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Game Analysis of Policy for Forest Certification

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Abstract: Forest certification is promoting sustainable managed forest, it has become an excellent tool for forestry products green procurement and it prevented the illegal logging and purchasing effectively. Forest certification makes the forestry enterprise add the more cost and reduces its profit. Forest certification meets the need of sustainable development due to the important role of forest in the society and enlarges the certified product's market in an environment friendly background. Now there are many debates about the policy effect, integrated all above into social effect, the study analyzed the policy game between the rich forest resource countries and the scarce, the two countries' enterprises competition model, government and enterprise and obtained the different gaming result based on the different condition.

Key words: Forest certification, forest, game analysis

INTRODUCTION

Due to the role of forests in sustainable development, some scholars or experts in developed countries and NGO raise wood consuming market entry access, require to purchase the green, sustainable wood and manufacturers are asked to provide relevant evidence to prove the wood are from legal sources, those who can't prove wood and woodwork of legal source will lose their market, that is called "forestry product green procurement". The point of "forestry product green procurement" is accepted by developed countries after publicizing, which is executed in their public procurement. With the increase of environmental protection concept of consumer, the idea of green consumption and sustainable consumption is strengthening. Forest certification is a process through which transnational networks of diverse actors set and enforce standards for the management of forests around the world. The central purpose of forest certification programs is to verify for interested outsiders that the management activities of certified enterprises are acceptable and appropriate. Forest certification is promoting forest sustainable development, meets the sustainable development need and it is a necessary and valid method to prevent illegal purchase. Therefore forest certification is a tool to implement green procurement for developed countries and consumer. With the sustainable point deep into people's heart, forest certification will

become more popular and develop one trend in the future, while every country will produce different social welfare in implementing forest certification.

In game study, DENG Qing analyzed and researched one single company and its single supplying chain system, he established models about game theory and expressed the conditions of green procurement activities. Yao (2006) studied the competing game models to analyze every country on how to choose the technical trade barrier. Based on the existing research and analysis, integrating the forest certification externality the author researches the policy game between country and country, enterprise and enterprise, government and enterprise.

Game between rich and scare resource countries: Forest area is unevenly distributed around the world. Two-thirds of forest distribution centralizes in more than 10 countries, including Russia (20.5%), Brazil (12.1%), Canada (7.8%), the United States (7.7%), China (5.0%), Australia (4.1), the democratic republic of Congo (3.4%), Indonesia (42.2%), Peru (1.7%) and India (1.7%), the former five national forest area accounts for more than 50% of globe. There are 105 countries whose forest area proportion (forest area takes up land area, excluding the proportion of inland waters) exceeds the global average. However there are also 62 countries whose forest area proportion accounts for land area (excluding inland waters) is less than 10% in the world, among of them, some countries such as

Lesotho, Djibouti, Egypt and Libya, Mauritania, Kuwait, Monaco and Nauru fall below 0.5%. Due to the difference of forest resource in each country, forest certification has different effect. In order to effectively analyze policy game between rich forest resource countries and scarce ones in forest certification, the author defines rich forest resource countries as the Rich, scarce forest resource as the Scarce.

The gaming result in forest certification between the Rich and the Scarce will be as follows: One is the Scarce unilaterally put forward certification requirements; second is the Rich propose forest certification requirements unilaterally; third is the Rich and the Scarce put forward forest certification requirements together.

In the first case, the Scarce enterprises increase their profit (α), oppositely the Rich enterprises obtain (-c). Because forest certification adds the marginal cost of the Scarce enterprises and cause them to yield less; while the Scarce enterprises correspondingly increase their yield and grab a large market share. In this case, the total output of the Rich and the Scarce lowers before, while the price goes up. The benefit of consumer for the two countries suffers loss (-b, -d), by contrast, the Scarce consumer is more seriously damaged. So, in this case forest certification is the profiting tool for the Scarce enterprises, all others will be damaged.

