The impact of government subsidy of manufacturing firm innovative decision in the background of low-carbon

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Abstract. In the low-carbon background, the green manufacturing and a new road to industrialization should be developed in China. Government subsidies can promote the promotion of low-energy products, and thus control the total carbon emissions. Aiming at an innovation-decision dilemma of a kind of self-research and development manufacturing firms, the characteristics of disruptive innovation and sustaining innovation were analyzed in the viewpoint of the firms' dynamic competitive advantages. A 0-1 nonlinear decision model was built with consumer surplus as the optimization objective. This model can provide guidance for government policy strategy and manufacturing firm innovation decision. A genetic algorithm was developed to solve the 0-1 nonlinear decision model. A case study of an automobile was reported to demonstrate the feasibility and rationality of this approach.

1. Introduction
The rapid development of human society has led to the destruction of the climate and the environment. In particular, the massive emissions of greenhouse gases have exacerbated the further deterioration of the climate. According to the IPCC report, greenhouse gas emissions from human activities are the main cause of global warming and frequent occurrence of extreme weather [1]. As the world's largest manufacturing country, China's greenhouse gas emissions are the second highest in the world. In order to actively respond to and improve this deterioration, the National Development and Reform Commission issued the Interim Measures for the Management of Low-Carbon Products Certification in 2013, strengthening the low-carbon product certification system and encouraging the development and production of low-carbon products. In March 2015, "Made in China 2025” proposed a green development background, China will turn from a manufacturing power to a manufacturing power, actively develop green manufacturing, and take a new road to industrialization, which coincides with the vision of Industry 4.0. Some scholars have also argued that different local government tax policies will directly affect the production decision-making and operation mode of enterprises. In summary, it can be seen that the government's low-carbon subsidy policy can promote the production and promotion of low-energy products, and thus control the total amount of carbon emissions.

In this new situation and new background, more and more consumers have a low-carbon consumption concept. Liu [2] pointed out in the study that consumers' environmental awareness was gradually increasing and they were willing to pay additional fees for green low-carbon products. Fu[3] found through market research that more than half of auto consumers were more inclined to buy more energy-efficient hybrid vehicles. On the other hand, the price of low-carbon products constrains most consumers' final purchase decisions. Xu surveyed the household appliance market and found that low-carbon environmentally friendly products cost hundreds to thousands of dollars more than ordinary
products, which eventually led to a large number of low- and middle-income families to abandon the purchase of low-carbon environmentally friendly products.

Innovation can be divided into destructive innovation and maintenance innovation by measuring the organizational structure and the degree of market change. Destructive innovation has two basic attributes: one is to change the path of existing technology development, and the other is to break the original market structure. The target group for most destructive innovations is the Bottom of Pyramid [4]. Destructive innovation can capture more market share by catering to the special needs of consumers [5]. However, the conversion of the target market will also increase the R&D and production costs of the company [6]. Due to the change of the technical trajectory of the original products, the consumer market's recognition of destructive innovation products and the strategies of the incumbent companies for the emergence of destructive innovation products are unpredictable. Maintenance innovation is to continuously improve products without changing the original technological development path of products, so that enterprises can obtain greater profits [7]. The advantage of sustaining innovation versus disruptive innovation is lower R&D, production costs, and a more stable market share. However, as the demand of consumers in the market continues to evolve, maintenance innovation will be difficult to meet the needs of emerging markets, leading to the loss of competitive advantage [8]. Most of the research on innovation decision-making in existing enterprises separates destructive innovation from maintenance innovation, and rarely seen research and analysis on how to make innovative decisions on the premise of limited resources, especially optimization research. At the same time, the literature on innovation of most research enterprises does not consider the government subsidy policy or assume that the government subsidy policy is constant, and ignores that different government subsidy policies will lead the enterprise innovation decision-making to a certain extent.

This paper will build a decision-making system and optimization model for a group of post-development enterprises based on independent research and development. On this basis, we study the guiding effect of different government subsidy policies on enterprise innovation decision-making. Compared with the innovation decisions of enterprises under different policies, which government subsidy policies promote the promotion of low-carbon products.

