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Game theory application in government's guide on the implementation of enterprises recovery reverse logistics

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Abstract: In order to pursue the operation objective of biggest profit, the enterprise is not willing to pay the cost for the implementation recovery reverse logistics. The government as the macroeconomic regulation and control department is necessary to guide it. Using the game theory, this article analyzes the government and the enterprise about the implementation of recovery reverse logistics, and proposes the most superior strategy of the government guiding on the implementation of enterprise recovery reverse logistics.

Keywords: Strategy, Game Theory, Recovery Reverse Logistics

1. Introduction

With the rapid development of economy, enterprise logistics activities produce a large number of industry wastes, which caused global warming, greenhouse effect and environment pollution. However, every enterprise all pursues the operation objective of biggest profit. Whether enterprises can implement recovery reverse logistics actively depends on government's attitude (Stock, 1992; Jia, 2005; Wu & Liu, 2005). Chinese Government is now caring more and more about the implementation of recovery reverse logistics. As we all know that production is like people's arteries, recovery is like people's vein, which is difficult to drive relying on interest. Therefore, we need for government's environment protection policy, tax policy, as well as a series of co-operation mechanisms punishment.

2. Government and enterprises' role in the implementation of recovery reverse logistics

Wherever recovery Reverse Logistics will take waste materials held by the ultimate customers to each node in the supply chain. It includes five kinds of material flow: Direct re-sold product flow (recovery → test → distribution), re-processing product flow (recovery → test → reprocessing), components processing flow (recovery →test →split → reprocessing), scrapping product flow (recovery → test → treatment), end-of-life components and parts flow (recovery →test →split → treatment). Government and enterprises play different role in implementation of recovery reverse logistics. So they have different point of view on recovery reverse logistics (Kopicky, Berg, & Legg, 1993).

Enterprises implementing the recovery reverse logistics will improve their resource utilization, enhance corporate image and win the trust and support from consumers, which will promote their sustainable development so as to obtain long-term profits (Tan, 2006; Dormer, Cleary, & Dunstall, 2011).

However, enterprises must pay some cost. After comparison with benefits and costs, enterprises will have a final decision on whether to implement the recovery reverse logistics.

Government, as the macroeconomic regulation and control department, has the responsibility to maintain society stability and promote sustainable economic development and improve people's quality of life (Wang**,** 2004; Wang, 2002). These responsibilities promote government to be involved in recovery reverse logistics in order to achieve rational use of resources, protect for ecology and environment.

3. Game analysis on governments and enterprises in the implementation of recovery reverse logistics

3.1. Model Assumptions

In this paper, we assume that government and enterprises are risk-neutral. On one hand, government firstly sets a recovery reverse logistics standard G , which is a standard vector including enterprises' ability of renewable resources, waste disposing capacity and the ability of Environment Protection. On the other hand, enterprises decide whether achieve the standards set by Government in the implementation of recovery reverse logistics.

The extent of Enterprises implanting recovery reverse logistics is T , which is variable. In general, there is inequality $T \le G$, the cost that enterprises needed in the implementation of recovery reverse logistics is $C_1 = C_1(T)$, at the same time, there is $\frac{\partial C_1}{\partial T} > 0$. The enterprise benefits from recovery reverse logistics is R , so there is $R = R(T)$,at the same time $\frac{\partial R}{\partial T} > 0$, which means the more actively enterprises implement recovery reverse logistics, the more benefits they will obtain.

If enterprises implement recovery reverse logistics without achieving the standard, there will be some side effect. The cost government burdened is C_3 , $C_3 = C_3(T)$ and $\frac{\partial C_3}{\partial T} < 0$, which means that the more actively enterprises implement recovery reverse logistics, the less cost government burdened is.

When enterprises achieve the standard set by government, that is $T = G$, at this time, private costs and social costs are equal, we have $C_3(T) = 0$.

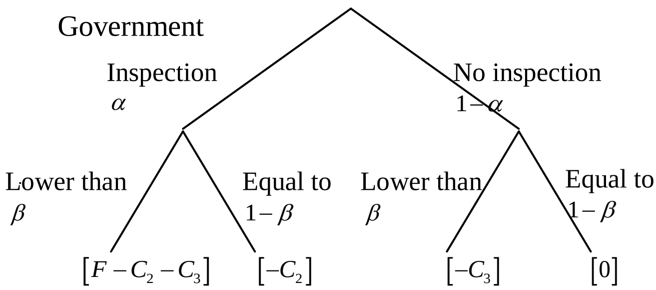
3.2. Model Analysis

Government hopes that enterprises will achieve the standard. The probability of government’s inspection to enterprises is α , the cost of its inspection is C_2 . When government finds $T < G$, it will take the punishment. Penalty function is as follows,

$$F = F(G-T) \quad \frac{\partial F}{\partial (G-T)} > 0$$

When $T = G$, there is $F(0) = 0$.

The probability of enterprises not achieving the standard in the implementation of recovery reverse logistics is β .Based on the above assumptions, the game process between government and enterprises are shown below,



We can obtain enterprises' biggest profits is as follows,

$$A=\alpha\beta\left[R(T)-F-C_1(T)\right]+\alpha(1-\beta)\left[R(G)-C_1(G)\right]$$
$$+\beta(1-\alpha)\left[R(T)-C_1(T)\right]+(1-\alpha)(1-\beta)\left[R(G)-C_1(G)\right]$$

After calculating, we can get

$$A=R(G)+\beta C_1(G)+\beta R(T)-\alpha\beta F-C_1(G)-\beta R(G)-\beta R(T)$$

We can obtain government's biggest profits is as follows,

$$B=\alpha\beta(F-C_2-C_3)+\alpha(1-\beta)(-C_2)+\alpha(1-\beta)(-C_3)$$

After calculating, we can get

$$B=\alpha\beta F-\alpha C_2-\beta C_3$$

As for enterprises, when $\frac{\partial A}{\partial \beta}=0$,they can have the biggest profits. Then, $C_1(G)+R(T)-\alpha F-R(G)-R(T)=0$.