In the second case, the Rich put forward certification unilaterally, there is little influence for the Scarce enterprises, the exported industry products from the Scarce to the Rich are less or nearly 0, but for the Rich themselves have influence, that is to say that certification requirement undermines their own country enterprises interest (-e). On the one hand, certification requirements will make importing restriction which can cause the Scarce to turn on the domestic market, the Scarce in return, will also set other corresponding barrier, thus make more requirements for other exporting commodities of the Rich into the Scarce and form "squeeze out" the Scarce market. On the other hand, the Rich have offered certification, increase domestic enterprises' production cost and reduce their profit in the Scarce market and their loss exceeds earned profit in domestic protection. In this case, companies and consumer in the two countries are required to cancel the forest certification requirements.

In the third case, the interest of consumer in the two countries is hurting (-h, -j), but the Rich is worse than the Scarce. Even in the face of certification of the Rich the Scarce enterprises can earn more profit (g), because the Scarce exporting enterprises will reduce production, cause the industry to raise competitive elements and push price to fall. The Rich enterprises' profit will fall firstly with the increase of forest certification requirements (-f), reach a

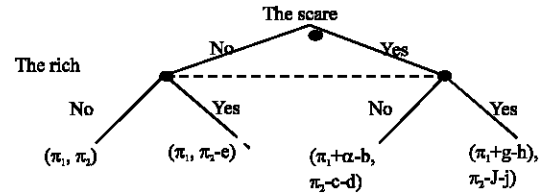


Fig. 1: Game analysis of enlarging model

moderate level and again add with the increase of the limiting level, but the highest level doesn't exceed the profit in free trade.

As such the above three kinds of situation, the following extended type of game expression is shown in Fig. 1.

The Scarce and the Rich don't put forward forest certification, they will get benefit for (π_1, π_2), namely in free trade, but in forest certification the benefit for two countries has changed. From the above analysis, when the Scarce do not set certification, dominant strategy for the Rich is not to set, when the Scarce set certification, the Rich will choose payment between -c-d or -f-j, Get function: $f = e+c$, which means that when the Rich set forest certification, the domestic enterprises suffer the dual standard: foreign and national influence, one effect is to increase cost for exporting enterprises, another is to raise production cost for domestic enterprises. In the view of national benefit the loss of the Rich consumer's interest in having set the certification is more than not being set, because production factor price has got an increase, get $j>d$. Thus, the Scarce choose certification, the dominant strategy for the Rich is not to set. If the Scarce enterprises obtain $a-b>0$, namely, increasing profit is more than the loss of consumer; the Scarce can choose forest certification, thus (set, not set for the game of Nash equilibrium).

However, in real life the first and second situations rarely appear, usually the third gaming result will appear. The main reason: Firstly the forest resource is one of the most important resources on earth and it is the basis of biological diversity. Forest resource is not only the important as an economic and social development's base material, but also has good ecological and social benefits and it is important for the development of human society to maintain and manage forest sustainability. Every government around the world has realized it; therefore every country puts forward the forest sustainable management requirements from sustainable development perspective. Secondly the Rich mostly belong to the developing countries and the Scarce are subjected to the developed countries, Therefore forest certification between countries has become a policy tool as trade

negotiation, although at that time the profit of the business and welfare of domestic consumer are affected.

Two countries' enterprises competition game

Game analysis under the same certificating standard:

According to the FSC-STD-40-004 first edition standard, FSC certified products is divided into three categories: complete FSC, mixed FSCs and recycled FSC, accordingly the cost is also different in the three categories, apparently the complete FSC has the highest cost, next mixed, finally recovered.

When the two enterprises select certificating standard, they will face three conditions: The same standard, their own standards and each other of national standards. In order to do business smoothly, they select the same standard, the both sides can all reduce cost and both sides obtain the maximal profit. If all enterprises admit their own standard, exported products are required to comply with other side's standard, thus the gain for both sides will be lower than the former one due to the higher cost. In the third case all countries use each other's standard, which results in both sides not being able to receive any interest. Suppose foreign standard is higher, according to the above, then educe interest matrix in Table 3.