2. Government subsidies and enterprise innovation
Government subsidies refer to the free transfer of funds provided by the government directly or indirectly to microeconomic entities in order to achieve political and economic goals [9]. Government subsidies can effectively solve the "market failure" problem, and at the same time can affect the innovation path of enterprises to some extent. Xiao studied the motives of government subsidies from the perspective of official incentives and found that promoting corporate innovation is one of the main motives for government subsidies. As a routine means of government support for enterprise development, the impact of government subsidies on corporate innovation has caused heated debate among scholars. Some scholars believe that government subsidies can enhance the R&D capabilities of enterprises affected by market failures and drive the enthusiasm of enterprise innovation by influencing the market environment. Other scholars believe that government subsidies are prone to distortionary incentives, which have a negative impact on corporate innovation [10][11]. The impact of different government subsidies on different types of enterprises is also different. This paper will focus on the impact of different government subsidies on the innovation decision-making of post-development enterprises with independent research and development.

3. Problem Description
This paper studies the optimization problem of a group of independent research and development-oriented late-stage enterprises facing the technical innovation decision-making dilemma based on the low-carbon perspective, and analyzes the impact of different government subsidy policies on enterprise innovation decision-making. Whether destructive innovation and sustaining innovation can be balanced at the same time, considering the limited resources of the enterprise. After the enterprise's
innovation decision is determined, the product attributes are derived based on the enterprise cost and customer utility to optimize the product attributes. This paper will compare the innovation decisions of enterprises under the four different policies of government subsidy (no policy support, carbon allowance subsidy policy, tax subsidy policy, low energy consumption subsidy policy). The details of the specific problem are shown in Figure 1.

4. Optimization model

The optimization model is constructed based on the enterprise innovation decision-making mechanism explained above. This section will explain the specific components and constraints of the optimization model.

The optimization goal of this paper is that the product family can meet the needs of different market segments and maximize the profit of the company. The attribute level of the objective function decision product. Assume that the maintenance innovation product in the product family can select a total of \(N\) attributes, denoted as \(a_n \in \{1, 2, \ldots, N\}\). Each attribute \(a_n\) is divided into \(L_n\) horizontal levels. Then the \(l\) horizontal level of the \(n\) attribute is expressed as \(a_{nl}\). Destructive innovative products can choose a total of attributes \(Z\), recorded as \(b_z \in \{1, 2, \ldots, Z\}\). Each attribute \(b_z\) is divided into \(K_z\) horizontal levels. Then the \(z\) horizontal level of the \(k\) attribute is expressed as \(b_{zk}\).

A product can be seen as a combination of the attributes selected for each attribute. Maintaining an innovative product, \(N\) type of attribute each selected a grade consisting of a total of \(J = \prod_{n=1}^{N} L_n\).

Destructive innovation products \(Z\) type of attribute each selected a grade consisting of a total of \(G = \prod_{z=1}^{Z} K_z\). Assume that each permutation has a corresponding product configuration scheme, which is denoted as \(P_j, j = 1, \ldots, J; Q_g, g = 1, \ldots, G\). The set of products for sustaining innovation and disruptive innovation is \(P = \{P_j, j = 1, \ldots, J\}, Q = \{Q_g, g = 1, \ldots, G\}\). Decision variables \(x_j \in \{0, 1\}, j = 1, \ldots, J\). Where \(x_0 = 1\) represents the production of maintenance innovation.
products, and \( x_q = 0 \) opposite. \( x_j = 1, j = 1, \ldots J \) indicates the production of the \( j \) model, and \( x_j = 0, j = 1, \ldots J \) opposite. The same as decision variables \( y_m \in \{0,1\}, m = 0,1,\ldots,M \). The decision variable \( v_{jnl} \in \{0,1\}, v_{jnl} = 1 \) indicates that the \( j \) product selects the \( l \) attribute level of the \( n \) attribute. The same as Decision variables \( q_{mkz} \in \{0,1\}, q_{mkz} = 1 \). The objective function is as in Equation 1:

\[
\max F = \sum_{i=1}^{I} \sum_{j=0}^{J} \frac{U_{ij}}{C_j} \cdot P_{ij} \cdot Q_i \cdot x_j + \sum_{i=1}^{I} \sum_{m=0}^{M} \frac{U_{im}}{C_m} \cdot P_{im} \cdot Q_i \cdot y_m
\]  

(1)

