

# Empirical Study on the Impact of Bio-energy Policy on Economy based on Decision Tree Classification

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**Abstract.** China is currently in the critical stage of strategic structural adjustment, and the successful structural transformation not only means a qualitative leap in China's overall economic development, but also plays an important role in improving China's energy utilization efficiency. Facing the double pressures of international energy security and environmental degradation, biomass energy, as a new renewable energy source, has attracted unprecedented attention from all countries in the world. Developing biofuels has become a guide of energy policies in many countries including China. In this paper, a decision tree classification model is established to measure energy efficiency. Through theoretical analysis and empirical research, the impact of Bio-energy policy changes on economy is explored. The empirical results show that the adjustment of industrial structure has a significant impact on energy and environment, and the variables are highly sensitive, and the marginal cost of emission reduction is increasing. The conclusion of the study has forward-looking reference value for implementing the strategy of energy diversification and substitution, developing bioenergy and adjusting the policy system of agricultural development.

**Keywords:** Decision Tree; Energy Utilization Efficiency; Bioenergy Policy; Industrial Structure.

## 1. Introduction

In recent years, with the rapid advancement of China's urbanization process and the continuous expansion of population size, the contradiction between energy environment and economic development has become increasingly prominent. The problem of energy and environment is gradually moving from a marginal problem to the center of the global political and economic agenda [1]. For example, residents use electricity, coal and natural gas for living, coal, electricity and natural gas for heating, coal, oil and electricity for transportation, and coal, oil and electricity for machine operation in industrial enterprises. In recent ten years, China's total energy consumption has increased rapidly, becoming the largest energy consumer in the world, surpassing the United States [2]. Biomass energy, represented by biofuel ethanol and biodiesel, has developed rapidly in many countries around the world, and developing biofuels has become a guide of energy policies in many countries including China.

Overall, the total energy consumption in the world will continue to increase at an average annual rate of more than 1% in the next 20 years, and fossil energy will remain above 60% under the premise that the current laws and policies remain basically unchanged [3]. At the same time, with the rapid development of technology and the shortening of the cycle of scientific and technological innovation, the scope of network cultural products spreading in cyberspace has been continuously expanded [4]. We will use decision model tree as a data mining technology to classify economic information data, establish a decision tree classification model, and analyze the effectiveness of the classification model. It can automatically search the database to find hidden data patterns and find out the prediction information that even experts may miss, thus alleviating the problem of "rich data but poor knowledge" to a certain extent.

## 2. Decision Tree Classification Model

Decision tree is a data mining method to solve the classification problem in practical application, which is intuitive, high in classification rate and easy to understand. Decision tree model can be represented by graphics or rules, and these rules are easy to explain and understand, easy to use and

effective [5]. In the future, the improvement of biofuel production technology will focus on the selection of raw materials and the reduction of cost. This situation is in sharp contrast with the requirements of non-renewable fossil energy, gradual depletion of energy resources and energy conservation and emission reduction. Through the purchase of products and services, funds flow from the government and residents to enterprises; The government takes various taxes as the main capital inflow, and the transfer payment to enterprises and residents as the main capital outflow; Branches are established by different values of this attribute, and then the method is recursively called to establish branches of decision tree nodes for subsets of each branch until all subsets only contain data of the same category. Finally, a decision tree is obtained, which can be used to classify new samples.

Compare the attribute values at the internal nodes of the decision tree, and branch down from this node according to different attribute values. The leaf nodes are the classes to be divided. People can divide the samples into several groups by using the branches of each node in the tree, and classify the data by selection. Can process incomplete data. This model can not only explain the dynamic correlation among variables, but also avoid the problem of large estimation error caused by the complexity of endogenous variables.

### 3. Construction and Analysis of Decision Tree Model of Bioenergy Policy's Impact on Economy

#### 3.1 Model Design and Data Processing

For a long time, China's rural energy problems have been separated from the national energy system, and rural areas cannot enjoy the national energy public services like cities. Although it is convenient for research and calculation, the results are out of line with production practice, and the representativeness of data needs to be considered. Discretization of continuous value attribute value means setting several discretization points in the range of specific continuous value attribute, dividing the range of attribute into some discretization intervals, and finally representing the attribute value falling in each sub-interval with different symbols or integer values. Although the production of biofuels requires the input of petrochemical energy, there is more energy after conversion, which is meaningful from the perspective of output-input ratio, which not only increases the amount of energy but also prolongs the service life of fossil energy.

Technological progress in fuel ethanol production determines the conversion rate of corn ethanol, which has an important impact on the profit of ethanol production [6]. Let  $P_e$  and  $P_f$  be the price of ethanol and its input factor, that is, energy, respectively. Under the given technology and price conditions, the fuel ethanol producers pursue the maximum profit output, which can be obtained

$$\begin{aligned} \max_{Q_e} \pi_e &= P_e Q_e - P_c Q_c - P_f Q_f \\ &= P_e V_{c,e} - P_c Q_c - P_f V_{c,f} Q_c \end{aligned} \tag{1}$$

$\pi$  is the profit of fuel ethanol production, and  $Q_i$  is the quantity of commodity  $i$  including ethanol, corn and energy? Generally speaking, we think that the price of ethanol is an exogenous variable, that is, its price will not be affected by the output of ethanol.