Take further analysis: when the domestic and foreign forestry enterprise select the same certificating standard, while the domestic enterprise face own market, foreign enterprise direct in the domestic and foreign market. Assume that standard make the domestic enterprise production cost more, first, analyze the foreign enterprise responds to the minimum standards and then analyze the lowest conditions for domestic enterprise to squeeze foreign competitors.

First, assume that foreign forestry enterprise have less cost than the domestic, in order to adapt domestic standard, foreign enterprise must pay a fixed additional cost. Thus, the higher standard will force foreign enterprises to raise level and bear the extra cost, or give up exporting and focus on the local market. Analyze forestry enterprise whether strengthening the certified forestry cover mainly depending on the weigh of the costs and benefits.

From the aspect of cost, foreign enterprise will increase cost under the certificating demand, according to $\nabla\pi = PVQ+QVP-VC$, integrated into grad function theory and calculation equation, result in $\nabla\pi = PVQ+QVP-VC$.

If the forestry enterprise keeps total output constant, $\nabla Q = 0$, we get function $\nabla\pi = QVP-VC$, from the analysis of profit and cost, producing process is determined by the

change of total profit grad. The change of profit relies on price and cost and has positive relation with price grad, but has reverse relation with cost grad. Price grad increase and profit grad will obtain more, otherwise less; Cost grad increase and profit grad will obtain less, otherwise more. If the price grad change is equal to or greater than costs grad change, the enterprise profit grad increase or keep constant, foreign forestry enterprise can benefit from the domestic market or keep unchanged and then the foreign forestry enterprise will try to enter the domestic market, if the price grad is less than the cost, the enterprise profits grad change less, the foreign forestry enterprise will not benefit from the domestic markets and they will not enter the domestic market.

Of course, the domestic forestry enterprise can implement higher certificating standard to squeeze foreign company, their cost will increase as well, under the same certified level and the added cost should be same. The benefit of squeezing foreign enterprise contains two parts: One is from monopoly and added price; the other is enlarging production scale brings more after squeezing out of the foreign enterprise. The domestic enterprise repelling the foreign is also determined on the cost and price grad. If the price grad increases more than the cost grad, the domestic enterprise will take the minimum standard ejecting competitor. But the domestic enterprise should notice that the added price will reduce the marker demand, so that the enlarging scale can not bring enough benefit. Das and Donnenfeld (1989) found that foreign enterprise minimum rejecting standards will also reduce domestic company profits and domestic welfare. Therefore, in selecting certificating standard, the enterprise face the cost estimate, if the lowest cost exceeds the accepted standard, the domestic enterprise would think no to any standard in the domestic market. Otherwise, they would take minimum standards rejecting the opponent.

Game behavior analysis under the different certificating standard:

According to the prior analysis, every country gets less profit under the different certificating standard than the same kind of standard. Now assume that in one country there are two kinds of competition forestry products for final consumption in the market, one is produced by the country's domestic enterprise A, another is imported from abroad and produced by the foreign enterprise B, the two kinds of goods can replace each other, but due to the materials from different certificating standard, there is different environment quality. In the domestic market, assume that the domestic enterprise A products come from higher certificating standard forest, therefore they have higher environmental quality q_1 and

the imported products come from the lower certifying standard, thus q_l environment quality is relatively lower, $q_h > q_l > 0$; And in the short term q_h and q_l limited by the production condition will not produce significant changes with the change of the market demand and commodity price. Enterprise A and B will game in market choice and sales stages. In the first stage, the enterprise B decides whether to enter the domestic market, in the second stage, the two enterprises set forest products output and price and compete in the market. In this study, we suppose that the environmental quality information of product is completely open, namely enterprise understand competitors' products environment level and their own products environment level and based on those condition make a decision.

In the point of cost, in order to simplify the analysis, hypothesize the two enterprises variable cost are zero. Because the higher certifying standard will force the foreign enterprises to pay extra fees for exporting, the expenditure include standard information collection fees, the increased cost for applying new standards and updating equipment, product inspection charges, registration and the certifying cost and so on. Now assume that the cost is same for all foreign enterprises and a unit fixed cost isk , k is influenced by certifying standard differences and $k > 0$ and k is determined on two factors: One is the environment attention from importing countries, if the importing countries set the higher standard, it is equivalent to the set of higher environment barriers which will produce more cost, another is that enterprise B faces its own production situation and environment focus. If the enterprise B values environment as very high degree itself, it can adjust production target in a very short time according to the requirements of the importing country, update the process flow and increase unit cost k .