\( U_{ij} \) indicates the perceived utility of the \( i ( i = 1,2,\ldots,I ) \) segment of the \( j ( j = 1,2,\ldots,J ) \) product. \( U_{im} \) indicates the perceived utility of the \( i ( i = 1,2,\ldots,I ) \) segment of the \( m ( m = 1,2,\ldots,M ) \) product. \( u_{nl} \) and \( \omega_{jm} \) respectively represent the score utility and the corresponding weight coefficient of the \( n \) module of the \( j \) product in the \( i \) market segment. \( \pi_{ij} \) indicates the combined utility of the \( i \) market segment for the \( j \) product. The same as decision variables \( \mu_{zk} \) and \( \omega_{mz} \) and \( \pi_{im} \). Expressions such as 2, 3.

\[
U_{ij} = \sum_{n=1}^{N} \sum_{l=1}^{L} (\omega_{in} \mu_{in} v_{jnl} + \pi_{ij}) + \varepsilon_{ij}, \forall i,j
\]  

(2)

\[
U_{im} = \sum_{z=1}^{Z} \sum_{k=1}^{K} (\omega_{mz} \mu_{izk} q_{mkz} + \pi_{im}) + \varepsilon_{im}, \forall i,m
\]  

(3)

\( Q_i \) indicates the size of the market. \( P_{ij} \) and \( P_{im} \) indicate that the probability of the \( i \) segment consumer selecting the \( j \) product and the \( m \) product is as shown in equations 4 and 5.

\[
P_{ij} = \frac{\exp(\mu U_{ij})}{\sum_{e=1}^{E} \exp(\mu U_{ie})}
\]  

(4)

\[
P_{im} = \frac{\exp(\mu U_{im})}{\sum_{h=1}^{H} \exp(\mu U_{ih})}
\]  

(5)

\( C_j^a \) and \( C_m^b \) represent the cost of the \( j \) product and the \( m \) product, respectively, as in equations 6, 7.

\[
C_j^a = \sum_{n=1}^{N} \sum_{l=1}^{L} v_{jnl} \xi_l
\]  

(6)

\[
C_m^b = \sum_{z=1}^{Z} \sum_{k=1}^{K} q_{mkz} \xi_k
\]  

(7)

In addition, in order to ensure the difference between products, give the corresponding constraints on the choice of equations 8 and 9.

\[
\sum_{n=1}^{N} \sum_{l=1}^{L} |v_{jnl} - v_{j'nl}| > 0, \forall j,j', j \neq j'
\]  

(8)

\[
\sum_{z=1}^{Z} \sum_{k=1}^{K} |q_{mkz} - q_{m'zk}| > 0, \forall m,m', m \neq m'
\]  

(9)

The enterprise innovation decision-making optimization model is as follows:
$$MaxF = \sum_{i=1}^{I} \sum_{j=0}^{J} \frac{U_{ij}}{C_{j}} \cdot P_{ij} \cdot Q_{i} \cdot x_{j} + \sum_{i=1}^{I} \sum_{m=0}^{M} \frac{U_{im}}{C_{m}} \cdot P_{im} \cdot Q_{i} \cdot y_{m}$$

s.t.  
$$U_{ij} = \sum_{n=1}^{N} \sum_{l=1}^{L} (\omega_{jn} \mu_{int} v_{jnl} + \pi_{ij}) + \epsilon_{ij}, \forall i, j$$

$$U_{im} = \sum_{z=1}^{Z} \sum_{k=1}^{K} (\omega_{mz} \mu_{izk} q_{mzk} + \pi_{im}) + \epsilon_{im}, \forall i, m$$

$$C_{j}^{a} = \sum_{n=1}^{N} \sum_{l=1}^{L} v_{jnl} e_{l}$$

$$C_{m}^{b} = \sum_{z=1}^{Z} \sum_{k=1}^{K} q_{mzk} c_{k}$$

(10)

$$x_{j} \in \{0, 1\}, v_{jnl} \in \{0, 1\}, y_{m} \in \{0, 1\}, q_{mzk} \in \{0, 1\}$$

$$x_{0} \cdot \sum_{j=1}^{J} x_{j} + (1 - x_{0}) \left(1 - \sum_{j=1}^{J} x_{j}\right) \geq 1$$