Therefore, the long-term equilibrium conditions of ethanol production are as follows

$$\frac{\partial \pi_e}{\partial Q_e} P_c V_{c,e} - P_c - P_f V_{c,f} \leq 0, \frac{\partial \pi_e}{\partial Q_c} = 0, Q_c^{eD} \geq 0 \tag{2}$$

Where  $Q_c^{eD}$  is the equilibrium demand of corn in ethanol production, we can express the corn demand of ethanol plant as follows

$$\begin{aligned} & \text{if, } P_c - P_e V_{c,e} - P_f V_{c,f}, \text{ then, } Q_c^{eD}(P_c) = +\infty \\ & \text{if, } P_c > P_e V_{c,e} - P_f V_{c,f}, \text{ then, } Q_c^{eD}(P_c) = 0 \end{aligned} \quad (3)$$

Formula (3) shows that when the price of corn is equal to the difference between the value of ethanol converted from one unit of corn and the cost in the conversion process, the demand for corn in ethanol production is completely elastic, but when the price of corn is higher than the difference between the value of ethanol per unit and the conversion cost, the demand for corn in ethanol production is zero.

The advantages and functions of bioenergy determine its positive role and rising status in the realization of fossil energy substitution strategy. At present, China's agricultural and forestry labor intensity is high, the degree of environmental pollution is high, the idle rate of agricultural and forestry fields is high, the degree of mechanization is low, the utilization rate of agricultural and forestry resources and the rate of return on investment are low, and farmers' enthusiasm for farming is low [7]. When constructing a node of decision tree, the information gain rate of discrete value attribute only needs to be calculated once. Under the influence of economic policies, due to the change of capital price, enterprises can adjust the capital stock, realize the free flow of capital, and finally realize the full use of capital.

### 3.2 Empirical Results and Analysis

Using crops with high input and low biodiversity as biofuel raw materials may have the effect of increasing greenhouse gas emissions. Even considering the policy support factors for renewable energy, bioenergy cannot become the main force of energy consumption, let alone the mainstream. That is to say, at present, the improvement of energy utilization efficiency by technological progress is still in a state of slight inhibition, and if it continues to develop, it will turn inhibition into promotion, and its role can not be ignored. The contribution of technological progress is less than that of industrial structure. The development and utilization of forest biomass energy has changed the combination ratio of various departments of agricultural production structure, increased the content of agricultural production, especially extended the forestry production chain, and created more employment opportunities for forest farmers. With the addition of new industries and new energy enterprises, the path dependence of economy and society on environment for growth has been weakened, and the carbon emissions and carbon emission intensity have obviously improved.

In China, the demand and price of corn increased due to the development of biofuels, which led to the price increase of downstream products such as pork, chicken and eggs. There is a strong correlation between the prices of corn and related agricultural products. Let the relation equation between agricultural product price and corn price be as follows

$$\ln P_i = \varepsilon_{0i} + \varepsilon_{1i} \ln P_c \quad (4)$$

Among them,  $P_i$  represents the prices of various agricultural products. This paper mainly studies the prices of pork, chicken, eggs and milk mainly consumed by Chinese consumers, and  $P_c$  represents the price of corn.

Data from 2010 to 2019 are selected for pork prices, and data from 2015 to 2019 are selected for chicken, eggs and milk prices. The results of regression estimation of this model by software are given in Table 1.

At present, the key development field is directional cultivation of energy forest, and the forest coverage rate is bound to be greatly increased through improved seed selection and intensive cultivation of energy plants. Because of the rebound effect of technological progress, it will promote economic development and increase energy consumption [9], and inhibit energy utilization efficiency. The performance of the new agricultural system in time and space is that modern biotechnology has

changed the content, form and rhythm of biomass and energy transformation, thus greatly expanding the time and space scope of agricultural production. With the continuous innovation and progress of technology, school-enterprise cooperation, enterprises and institutions jointly develop new energy products, energy-saving products and energy-saving technologies and other high-tech products, which can not only reduce primary energy consumption, but also create more economic and ecological values, and then promote the positive development of energy utilization efficiency in the future.

**Table 1.** Estimation results of correlation degree parameters between related agricultural product prices and corn prices

Variable	Coefficient	AdR <sup>2</sup>	t-statistic	DW
Pork price	0.9224	0.9827	10.2473	1.9508
Chicken price	0.7012	0.9046	6.6522	2.2135
Chicken and egg price	0.6691	0.8546	5.0196	4.0127
Milk price	0.3341	0.8790	3.4018	2.2881

The proportion of oil consumption, natural gas consumption and primary power and other energy consumption are highly correlated, and the correlation between natural gas consumption and primary power and other energy consumption is higher than 0.6. In addition, because the  $P$  value corresponding to the  $t$  value of oil consumption ratio coefficient is the largest, we can try to eliminate the explanatory variable of oil consumption ratio first. Re-establish the regression model between energy utilization efficiency and other explanatory variables, which is as follows:

$$LN(NLX) = B_0 + B_1LN(MX) + B_2LN(TX) + B_3LN(DX) + \varepsilon_0 \quad (5)$$

The regression results of the model (5) (Table 2) show that the goodness of fit  $R^2$  of the regression model is 0.8762, and the adjusted goodness of fit  $R^2$  is 0.9632. The significance  $F$  value of the equation passes the test, which shows that the model fits the dependent variable well.