In the consumer market, the different consumers have different preference on the different environment level products. Now assume that consumers lie in uniform distribution interval $(0, 1)$ and consumers decided to a purchase a commodity which is influenced by their environmental preference parameters θ and set all the consuming maximum number for 1. Set the indirect consumer utility function form for:

$$U_{i,\theta} = \int_0^1 \times q_i - p_i; i \in \{l, h\} \tag{1}$$

The function means that when manufacturers raise prices consumers will reduce consumer utility under the condition of invariable environmental quality products, also in the same case, consumers have a strong preference for the high environmental level products.

Assume $\theta = \theta_1$, consumers have same preference for the higher and lower environmental level products, when $\theta = \theta_1$, consumers buy or do not buy products between the lower and higher environmental without any distinction, so we can get the following function:

$$\theta_1 = \frac{p_h - p_l}{q_h - q_l}; \theta_0 = \frac{p_l}{q_l} \tag{2}$$

Thus, demand function:

$$D_h = 1 - \theta_1 = 1 - \frac{p_h - p_l}{q_h - q_l}$$

$$D_l = \theta_1 - \theta_0 = \frac{p_h - p_l}{q_h - q_l} - \frac{p_l}{q_l} \tag{3}$$

Enterprise A and enterprise B profit function:

$$\pi_h = p_h D_h = p_h (1 - \frac{p_h - p_l}{q_h - q_l}) \tag{4}$$

$$\pi_l = (p_l - k) D_l = (p_l - k) (\frac{p_h - p_l}{q_h - q_l} - \frac{p_l}{q_l}) \tag{5}$$

After using the backward induction to solve the game, in the second stage game, the enterprise maximizes its respective option price to obtain profits. Through Nash equilibrium we get:

$$p_h^{NE} = \frac{q_h(2q_h - 2q_l + k)}{4q_h - q_l}$$

$$p_l^{NE} = \frac{q_l(q_h - q_l) + 2kq_h}{4q_h - q_l} \tag{6}$$

The equilibrium price substitute (3) formula, the two enterprises produce the quantity for:

$$Q_h^{NE} = \frac{q_h(2q_h - 2q_l + k)}{(4q_h - q_l)(q_h - q_l)}$$

$$Q_l^{NE} = \frac{q_h(-2kq_h - q_l^2 + kq_l + q_lq_h)}{(4q_h - q_l)(q_h - q_l)q_l} \tag{7}$$

And the maximum profits of the two enterprises are for:

$$\pi_h^{NE} = \frac{q_h^2(2q_h - 2q_l + k)^2}{(4q_h - q_l)^2(q_h - q_l)}$$

$$\pi_l^{NE} = \frac{q_h(q_hq_l - q_l^2 + kq_l - 2kq_h)^2}{q_l(4q_h - q_l)^2(q_h - q_l)} \tag{8}$$

In the first game phase, foreign enterprise B decides whether to export the domestic market facing the higher certificating standards, from Eq. 8, it is well known that the point depends on π_1^{NE} greater than 0, because the foreign forestry enterprise meet the higher standard to pay an extra unit cost k and k is greater than zero. π_1^{NE} is greater than 0, which will depend on $(q_h q_l - q_l^2 + k q_l - 2h q_l)_h$ unequal to zero, namely k is unequal to:

$$\frac{q_l(q_h - q_l)}{2q_h - q_l}$$

and the most maximum profit is always greater than zero. If k is greater than:

$$\frac{q_l(q_h - q_l)}{2q_h - q_l}$$

The enterprise will bear the unit cost greater than price of commodity, at the same time the product amount will be less than zero(could be calculated). So, the degree of certificating standard will influence the foreign enterprise's decision in the first stage, the foreign enterprise will export the domestic market according to the unit cost k and take action to compete with domestic enterprise in the second stage. From all above, in the first stage the enterprise Nash equilibrium strategy is:

$$k < \frac{q_l(q_h - q_l)}{2q_h - q_l}$$

at that time the foreign enterprise will enter the domestic market, otherwise the foreign company will give up.

