**1. 논문제목 (국문 혹은 영문)**

**(국문) 닫힌 공급망에서의 친환경 최적 광고모형 연구**

**(영문) Optimal green advertising incentive model in a closed loop supply chain**

**2. 분야 : 생산계량**

**3. 저자명 및 소속(국문/영문) :**

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**Optimal green advertising incentive model in a closed loop supply chain**

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**Abstract** This research investigates green advertising incentive strategies in a dynamic dual-channel closed-loop supply chain (CLSC) where a manufacturer as a leader directing both traditional retailer channel and e-retail (online) channel. We built three different green advertising incentive models: a non co-op green advertising incentive model (NGA-Model); a unilateral co-op green advertising incentive model (CGA-Model); and, a bilateral co-op green advertising incentive model (BGA-Model). The results show that the BGA-Model is the best than the other two green advertising incentive strategies in CLSC system.

**Keywords**: closed-loop supply chain · green advertising · incentive mechanisms · equilibrium · remanufacturer

# **1. Introduction**

As the rapid development of online technology, a large number of manufacturers (or suppliers) such as IBM. P&G and HP are involved to introduced direct e-tail (online) orders to redesign their supply chain channels (Chiang *et al.* 2003; Yan *et al .*2016; Gao and Su, 2017). Meanwhile, with the environmental degradation and resource shortage, more and more enterprises recognize the importance of sustainable development. The companies such as Ford and IBM through reverse logistics remanufacturing of used products in the closed-loop supply chain (CLSC) to save raw material, effectively allocate existing resources, material recycling and ultimately achieve the goals of profit maximization and sustainable development. (Guide *et al.* 2003).

There are two streams about the advertising incentive mechanisms, static game framework, and dynamic game framework. We built three different dynamic green advertising incentive strategies: a non co-op green advertising model (NGA-Model) where both of the players invest in green advertising, separately; a co-op green advertising model (CGA-Model) where the manufacturer supports part of the retailer’s green advertising cost incentive it to increase its green advertising investments; and, a bilateral co-op green advertising model (BGA-Model) where the manufacturer and retailer support part of each other’s green advertising costs incentive each other to increase their green advertising investments. Our purpose is to investigate which green advertising coordination incentive mechanisms is the most effective for the success of a CLSC.

The reminder of this paper is as follows. Section 2 develops the green advertising incentive models. Section 3 characterizes three green advertising feedback equilibrium scenarios in CLSC system. Numerical analysis of green advertising incentive strategies are reported in section 4. Conclusions and suggests future research are summarized in section 5.

# **2. Model**

Let consider a green advertising coordination incentive mechanisms of CLSC can be illustrated as in Fig. 1.

Consumers’ return

Customers

Manufacturer

Traditional retailer

Forward logistics Reverse logistics Green incentive

Fig. 1. The dual-channel CLSC distribution diagram.

The green advertising strategies contribute to the build-up of dynamic return rate, the dynamic return rate can be modeled as follow:

The demands at any instant of time can be extended as follows:

)

The green advertising costs are assumed to have convex and increasing functions as:

The manufacturer’s objective function in an infinite-time horizon CLSC system can be extended as:

And the retailer’s objective function is:

**3. Equilibria**

**Proposition 1.** Under NAR-Model, feedback Equilibrium price strategies, and green advertising decisions are given by:

Where the parameters are the coefficients of the value function.

The dynamic return rate under noon co-op green advertising incentive strategy CLSC system as follow:

**Proposition 2.** Under CGA-Model, the feedback Equilibrium price strategies, and green advertising decisions are given by:

Where the parameters , are the coefficients of the value function.