**Table 2.** Model regression results

Explanatory variable	Coefficient	T statistical value	P value
Constant term	9.3271	40.1283	0
Proportion of coal consumption	-2.5071	-5.6637	0.0004
Proportion of natural gas consumption	0.0729	14.6029	0
Proportion of primary power and other energy consumption	0.0936	12.0179	0.0261
R-squared	0.8762	F-statistic	354.7162
Adjusted R-squared	0.9632	Prob(F-statistic)	0
Durbin-Watson stat	1.8059		

The development of forest biomass energy industry has become a "non-food" characteristic road of developing biomass energy in China, but attention should be paid to the secondary pollution problems in its production process. Industrial emissions are the main component of total carbon emissions in society, and energy is the main input and output consumable of industry, especially high energy-consuming industries. When the proportion of secondary industry is reduced, it brings "dilution effect" of high-density energy clusters. At present, the cost of biofuels in major biofuel producing countries is higher than that of traditional fossil fuels. Therefore, if biofuels are widely used in the future, the cost must be reduced. For example, in the past, the production mode of growing in a climate suitable area and occupying a large amount of farmland and pasture was adopted, and now and in the future, it can be carried out in a wider range of natural conditions or indoors.

## **4. Policy Recommendations**

### **4.1 Looking for Alternative Sources of Raw Materials and Taking the Development Path of Fuel Ethanol based on Non-grain**

From the experience of biofuel development in various countries, basically, all countries in the world develop biofuels according to their own advantages of resources. The high consistency of life essence makes it possible for genes to be transformed and expressed between different organisms, so that genes from two life forms can be integrated. In order to increase the share of the tertiary industry and reduce the share of the secondary industry while maintaining the continuous development and progress of the economy, the government needs to assist industrial enterprises to understand the opportunities and risks inherent in the low-carbon transformation of the industrial sector. We should give preferential policies to the biomass energy industry, focus on supporting the training, technology and information services provided by biomass energy enterprises for farmers, as well as the introduction and promotion of new varieties and technologies, and spare no effort to create a good market environment for its industrial development.

### **4.2 It is Necessary to Adhere to Scientific Development and Open up a Development Path of Diversified and Diversified Models**

It is necessary to take the technological research and development and independent innovation of forest biomass energy as the priority areas of industrial development planning, and actively introduce foreign advanced technology, equipment and funds to actively promote international cooperation and exchanges in the development and utilization of forest biomass energy; Seeking new alternative raw materials does not mean that China will not produce corn ethanol in the future, but we should focus on how to adjust the industrial structure of corn processing industry and improve production efficiency and use efficiency in the future. Therefore, on the one hand, the government can continue to urge the coal mining and washing industry to withdraw from the market; on the other hand, industrial enterprises can reduce the energy consumption of high energy-consuming enterprises by introducing energy-saving and emission-reducing technologies, innovating new energy products or transforming industries (transforming to modern service industries).

### **4.3 Make Full Use of China's Marginal Land Resources, Adhere to Non-grain Oriented, and Build a Diversified Supply System for Biofuel Ethanol Raw Materials**

For China, a developing country with a large population and a small land, the cultivated land resources are very limited, and food security is very important. Therefore, the feasibility of producing biofuel ethanol from corn, wheat and other food crops is very small. The coordination of bioenergy policy system mainly includes: fully developing Non-grain crops and using non-cultivated land, and actively developing the second generation technology and industry of biofuels; Pay attention to the protection of soil environment and biodiversity in the process of grabbing land biomass; At present, China is in the period of rapid urbanization. Accelerating the reform of economic system and promoting the optimization and upgrading of industrial structure are the primary tasks of socialist modernization. We must fully understand the life cycle characteristics of industrial development from the strategic perspective of sustainable development, and formulate a long-term and targeted policy system for it, especially to establish special countermeasures for the characteristics of forestry production and management.

## **5. Conclusion**

In this paper, the decision tree classification method is used to compare the production cost and raw material cost of biofuels with different raw materials, the production and use status, development goals, development policies and development potential of biofuels in major biofuel producing countries in the world. On the whole, the downward adjustment of the proportion of the secondary

industry will reduce the energy dependence of the whole society and drive the economic environment to develop intensively, but the simple de-industrialization development will also bring serious negative economic growth problems; Enterprises are the main body of economic development and the direct practitioners of production methods, while some enterprises are the destroyers of the environment. Therefore, enterprises themselves should increase the proportion of R&D investment in total expenditure. For lignocellulosic fuel ethanol technology, on the basis of increasing technology research and development in the future, improving the production technology of cellulase and xylanase and improving the fermentation conversion efficiency of pentose will be the key technical research points in the future.

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