An analysis of the Effect of Government-Enterprise Game in the Government-leading Industrial Energy Saving Model

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Abstract

The current industrial energy saving practice in China mostly relies on administrative controls and administrative orders means, and its efficiency and benefit is at a low level. One reason is that information asymmetry exists between the government's energy management and enterprises' energy-saving conducting. This article focuses on the game between the government and enterprises in the government-dominated industrial model of energy-saving, analyzing the effect that the government’s checking, penalty and reward policies, and transformation cost have done on enterprises’ energy-saving behaviour, and put forward some policy-making suggestions.

Keywords: industrial energy-saving; the government-enterprise game; information asymmetry

1. Introduction

The current industrial energy saving activities in China mostly relies on administrative controls and administrative orders. The government forces industrial enterprises to reach their energy saving targets by measures such as target responsibility system, accountability, one-vote-down system and rules-violation fines and etc. For example, in the second half of the year 2010, some local governments have conducted power rationing to force enterprises to reduce energy consumption for the purpose of reaching the energy saving target of “the eleventh five-year plan”. This administrative type of energy-saving model is comparatively low in efficiency and economic profit. The reasons are as follows:

First, industrial energy saving is a complex matter[1]. Industrial energy-saving management covers the whole process of product life cycle, which ranges from product design, raw materials, fuels and

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equipment procurement, production, product marketing and product recycling, disposal and reuse. The implementation and effect of energy saving activities are bound to be subjected to internal factors of enterprises such as energy saving technology, production technology, equipment, raw materials, management system and enterprise culture, as well as external factors such as government energy-saving policy, energy prices, energy-saving information and social evaluation.

Second, Information asymmetry exists between the administrative energy-saving management and corporate energy saving behaviour. The government, as an energy-saving administrator, can compile by legislation means (making some laws and regulations), energy-guzzling enterprises to conduct energy saving transformations. But in practice, enterprises tend to have more information than the government, which often places the government in an asymmetrical status in acquisition of industrial energy saving information. Restricted by its insufficient knowledge of enterprises’ resources, patterns of energy consumption and energy conservation potential, and limited by the cost of supervision, audit and checking, by some enterprises’ intentional concealing behaviors, the government is not in the position to know everything about what they really do in reducing energy consumption. Besides, enterprises may also set their energy-saving goals at too low a level, and thus hinder the energy conservation process of the whole society. Or they may overstate the difficulties they encounter as to less perform, or even not to fulfill their responsibilities and obligations in energy-saving.

This article is to focus on a detailed analysis of the game between the government and enterprises in the government-dominated industrial energy-saving model.

2. An analysis of the game between the government and enterprises

Based on the status of the government and enterprises in energy conservation activities, there are assumptions as follows:

(1) The players, the government and enterprises, both are pursuing utility maximization.

(2) There are two kinds of action strategies for enterprises: active and inactive. Here "active" means enterprises actively response to government requirements, and do their best to take measures for energy conservation and emissions reduction. And "inactive" points to the fact that enterprises negatively treat government’s regulating requirements for fear of the rise in costs in operation, and as a result, fail to reach energy conservation and emission reduction targets. The probability for enterprises to actively adopt energy conservation action is y, and the probability for them to take inactive actions is (1 - y).

(3) C stands for the investment cost for enterprises to carry out positive energy conservation activities (updating and upgrading the existing equipment and technology, introducing new equipment and technology, or training personnel, etc.). S stands for the expenses saved as a result of enterprises’ positive energy conservation actions. The probability for enterprises to take "passive" actions is 0.

(4) Government action strategies fall into two kinds: checking; no-checking. Probability for checking is x; for no-checking is 1 - x.

(5) C is the supervision cost for the government to evaluate how well enterprises do in reaching their energy conservation and emission reduction targets. Enterprises completing the energy-saving index set by the government can obtain governmental reward J, which are mostly given in the form of financial subsidies or preferential. If companies fail to reach their energy-saving index will suffer from fines, and that is F.

See the following the matrices:

Table 1 enterprise and government profit matrix

<table>
<thead>
<tr>
<th></th>
<th>(x)</th>
<th>(1-x)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Checking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No-checking</td>
<td></td>
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From the above matrix, it can be seen that the so-called pure strategy Nash equilibrium, which is of bilateral benefit does not exist. So here we are to analyze the Mixed strategy Nash equilibrium in the two-side game.

The government's predicted profit is:

\[ U_{\text{gov}} = x[y(-C - J) + (1 - y)(-C + F)] + (1 - x)[y(0) - (1 - y)(0)] \]

\[ \frac{\partial U_{\text{gov}}}{\partial x} = -Jy - Fy - C + F = 0 \]

\[ y^* = \frac{F - C}{F + J} \]  (1)

Enterprise's predicted profit is:

\[ U_{\text{ent}} = y[x(-D + J + S) + (1 - x)(-D + S)] + (1 - y)[x(-F) + (1 - x)(0)] \]

\[ \frac{\partial U_{\text{ent}}}{\partial y} = xJ + S - D + xF = 0 \]

\[ x^* = \frac{D - S}{F + J} \]  (2)

This is the mixed strategy Nash equilibrium solution in the game between the government and enterprises in energy conservation and emission reduction.

The formula (1) reveals that, the greater F is, the greater y* is. That is, the greater the penalties that substandard enterprises are imposed upon, the more likely the enterprises are to carry out actively energy conservation activities. On the other hand, the smaller y* is, the less likely an enterprise is to reach its energy conservation and emission reduction targets, the more reward should be given to the enterprise that has completed its. Only in this way, can the government stimulate enterprises to take more active measures. The smaller C (the government's checking cost) is, the greater y* (the probability of an enterprise to carry out actively energy conservation activities) is. As smaller checking cost implies that the government possesses more information about how l an enterprise’s energy conservation activities and energy-saving attempts are going on, it is less possible for it to hide energy-consumption information and react inactively to the government’s compulsory energy-saving goal. In a more well-informed environment, is less likely to see the failure of the energy saving and emission reduction policy, which is often the consequence of information asymmetry. Complete information is able to promote the market integrity, and thus further promote the efficiency of the on-going economy and that of energy saving and emission reduction as well.