$$y_{0} \cdot \sum_{m=1}^{M} y_{m} + (1 - y_{0}) \left(1 - \sum_{m=1}^{M} y_{m}\right) \geq 1$$

$$\sum_{l=1}^{L} v_{jnl} = 1, \forall j, n \sum_{k=1}^{K} q_{mzk} = 1, \forall m, z$$

$$\sum_{j=1}^{J} x_{j} + \sum_{m=1}^{M} y_{m} \leq K$$

$$\sum_{n=1}^{N} \sum_{l=1}^{L} |v_{jnl} - v_{j'nl}| > 0, \forall j, j', j \neq j'$$

$$\sum_{z=1}^{Z} \sum_{k=1}^{K} |q_{mzk} - q_{m'zk}| > 0, \forall m, m', m \neq m'$$

$$i = 1, 2, ..., I; j = 0, 1, ..., J; m = 0, 1, ..., M;$$

$$n = 1, 2, ..., N; z = 1, 2, ..., Z; l = 1, 2, ..., L; k = 1, 2, ..., K$$

5. Case study

5.1. Background description

Taking a well-known automobile company in China as a case, the optimization process proves that the optimization model is applicable to the decision-making optimization problem of enterprises. At the same time, compare the results of the innovation decision of the enterprise under the influence of the four government policies. According to actual research, the government’s carbon emission limit for the company is 1000kg/year. The government subsidy carbon allowance policy is 8% (enterprise production of hybrid vehicles), 12% (enterprise hybrid vehicle production accounts for 50% or more of total production). The government’s tax incentives range from 3% (enterprise production of hybrid vehicles) and 7% (enterprise hybrid vehicle production accounts for 50% or more of total production). The government subsidy standard for hybrid vehicles is 18% of the selling price. This article will use the automotive enterprise as an application case to optimize its decision-making mechanism. Compare the innovation decisions of enterprises under the influence of four different policies.
Through the investigation and analysis of actual production, it is known that the composition and grades of the traditional and hybrid vehicles that the automobile company can produce, the grades and the cost of each grade (Tables 1, 2) and the carbon emissions of the production vehicles (Tables 3, 4).

Table 1. Traditional car attribute composition information.

| Attributes      | Attribute item | Type description        | Cost (yuan) |
|-----------------|----------------|-------------------------|-------------|
| Body structure  |                | Carrier                 | 10720       |
| Suspension      |                | All metal enclosed load bearing | 22360   |
| structure       |                | Multi-link suspension system | 900     |
| ...             |                | ...                     | ...         |
| Gearbox         | $a_{11}$       | MT                      | 1350        |
|                 | $a_{22}$       | CVT                     | 1690        |
|                 | $a_{33}$       | AT                      | 3050        |
| ...             |                | ...                     | ...         |

Table 2. Hybrid car attribute composition and related information.

| Attributes      | Attribute item | Type description                        | Cost (yuan) |
|-----------------|----------------|-----------------------------------------|-------------|
| Body structure  | $b_{11}$       | Carrier                                 | 10720       |
|                 | $b_{12}$       | All metal enclosed load bearing         | 22360       |
|                 | $b_{44}$       | Inline four-cylinder Atkinson cycle      | 73000       |
| engine          |                |                                         |             |
| Gearbox         | $b_{23}$       | MT                                      | 1350        |
|                 | $b_{33}$       | CVT                                     | 1690        |
|                 | $b_{73}$       | AT                                      | 3050        |
| ...             |                |                                         |             |

Table 3. Traditional car attribute grade composition and carbon emissions.

| Product serial number | Attribute level composition | Carbon emissions (t) |
|-----------------------|-----------------------------|----------------------|
| 1                     | $a_{11} a_{21} a_{31} a_{41} a_{51} a_{61} a_{71} a_{81}$ | 0.82                 |
| 2                     | $a_{12} a_{22} a_{32} a_{42} a_{52} a_{62} a_{72} a_{82}$ | 0.81                 |
| 3                     | $a_{13} a_{23} a_{33} a_{43} a_{53} a_{63} a_{73} a_{83}$ | 0.87                 |
| ...                   | ...                         | ...                  |
| 239                   | $a_{14} a_{24} a_{34} a_{44} a_{54} a_{64} a_{74} a_{84}$ | 1.14                 |
| 240                   | $a_{15} a_{25} a_{35} a_{45} a_{55} a_{65} a_{75} a_{85}$ | 1.17                 |