The domestic enterprise produces high standards, which make the certified forest product have obviously different advantage, as administration departments set certificating standard they have expressed trade protection and weakened the foreign companies' competition. Maybe the administration departments only take the forest protection and sustainable development into consideration and do not consider this point, but from the above analysis, it is obvious. From the maximum profit function π_1^{NE} and π_l^{NE} and the solution to π_h^{NE} analysis, because $k \gg 0$, so $\pi_h^{NE} \gg 0$ and as the unit cost k increase, also π_h^{NE} will increase. The standard variance between the foreign and domestic country results in k and more variance, greater k , once the administration departments put forward the higher certificating standard, the domestic company will obtain more profit. But from the other aspect analysis, as to the foreign enterprise when:

$$k < \frac{q_l(q_h - q_l)}{2q_h - q_l}$$

The enterprise will export commodity to the domestic market, according to the foreign enterprise function, more k and less profit for enterprise. As long as $k = 0$, namely forest certificating standard is completely same, the company will get the maximum profit:

$$\frac{q_h q_l (q_h - q_l)}{(4q_h - q_l)^2}$$

Analyze the influence of the higher forest certification standard to consumers, according to indirect utility function (1), social total consumer surplus have two parts: low environmental quality and high environmental quality forest product consumer surplus:

$$\int_{\theta_0}^{\theta_1} (\theta q_l - p_l) d\theta + \int_{\theta_1}^1 (\theta q_h - p_h) d\theta$$

$$\theta_1 = \frac{p_h - p_l}{q_h - q_l}, \theta_0 = \frac{p_l}{q_l}$$

and Eq. 6 substitutes the above formula and get the total consumer surplus when enterprise A and B reach maximum profit:

$$CS^0 = \frac{q_h(12q_h^3 - 15q_l q_h^2 + 2q_h q_l + 2k q_l q_l + 2k^2 q_h + q_l^3 - 2k q_l^2)}{2(4q_h - q_l)^2 (q_h - q_l)} \tag{9}$$

Due to the forestry enterprises develop sustainable management, protect environment, promote ecological improvement, which also has a certain role in addition to the enterprise income, we call social benefits, so gross income can be for the performance of the enterprise profit and the sum of social income.

Gross income performance can be ϕ times for enterprise income, $\phi > 1$ and the domestic enterprise gross income for:

$$TR_h = \phi \times p_h D_h = \frac{\phi q_h^2 (2q_h \cdot 2q_l + k)^2}{(4q_h - q_l)^2 (q_h - q_l)} \tag{10}$$

The total foreign enterprise income performance for:

$$TR = \phi \times p D = \frac{\phi q_h (q_h q_l - q_l^2 + 2k q_h) (-2k q_h - q_l^2 + k q_l + q_l q_h)}{(4q_h - q_l)^2 (q_h - q_l) q_l} \tag{11}$$

Government and enterprise's game: In the view of barriers, setting sustainable forest management requirement has some meaning of government policy protecting. Fischer and Serra (2000) discusses countries and enterprises in applying the standard as a tool to protect the different strategic choice from microcosmic aspect. If we don't consider externalities, the government promulgates the certificating standard and mainly wants to crowd out the foreign enterprise and the government's decision-making is same as the domestic enterprises. The standard the government established repelling the foreign company has not reached the domestic companies' demand, because the government's objective contains consumer social welfare, the consumer social welfare will reduce along with the native enterprise market monopoly extent. Therefore, the government sets up exclusive requirement for foreign enterprise that is lower than the standard requirement of the domestic enterprise's preference, which is mainly from consumers' interests. But the proposed forest certificating standard absolutely not only considers the point of enterprise interests but also considers the interests of consumers and the global forest sustainable development.