The accumulation of consumer dynamic return rate under unilateral co-op green advertising incentive strategy CLSC system as follow:

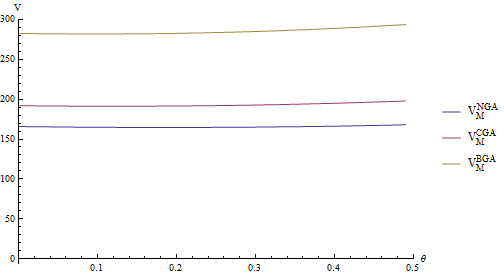
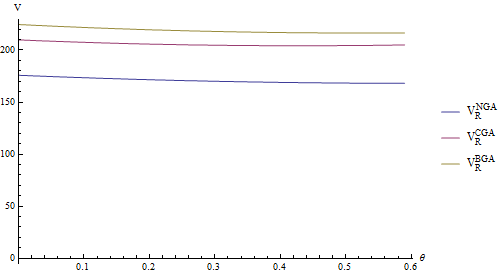
**Proposition 3.** Under BGA-Model, the feedback Equilibrium price strategies, and green advertising decisions are given by:

Where the parameters , are the coefficients of the value function.

The accumulation of consumer dynamic return rate under bilateral co-op green advertising incentive strategy CLSC system as follow:

# **4. Numerical analysis**

In order to get the numerical results, all of the parameters are assumed to be exogenous, according to the previous researches (e.g. De Giovanni 2014,2018, Giri *et al.* 2017,Song *et al.* 2017), the parameters are considered as follows:



(a) (b)

Figure 2. Relationship between each players’ profits and market-sharing parameter θ

As the market-sharing parameter increases, which means the customers are more prefer shopping online, therefore, the retailer’s profit decrease as his market sharing decrease (Fig.2(b)), the manufacturer’s profit increase due to his demand increase (Fig.2(a)).

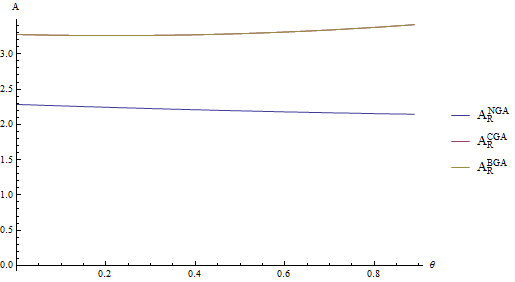


Figure 3. Relationship between retailer’s green advertising incentive and market-sharing parameter θ

Fig.3 depicts that as the market-sharing parameter increases, the retailer would reduce his green advertising invest under the non co-op green advertising incentive strategy. However, the co-op green advertising incentive strategies have a positive effect on the retailer’s invest of green advertising. On the other hand, unilateral co-op green advertising incentive strategy and bilateral co-op green advertising incentive strategy, they all have the same effect on retailer’s green advertising investment.

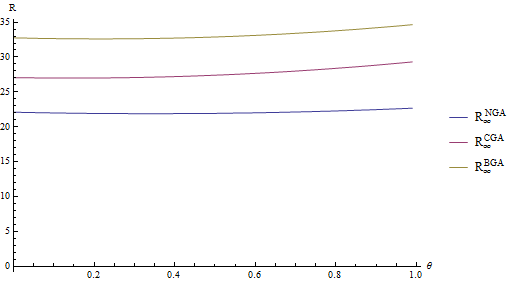


Figure 4. Relationship between return rate and market-sharing parameter θ

Figure 4 depicts that, among three green advertising incentive strategies, as the market-sharing parameter increases, the CLSC system has the highest return rate under bilateral co-op green advertising incentive strategy.

# **5. Conclusions**

In our research, our main results can be summarized as follows:

1. Among these three green advertising incentive strategy scenarios, the optimal price strategies are state-dependent. In contrast, the green advertising decisions are state-independent;
2. In the newly added online multi-channel situation, the green advertising incentive strategies have a positive effect of achieving the goals of profit maximization and sustainable development, and ultimately leading to an improved Pareto improving;
3. The outcomes for the manufacturer and retailer are always better under the bilateral co-op green advertising incentive model.

Future research of this note can be extended in several directions such as service decisions and information sharing. Second, it should be much more interesting to use different types of contracts such as revenue sharing contract and pay back contract in our model. Third, we assume there is no difference between manufactured and remanufactured products, however, the remanufactured products could not as good as the new one, therefore, it should be considered in the future research.

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