Table 4. Hybrid car attribute grade composition and carbon emissions.

| Product serial number | Attribute level composition | Carbon emissions (t) |
|-----------------------|-----------------------------|----------------------|
| 1                     | $b_{11} b_{21} b_{31} b_{41} b_{51} b_{61} b_{71} b_{81}$ | 0.99                 |
| 2                     | $b_{12} b_{22} b_{32} b_{42} b_{52} b_{62} b_{72} b_{82}$ | 0.97                 |
| ...                   | ...                         | ...                  |
| 169                   | $b_{13} b_{23} b_{33} b_{43} b_{53} b_{63} b_{73} b_{83}$ | 1.24                 |
| 170                   | $b_{14} b_{24} b_{34} b_{44} b_{54} b_{64} b_{74} b_{84}$ | 1.22                 |

5.2. mathematical model

This paper combines the actual situation of the automobile enterprise to give specific parameters, and builds a complete case of enterprise innovation decision-making mechanism optimization. Simplify the model appropriately without affecting the nature of the model, assuming that only one product
segment is considered, \( i = 1 \). Market size takes a fixed value \( Q_i = 1000 \). Through market research, the car company can produce the number of traditional car products \( J = 6 \), the number of hybrid car products \( M = 6 \). Utility functions \( U_{ij} \) and \( U_{im} \) are determined by \( \omega_{jn}, \mu_{inl}, \pi_{ij} \) and \( \omega_{im}, \mu_{ik}, \pi_{im} \). \( \mu_{inl}, \mu_{ik} \) are calculated by joint analysis (Tables 5, 6).

### Table 5. Traditional car attribute level utility value.

| Attribute item | \( \mu_{inl} \) | Attribute item | \( \mu_{inl} \) |
|----------------|----------------|----------------|----------------|
| 1_1            | 2.10           | 3_2            | 4.48           |
| 1_2            | 3.82           | 2_2            | 0.48           |
| 1_3            | 0.05           | 2_3            | 5.26           |
| 2_2            | 0.18           | 2_3            | 4.14           |
| 2_3            | 0.26           | 2_4            | 0.72           |
| 3_2            | 0.33           | 3_4            | 4.36           |
| 3_3            | 0.52           | 2_1            | 0.67           |
| 3_4            | 0.58           | 3_1            | 0.48           |
| 4_2            | -0.13          | 3_2            | 0.42           |
| 4_3            | 0.25           | 3_3            | 0.17           |
| 4_4            | 0.39           | 3_4            | 0.24           |
| 5_2            | 2.10           | 4_2            | 0.67           |
| 5_3            | 3.82           | 4_3            | 0.72           |
| 5_4            | 0.05           | 4_4            | 4.14           |
| 6_2            | 0.18           | 5_2            | 5.26           |
| 6_3            | 0.26           | 5_3            | 7.14           |
| 6_4            | 0.33           | 5_4            | 0.67           |
| 7_2            | 0.52           | 6_2            | 0.14           |
| 7_3            | 0.58           | 6_3            | 0.42           |
| 7_4            | -0.13          | 6_4            | 0.17           |
| 8_2            | 0.25           | 7_2            | 0.24           |
| 8_3            | 0.39           | 7_3            | 0.50           |
| 8_4            | 0.44           | 7_4            | 2.26           |
| 9_2            | 0.48           | 8_2            | 1.65           |