Assume that the government's goal is to keep sustainable forest management and maintain ecological environment, consider the global social welfare maximization and on this basis, setting the standard of sustainable forest management and suppose the administration departments have a perfect understanding for the domestic enterprise's environmental level and consumer utility and can predict that the certification standard will make the imported products unit cost increase, also know that if the setting of certificating standard is too high, the foreign enterprise could not enter the domestic market due to excessive costs and then the domestic enterprise will monopolize the whole market. Now suppose that foreign product enter in the domestic market and the domestic and foreign products are both in market, the social welfare is for W_0 , the social welfare for only domestic products in the market is for W_1 , the government goal is in the choice of the social welfare in the two kinds condition, namely $\text{Max}(W_0, W_1)$.

Only the domestic products in the market, the enterprise profits were:

$$D_h^{-1} = 1 - \frac{p_h}{q_h} \quad \pi_h^{-1} = D_h^{-1} p_h = (1 - \frac{p_h}{q_h}) p_h$$

The solution to the maximization of profit as the monopoly enterprise:

$$\text{Max } \pi_h^{-1} = D_h^{-1} p_h^{-1} = \frac{1}{2} \frac{q_h}{2} = \frac{q_h}{4}$$

Then, social gross income for:

$$TR_h = \phi \times p_h D_h = \frac{\phi q_h}{4}$$

Consumer surplus for:

$$CS^1 = \int_{p_h/q_h}^1 (\theta q_h - p_h) d\theta = \frac{1}{2} q_h - p_h + \frac{p_h^2}{2q_h}$$

Substitute:

$$p_h^* = \frac{q_h}{2}$$

Then:

$$CS^1 = \frac{1}{8} q_h$$

$$p_h^* \frac{q_h}{2} \quad CS^1 = \frac{1}{8} q_h$$

Thus, social welfare for:

$$W_1 = \frac{\phi q_h}{4} + \frac{1}{8} q_h$$

And from Eq. 8 and 9, we can calculate the social welfare lying in the two products in the market:

$$TR + CS^0 = \frac{\phi q^2 (2q \cdot 2q + k)^2}{(4q - q)^2 (q - q)} + \frac{q(12q^3 - 15qq^2 + 2qq + 2kqq + 2k^2q + q^3 - 2kq^2)}{2(4q - q)^2 (q - q)} \quad (12)$$

$W_0 > W_1$, Which means that there is competitiveness in the market, the native social welfare is more than the domestic product monopoly and the management bureau can reduce standard measures to improve social welfare. Otherwise, the government would rather select domestic products monopoly pattern, the government will increase the certification standard to block foreign product into.

CONCLUSION

In order to meet the need of forestry products green procurement and sustainable development, every country all start to implement forest certification, but between the

governments of the rich resource countries and the scarce ones, the domestic enterprise and the foreign and the government and the enterprise, the game result is different.

Under the Rich and the Scarce model, from the pure trade point policy perspective is that the rich don't set, the Scarce set, but joining in the role of certification, the Rich and Scarce all implement certification, loss of the rich will be more than the scarce. In selecting certifying standard different choice will result in different benefit and the certifying standard is same or different, which will produce the different results. In general the same standard will bring more profit, own standard will give less, each other's standard give zero. When selecting the domestic standard the enterprises need to consider the comparence between the increased cost of extruding the foreign enterprise and their monopoly profit, the foreign enterprise meet the unified standards to increase cost and think about whether the product price's increases can make up for the increased cost. Under the different situation of the certification standard, enterprise's game should consider more problems and enterprise should judge and do the choice according to the difference among enterprise's certification standard, if the difference is greater, a country want to enter another country and need pay more and the greater difference means that the increased cost is also bigger, the standard difference have a target, the target is k . If k is over a certain range, the foreign enterprise will not enter, otherwise, it will enter.

Between the government and enterprises policy game mainly displays that the government should promote the global sustainable development from the interests of consumers, prevent individual enterprise monopoly to damage the interests of consumers and prevent the higher standard to hinder the forest certification, so that the global ecological environment protection can not improve. Therefore game analysis need to compare the social welfare between competition and monopoly situation, then make judgment.

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