We can obtain,

$$\alpha=\frac{C_1(G)-R(G)}{F}$$

When enterprises obtain their biggest profits, the most superior strategy of the government is to inspect and compare with the benefits from achieving the standard and not achieving the standard. If the profits are too high, it is necessary for government to inspect. At the same time, if government punish too heavy, the probability of government's inspection will decrease.
Whether to inspect all depends on the government's profits;

$$\frac{\partial B}{\partial \beta}=\alpha F-C_2=0$$

At last, we get $\beta=\frac{C_2}{F}$ .When government has its biggest profits, we can find that the lower government's inspection cost is, the more actively enterprises achieve the standard in the implementation of recovery reverse logistics.

If the punishment taken by government is too high, enterprises will achieve the standard more actively.

3.3. The most superior strategy of the government guiding on the implementation of enterprise recovery reverse logistics

We consider that government inspect or not with enterprises not achieving the standard. The enterprises' profits are as follows,

$$A=\alpha\left[R(T)-F-C_1(T)\right]+(1-\beta)\left[R(T)-C_1(T)\right]=R(T)-C_1(T)-\alpha F$$

The government's profits are as follows,

$$B=\alpha\left[F-C_2(T)-C_3(T)\right]+(1-\beta)\left[-C_3(G)\right]=\alpha F-\alpha C_2(T)-C_3(T)$$

The social welfare is as follows,

$$D = R(T) - C_1(T) - \alpha C_2(T) - C_3(T)$$

As the macroeconomic regulation and control department, government has two goal to realize from the social welfare aspect. One is to realize biggest social welfare, the other one is enterprises implement recovery reverse logistics actively with achieving the standard set by government.

As a matter of fact, enterprises always pursue the operation objective of biggest profit. Therefore, if they can obtain more profits with achieving the standard than not achieving the standard, enterprises will certainly implement the recovery reverse logistics achieving the standard set by government.

$$\max_{T,\alpha} D = R(T) - C_1(T) - \alpha C_2(T) - C_3(T)$$

$$s.t. R(T) - C_1(T) - \alpha F \le R(G) - C_1(G)$$

$$\alpha \in [0,1]$$

Then,

$$\alpha \ge \frac{R(T) - C_1(T) - R(G) + C_1(G)}{F} \quad F \ge \frac{R(T) - C_1(T) - R(G) + C_1(G)}{\alpha}$$

Therefore, $F \ge R(T) - C_1(T) - R(G) + C_1(G)$, the punishment taken by government should bigger than F .When $T = G$, there is equality: $R(G) - C_1(G) = 0$ .So G is the most superior strategy of enterprises' implementing recovery reverse logistics. Based on the above analysis, the most superior strategy of government is,

$$\alpha = \max_{T} \frac{R(T) - C_1(T) - R(G) + C_1(G)}{F}$$

The most superior strategy of enterprises is $T = G$.

The inspection government taken to enterprises includes two aspects. One is the appropriate probability, the other one is the punishment degree. These two aspects can be replaced each other. We have obtained $F \ge \frac{R(T) - C_1(T) - R(G) + C_1(G)}{\alpha}$. When government inspect enterprises, that is to say, when $\alpha = 1$, $F = R(T) - C_1(T) - R(G) + C_1(G)$. But if government can't inspect enterprises, the punishment degree should add to,

$$\Delta F = \frac{R(T) - C_1(T) - R(G) + C_1(G)}{\alpha} - \left[R(T) - C_1(T) - R(G) + C_1(G)\right]$$

$$= \frac{1-\alpha}{\alpha}\left[R(T) - C_1(T) - R(G) + C_1(G)\right]$$

If government's inspection has difficulty, the punishment degree should increase. But if the probability of inspection is zero, the punishment degree has no meaning. Therefore, on one hand, government's inspection should exist, on the other hand, the punishment to enterprises should be appropriate. Then, good results are coming.

4. Conclusion

It is urgent for our society and government to find the effective measures for recovery reverse logistics. Based on the above analysis, it needs the co-operation of government, enterprises and customers.

References

Dormer, A., Cleary, P.W., & Dunstall, S. (2011). Evolution in engineering services and logistics: decision support from the cloud. *Journal of System and Management Sciences*, 1(5), 1-10.

Jia, X. M. (2005). The game analysis of reverse logistics. *Business Economics and Management*, (2), 9-12.

Kopicky, R.J., Berg, M.J., & Legg, L. (1993). *Reuse and Recycling: Reverse Logistics Opportunities*. Oak Brook, IL: Council of Logistics Management, USA, 44-47.

Stock, J. R. (1992). *Reverse Logistics*. Oak Brook Council of Logistics Management, USA, 58-61.

Tan, Y. H. (2006). Business activities of reverse logistics game analysis. *Green Economy*, (11), 77-79.

Wang, Q. (2004). *Green Logistics*. Chemical Industry Press, Beijing, 119-225.

Wang, S.Y. (2002). *Modern logistics*. People's Traffic Press, Beijing, 68-70.

Wu, Y.Z., Liu, H.H. (2005). The implementation of reverse logistics management research. *Modern Logistics*, (11), 47-48.