### Table 6. Hybrid car attribute level utility value.

| Attribute item | \( \mu_{inl} \) | Attribute item | \( \mu_{inl} \) |
|----------------|----------------|----------------|----------------|
| 1_1            | 2.10           | 3_2            | 6.73           |
| 1_2            | 3.82           | 2_2            | 0.48           |
| 1_3            | 0.05           | 2_3            | 5.26           |
| 2_2            | 0.18           | 2_3            | 4.14           |
| 2_3            | 0.26           | 2_4            | 0.72           |
| 3_2            | 0.33           | 3_4            | 4.36           |
| 3_3            | 0.52           | 2_1            | 0.67           |
| 3_4            | 0.58           | 3_1            | 0.48           |
| 4_2            | -0.13          | 3_2            | 0.42           |
| 4_3            | 0.25           | 3_3            | 0.17           |
| 4_4            | 0.39           | 3_4            | 0.24           |
| 5_2            | 2.10           | 4_2            | 0.67           |
| 5_3            | 3.82           | 4_3            | 0.72           |
| 5_4            | 0.05           | 4_4            | 4.14           |
| 6_2            | 0.18           | 5_2            | 5.26           |
| 6_3            | 0.26           | 5_3            | 7.14           |
| 6_4            | 0.33           | 5_4            | 0.67           |
| 7_2            | 0.52           | 6_2            | 0.14           |
| 7_3            | 0.58           | 6_3            | 0.42           |
| 7_4            | -0.13          | 6_4            | 0.17           |
| 8_2            | 0.25           | 7_2            | 0.24           |
| 8_3            | 0.39           | 7_3            | 0.50           |
| 8_4            | 0.44           | 7_4            | 2.26           |
| 9_2            | 0.48           | 8_2            | 1.65           |

5.3. Calculation solution

The optimization model of this paper is nonlinear, non-convex, and has 0-1 variables. The optimal or approximate optimal solution can be obtained by genetic algorithm. Set the initial population size to 100, the mutation probability to 0.005, the crossover probability to 0.6, and the algebra to 200. Get optimization results under four government policies (Tables 7-11).

### Table 7. Four government policy objectives optimization results.

| Government policy                          | Optimization Results |
|--------------------------------------------|----------------------|
| No support policy                          | \( F_i^* = 7.23 \)   |
| Increase carbon emissions policy           | \( F_i^* = 7.23 \)   |
| Low energy product subsidy policy | $F'_1 = 7.91$ |
|----------------------------------|----------------|
| Tax subsidy policy               | $F'_2 = 7.83$ |

Table 8. Enterprise optimization decision results without policy support.

| Enterprise product series | Attribute item |
|---------------------------|----------------|
| Traditional car#1        | $a_{11}, a_{22}, a_{33}, a_{44}, a_{55}, a_{66}, a_{77}, a_{88}$ |
| Traditional car#2        | $a_{11}, a_{23}, a_{34}, a_{45}, a_{56}, a_{67}, a_{78}, a_{89}$ |
| hybrid car#1              | $h_{11}, h_{22}, h_{33}, h_{44}, h_{55}, h_{66}, h_{77}, h_{88}, h_{99}$ |
| hybrid car#2              | $h_{11}, h_{22}, h_{33}, h_{44}, h_{55}, h_{66}, h_{77}, h_{88}, h_{99}$ |
| hybrid car#3              | $h_{11}, h_{22}, h_{33}, h_{44}, h_{55}, h_{66}, h_{77}, h_{88}, h_{99}$ |
| hybrid car#4              | $h_{11}, h_{22}, h_{33}, h_{44}, h_{55}, h_{66}, h_{77}, h_{88}, h_{99}$ |

Table 9. Enterprise optimization decision results supported by subsidized carbon allowance policy.

| Enterprise product series | Attribute item |
|---------------------------|----------------|
| Traditional car#1        | $a_{11}, a_{22}, a_{33}, a_{44}, a_{55}, a_{66}, a_{77}, a_{88}$ |
| Traditional car#2        | $a_{11}, a_{23}, a_{34}, a_{45}, a_{56}, a_{67}, a_{78}, a_{89}$ |
| hybrid car#1              | $h_{11}, h_{22}, h_{33}, h_{44}, h_{55}, h_{66}, h_{77}, h_{88}, h_{99}$ |
| hybrid car#2              | $h_{11}, h_{22}, h_{33}, h_{44}, h_{55}, h_{66}, h_{77}, h_{88}, h_{99}$ |
| hybrid car#3              | $h_{11}, h_{22}, h_{33}, h_{44}, h_{55}, h_{66}, h_{77}, h_{88}, h_{99}$ |
| hybrid car#4              | $h_{11}, h_{22}, h_{33}, h_{44}, h_{55}, h_{66}, h_{77}, h_{88}, h_{99}$ |

Table 10. Enterprise optimization decision results supported by low energy consumption subsidy policy.

