

Study on the Current Situation and Prospects of China's Pet Industry based on the GWO-ARIMA Model

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Abstract

With the economic development and the change of people's consumption concept, the pet industry has rapidly occupied the market share and driven the development of related industries, in order to further understand the current situation of the industry and its development prospects, to carry out this research. Based on the GWO-ARIMA model, the three major indicators for evaluating the development of the industry are "pet food", "pet supplies" and "pet services", and the data of the indicators in the past five years are collected and analyzed. Then, based on the correlation analysis-Pearson model, we select the influencing factor indicators and analyze the influence of each indicator on the development of the industry through heat map. Finally, we use the multiple linear regression model and the GWO-ARIMA model to predict that the development of China's pet industry in the next three years will be an upward trend with a bright future.

Keywords

GWO-ARIMA Model; Correlation Analysis-Pearson Model; Multiple Linear Regression Model.

1. Introduction

With the development of the economy, the improvement of people's income level, and the transformation and upgrading of consumer concepts, the pet industry has developed rapidly in the world and entered the Chinese market. In recent years, the share of the pet industry in China's consumer market has gradually increased, and it has also led to the rapid development of related industries, so the development trend and market demand of the pet industry have attracted widespread attention [1]. In order to further understand the current situation and development prospects of the pet industry in China, we launched a study.

2. Notation

Table 1. Notation

Notation	Mean
G_i	GDP
I_i	Per Capita Disposable Income
L_i	Personal Preference
F_i	Household Penetration
r	Correlation Coefficient

3. Data Sources

In order to establish a more accurate mathematical model to reasonably analyze and predict the development of the pet industry, this paper collects the relevant data to establish the model. