of network platform with ρ's change are shown in Fig 3.

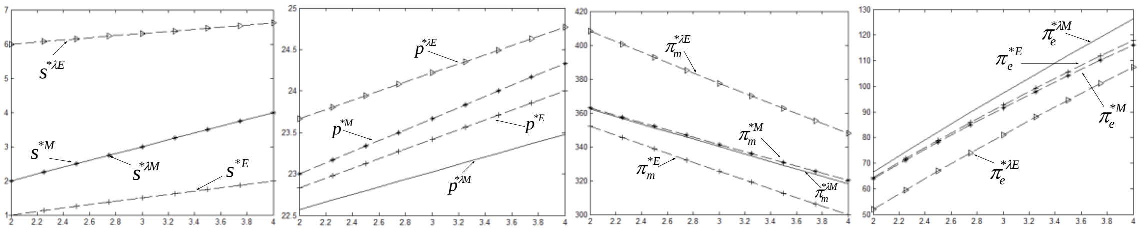

Fig 3: Change rule of service-level, sales price, and profits of manufacturer and platform

As shown in Fig 3, three conclusions can be obtained:

(1) No matter which enterprise was dominant, the service level, the sales price and the network platform's profit would increase with the growth of commission, while the manufacturer's profit would decrease.

(2) Network platform's service level became the highest when she was dominant with fairness concern, and lowest without a fairness concern. When the manufacturer was dominant, the network platform's profit did not change with a fairness concern. On the other hand, the sales price reached highest when the network platform dominated with a fairness concern and lowest when the manufacturer dominated with a fairness concern.

(3) Without a fairness concern, the dominant enterprise in supply chain could gain more profit. However, after considering fairness, the dominant party showed lower profit. This is because the enterprises with more power would sacrifice their own profit to achieve fairness.

Assume that $\rho = 3$ and let λ be the independent variable. The fairness concern coefficient is uniformly distributed between [0,0.5]. The change rule of service-level, sales price, profits of manufacturer and profits of network platform with λ's change are shown as Fig 4.

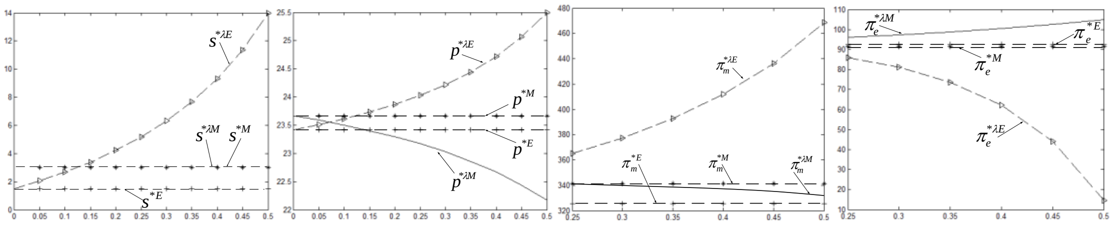

Fig 4: Change rule of service-level, sales price and profits of manufacturer and platform

As shown in Fig 4, two conclusions can be obtained:

(1) When the network platform dominated with a fairness concern, the service level improved with the growth of fairness concern's degree. In other models, however, it was irrelevant to fairness concern. As for the sales price, when the network platform dominated with fairness concern, it increased with the growth of fairness concern's degree. When the manufacturer dominated with fairness concern, it decreased with the growth of fairness concern's degree.

(2) Regarding the manufacturer's and network platform's profits, they both changed with the fairness concern's degree. Manufacturer's profit increased and network platform's decreased with the growth of fairness concern's degree when the network platform dominated.

Manufacturer's profit decreased and network platform's increased with the growth of fairness concern's degree when the manufacturer dominated. Furthermore, the fairness concern would decrease the dominant enterprise's profit.

7 Conclusion

This article aimed at an E-SC consisting of one manufacturer and one network platform, researching on two dominant models and discussing the decision-making process with or without fairness concern. The conclusions are as follows:

(1) As for consumers, if they want a higher service-level, they must pay more. Meanwhile, sales price, service-level and profit of network platform increase with the growth of commission. On the contrary, the manufacturer's profit decreases and dominant manufacturer will not increase commission forwardly.
(2) When the variables are within a certain range, service-level and sales price are both highest with the dominant network platform that concerns fairness. Furthermore, these two decision variables increase with the enhancement of fairness's degree when the network platform is dominant.
(3) Fairness concern is an important factor in enhancing consumer stickiness, so the dominant enterprises will sacrifice their profit for considering fairness. On the other hand, both manufacturer and network platform are not willing to consider this factor when they are dominant.
In exploring the E-SC, a number of issues remain for further study. These include how the E-SC coordinates and reaches its best state under different dominant models. Coordination and pricing have a significant impact on E-SC operations. With future research focused on these fields, such studies will help enterprises make better decisions.

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Appendix 1

By assume that $\rho > \lambda k,\ \beta k > r^2, \alpha > \beta(\rho + c), \lambda < 0.5$.

1. $s^{*\lambda E} - s^{*M} = \frac{r[\alpha\lambda k + \lambda\rho r^2 - \beta k(\lambda c + \rho)]}{k[2\beta k(1-\lambda) - \lambda r^2]} > 0$, $s^{*\lambda M} - s^{*E} = \frac{\rho r}{2k} > 0$, $\frac{\partial s^{*E}}{\partial \rho} = \frac{r}{2k} > 0$, $\frac{\partial s^{*\lambda M}}{\partial \rho} =$

$\frac{\partial s^{*\lambda M}}{\partial \rho} = \frac{r}{k} > 0, \frac{\partial s^{*\lambda E}}{\partial \rho} = \frac{\beta r(1-2\lambda)}{2\beta k(1-\lambda)-\lambda r^2} > 0.$

2. $p^{*\lambda E} - p^{*M} = \frac{r^2[\alpha\lambda k+\lambda\rho r^2-\beta k(\lambda c+\rho)]}{2\beta k[2\beta k(1-\lambda)-\lambda r^2]} > 0$, $p^{*M} - p^{*E} = \frac{\rho r^2}{4\beta k} > 0$, $p^{*E} - p^{*\lambda M} = \frac{\rho[2\lambda\beta k-r^2(1-\lambda)]}{4\beta k(1-\lambda)} > 0$, $\frac{\partial p^{*M}}{\partial \rho} = \frac{r^2}{2\beta k} + \frac{1}{2} > 0$, $\frac{\partial p^{*\lambda M}}{\partial \rho} = \frac{r^2}{2\beta k} + \frac{1-2\lambda}{2(1-\lambda)} > 0$, $\frac{\partial p^{*E}}{\partial \rho} = \frac{r^2}{4\beta k} + \frac{1}{2} > 0, \frac{\partial p^{*\lambda E}}{\partial \rho} = \frac{2\beta k(1-\lambda)+r^2(1-3\lambda)}{2[2\beta k(1-\lambda)-\lambda r^2]} > 0.$

Appendix 2

1. $\pi_m^{*M} - \pi_m^{*E} = \frac{\rho r^2[4\alpha k+3\rho r^2-4\beta k(c+\rho)]}{16\beta k^2} > 0$, $\pi_m^{*M} - \pi_m^{*\lambda M} = \frac{\beta\lambda^2\rho^2}{4(1-\lambda)^2} > 0$, $\pi_m^{*\lambda E} - \pi_m^{*E} = \frac{\lambda r^2[4\beta k(1-\lambda)-\lambda r^2][2\alpha k+\rho r^2-2\beta k(c+\rho)]^2}{16\beta k^2[2\beta k(1-\lambda)-\lambda r^2]^2} > 0$, $\pi_m^{*\lambda E} - \pi_m^{*\lambda M} = \beta\left[\frac{\alpha k+\rho r^2}{2\beta k} + \frac{\lambda\rho}{2(1-\lambda)} - \frac{c+\rho}{2}\right]^2 + \frac{\beta(1-\lambda)^2[2\alpha k+\rho r^2-2\beta k(c+\rho)]^2}{4[2\beta k(1-\lambda)-\lambda r^2]^2} > 0$, $\frac{\partial \pi_m^{*M}}{\partial \rho} = -\frac{(\beta k-r^2)[\alpha k+\rho r^2-\beta k(c+\rho)]}{2\beta k^2} < 0$, $\frac{\partial \pi_m^{*E}}{\partial \rho} = -\frac{(2\beta k-r^2)[2\alpha k+\rho r^2-2\beta k(c+\rho)]}{8\beta k^2} < 0$, $\frac{\partial \pi_m^{*\lambda E}}{\partial \rho} = -\frac{\beta(1-\lambda)^2(2\beta k-r^2)[2\alpha k+\rho r^2-2\beta k(c+\rho)]}{2[2\beta k(1-\lambda)-\lambda r^2]^2} < 0$, $\frac{\partial \pi_m^{*\lambda M}}{\partial \rho} = -\frac{[\beta k(1-2\lambda)+r^2(1-\lambda)][\alpha k(1-\lambda)+\rho r^2(1-\lambda)-\beta k(c+\rho-\lambda c)]}{4\beta k^2(1-\lambda)^2} - \frac{\beta k-r^2(1-\lambda)}{2\beta k(1-\lambda)}[\frac{\alpha k+\rho r^2}{2k} + \frac{\lambda\beta\rho}{2(1-\lambda)} - \frac{\beta(c+\rho)}{2}] < 0.$