| Enterprise product series | Attribute item |
|---------------------------|----------------|
| hybrid car #1             | $h_{11}, h_{22}, h_{33}, h_{44}, h_{55}, h_{66}, h_{77}, h_{88}, h_{99}$ |
| hybrid car #2             | $h_{11}, h_{22}, h_{33}, h_{44}, h_{55}, h_{66}, h_{77}, h_{88}, h_{99}$ |
| hybrid car #3             | $h_{11}, h_{22}, h_{33}, h_{44}, h_{55}, h_{66}, h_{77}, h_{88}, h_{99}$ |
| hybrid car #4             | $h_{11}, h_{22}, h_{33}, h_{44}, h_{55}, h_{66}, h_{77}, h_{88}, h_{99}$ |
| hybrid car #5             | $h_{11}, h_{22}, h_{33}, h_{44}, h_{55}, h_{66}, h_{77}, h_{88}, h_{99}$ |
| hybrid car #6             | $h_{11}, h_{22}, h_{33}, h_{44}, h_{55}, h_{66}, h_{77}, h_{88}, h_{99}$ |

Table 11. Enterprise optimization decision results supported by tax subsidy policy.

| Enterprise product series | Attribute item |
|---------------------------|----------------|
| Traditional car#1        | $a_{11}, a_{22}, a_{33}, a_{44}, a_{55}, a_{66}, a_{77}, a_{88}$ |
| hybrid car #1             | $h_{11}, h_{22}, h_{33}, h_{44}, h_{55}, h_{66}, h_{77}, h_{88}, h_{99}$ |
| hybrid car #2             | $b_{11}, h_{22}, h_{33}, h_{44}, h_{55}, h_{66}, h_{77}, h_{88}, h_{99}$ |
| hybrid car #3             | $b_{11}, h_{22}, h_{33}, h_{44}, h_{55}, h_{66}, h_{77}, h_{88}, h_{99}$ |
| hybrid car #4             | $b_{11}, h_{22}, h_{33}, h_{44}, h_{55}, h_{66}, h_{77}, h_{88}, h_{99}$ |

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5.4. Result analysis

Table 7-11 shows the cost-efficiency ratios of enterprise innovation decision-making schemes and innovation schemes under the influence of different government policies. The implementation of low-energy product subsidy policy has the highest profit, followed by tax incentives. Implementation of subsidized carbon allowance policy and unsupported policy. The main reason is that the government formulates different policies according to different environments, goals and political factors, and the company's goal is to maximize profits. Based on the enterprise perspective, the low-energy product subsidy policy can bring the maximum profit to the enterprise, followed by the tax preferential policy. Based on the government's perspective, low-energy product subsidy policies and tax incentives can change corporate decision-making programs to produce products with lower energy consumption. Under the influence of tax incentives, enterprises will tilt more resources to destructive innovation products, but will still retain some of the “cost-effective” higher maintenance innovation products. The low-energy product subsidy policy will prompt enterprises to invest all their resources in destructive and innovative products, which will lead to a significant increase in government fiscal expenditure. In summary, this paper believes that in order to encourage enterprises to produce more energy-saving and environmentally friendly products, the government should give corresponding policy support. It should be considered that low-energy subsidy policies can encourage enterprises to produce products with higher technological content and lower energy consumption under financial constraints.

6. Conclusion

This paper conducts a more in-depth study on the innovation decision-making dilemma faced by a group of post-development enterprises with independent research and development. Study the guiding effect of different government subsidy policies on enterprise innovation decision-making. This paper compares which government subsidy policy has the highest degree of promotion of low-carbon products, and provides a theoretical basis for government policy formulation and enterprise innovation decision-making. This paper selects a case of a domestic automobile enterprise, applies the decision-making system and the optimization model to obtain an innovative decision-making scheme that brings the maximum profit to the enterprise, and verifies the applicability and effectiveness of the model.

The research object of this paper has certain limitations, it is only for the independent research and development-oriented enterprises in an industry. Subsequent research can consider the impact of the same government policies on corporate innovation decisions in different industries. This paper establishes a relatively complete model, but it can be further improved in the case application, for example, it can increase the constraints of different market segments on the special requirements of the corresponding products.

Acknowledgement

Fund project: Ministry of Science and Technology Innovation Strategy Research Special Project (ZLY201621) (ZLY201709) (ZLY201731), Beijing Science and Technology Plan(Z181100004118003)

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