The formula (2) reveals that, the more capital D is invested by an enterprise in reaching its energy-saving targets, the bigger the government’s inspection x* will be. The government needs to increase the checking intensity and frequency, to urge the enterprise to conduct its energy conservation activities. When the government increase the reward for the enterprises doing well in energy conservation as well as the penalty for those failing to arrive their targets, the x* of the government becomes smaller. The more expenses saved in energy saving actions (S), the more active and spontaneous enterprises are, the smaller the government’s probability of inspection will be.

3. Policy-making Suggestions
From the above equilibrium condition, it is evident that industrial energy-saving are affected by and subjected to many kinds of factors. Therefore, at present, in the government-dominated mode of energy saving, energy saving measures made by the government must be of diversity and comprehensiveness in order to achieve a win-win effect.

First, to establish a scientific and reasonable economic incentive mechanism to reduce the energy saving cost of enterprises.

From the game analysis above, it can be seen that, if the government increases its reward for the enterprises who have finished their energy-saving index, the other ones whose probability of reaching its energy saving and emission reduction targets \((y)\) is low, can be stimulated to adopt more positive measures. In industrial energy saving activities, there exists a typical client-agent relationship between the government and the enterprises. Restricted to supervision and audit costs, and the complexity of industrial enterprises’ energy-saving practice, it is not possible for the government to know everything industrial enterprises have or have not done in reducing energy consumption. So, in energy-saving transformation, enterprises run the moral risk of hiding their behaviors and information asymmetry exists between the government and enterprises. Thus, it is necessary for the government, as the client, to establish scientific and reasonable economic incentives, encouraging the enterprise to cut down energy saving cost and actively participate in energy saving transformation. Ma Aiying’s (2008)[2] studies reveal that China’s energy saving incentive policies are hysteretic, small in scope and less powerful in regulations making. Therefore, a reasonable choice of the most effective combinations of economic incentive tools and of operation modes to maximize the combined benefits is one of the long-acting mechanisms to promote industries’ energy-saving initiative.

Second, to set up a mechanism of the third party information disclosure to achieve the information openness of energy-saving.

From the above game analysis between enterprises and the government, it is evident that in a more well-informed environment, failure probability of energy conservation and emission reduction policies caused by incomplete or asymmetrical information will be greatly reduced.

Complete information is able to promote the market integrity, and thus further promote the efficiency of the on-going economy and that of energy saving and emission reduction as well. A report system of disclosing information and a system of public participation should be set up to arouse the public’s enthusiasm in participation and put the sporadic social forces together to achieve the common goal.

Thus, Energy-saving information is to be released not only by the enterprise itself and the government, but also by the third-party organization. Liu bin’s (2009) [3] studies indicate that the third party’s information release has exerted more and more influence on energy-saving practice in the international scope. On the one hand, more and more information from enterprises is mostly released by the third party, and on the other hand, public information is mostly collected and integrated by third party organizations as feedback to enterprises.

As in the case of Japan Energy Conservation Center, it is the largest and most authoritative organization, releasing enterprise information about energy consumption, energy saving, energy saving equipment and technology, etc. JECC, as a third-party information provider besides the government and the enterprise, plays a tremendous role in the advance and rapid development of Japan’s energy conservation practice.

Third, to improve the scientificity and accuracy of the government’s evaluation on enterprises’ energy conservation and emissions reduction

Only when the government increases its checking efficacy, takes advantage of reasonable but effective rewards and punishment, strengthens its policy prestige degree, can enterprises’ energy conservation and emissions reduction be achieved. Huang Xin etc’s (2008) [4] studies prove that enterprises’ intention of energy conservation and emission reduction tends to fall with the government supervision frequency.
increases, as too harsh supervision can do nothing good but increase enterprises’ management costs (such as frequent spot checks or energy audit will add to personnel and financial expenditure), which may lead to some deceptive behaviors of enterprises. Therefore, it is advised to make full use of technological means to reduce the checking cost of the government and enterprises, and improve work efficiency for the purpose of making the government’s evaluation scientific and accurate. The more acute, more better the government is at recognizing fraud or ineffective actions, the more down-to-earth, more serious, and more productive enterprises’ work for energy conservation and emissions reduction will be.

Fourth, to reinforce the voluntary agreement actions of energy-saving to improve enterprises’ initiative

In the traditional government leading practice of energy conservation and emission reduction, the government and enterprises always play the game of cat and mouse, only to find energy-saving efficiency and benefit not rarely satisfactory.

Voluntary agreement model of energy-saving, with its non-obligatory nature, is easy for enterprises to accept, and as a result, can arouse enterprises’ enthusiasm and initiative in environmental protection. Enterprises can decide on their own energy saving behavior, and therefore, are willing to make known their true ideas and set their own attainable goals. Voluntary agreement pattern of energy saving is to help enterprises and the local government gain win-win economic benefits and environmental benefits. It can also bring about changes in enterprises’ concept of management. Enterprises are willing to bring environmental consideration into the making of their own management system, which is to make their management and decisions more scientific and feasible. Voluntary agreement of energy-saving is still a new thing in China. It is one of the long-acting mechanisms to ensure autonomous energy saving behaviors to explore some supporting policies (in tax, technology and finance), ways of evaluation, standardization of the form of agreement.

References