2. $\pi_e^{*E} - \pi_e^{*M} = \frac{\lambda^2\rho^2}{8k}, \pi_e^{*\lambda M} - \pi_e^{*M} = \frac{\lambda\beta\rho^2}{2(1-\lambda)}, \pi_e^{*E} - \pi_e^{*\lambda E} = \frac{\lambda^2 r^2[2\alpha k+\rho r^2-2\beta k(c+\rho)]^2}{8k[2\beta k(1-\lambda)-\lambda r^2]^2}$, $\pi_e^{*\lambda M} - \pi_e^{*\lambda E} = \frac{kr^2[\lambda\alpha+\beta\rho-\lambda\beta(c+2\rho)]^2}{2[2\beta k(1-\lambda)-\lambda r^2]^2} + \frac{\rho[\alpha(1-\lambda)-\beta(c+\rho)+\lambda\beta(c+2\rho)]}{2(1-\lambda)} + \frac{\beta\rho(1-\lambda)[2\alpha k+\rho r^2-2\beta k(c+\rho)]}{2[2\beta k(1-\lambda)-\lambda r^2]} > 0$, $\frac{\partial \pi_e^{*M}}{\partial \rho} = \frac{\alpha-\beta(c+2\rho)}{2} > 0, \frac{\partial \pi_e^{*E}}{\partial \rho} = \frac{\rho r^2+2\alpha k-2\beta k(c+2\rho)}{4k} > 0, \frac{\partial \pi_e^{*\lambda E}}{\partial \rho} = \frac{\alpha(1-\lambda)-\beta(c+\rho)+\lambda\beta(c+4\rho)}{2(1-\lambda)} > 0.$

Appendix 3

1. $s^{*M} = s^{*\lambda M} = \frac{\rho r}{k}$, when $s^{*\lambda E} - s^{*M} = 0$, $\lambda_1 = \frac{\beta k\rho}{\alpha k+\rho r^2-\beta ck}$.
2. $\frac{\partial s^{*\lambda E}}{\partial \lambda} = \frac{\beta r[2\alpha k+\rho r^2-2\beta k(c+\rho)]}{[2\beta k(1-\lambda)-\lambda r^2]^2} > 0.$
3. $\frac{\partial p^{*\lambda M}}{\partial \lambda} = -\frac{\rho}{2(1-\lambda)^2} < 0, \frac{\partial p^{*\lambda E}}{\partial \lambda} = \frac{r^2[2\alpha k+\rho r^2-2\beta k(c+\rho)]}{2[2\beta k(1-\lambda)-\lambda r^2]^2} > 0.$

Appendix 4

1. $\frac{\partial \pi_m^{*\lambda M}}{\partial \lambda} = -\frac{\lambda\beta\rho^2}{2(1-\lambda)^3} < 0, \frac{\partial \pi_m^{*\lambda E}}{\partial \lambda} = \frac{\beta r^2(1-\lambda)[2\alpha k+\rho r^2-2\beta k(c+\rho)]^2}{2[2\beta k(1-\lambda)-\lambda r^2]^3} > 0.$
2. $\frac{\partial \pi_e^{*\lambda E}}{\partial \lambda} = -\frac{\lambda\beta r^2[2\alpha k+\rho r^2-2\beta k(c+\rho)]^2}{2[2\beta k(1-\lambda)-\lambda r^2]^3} < 0, \frac{\partial \pi_e^{*\lambda M}}{\partial \lambda} = \frac{\beta\rho^2}{2(1-\lambda)^2} > 0.$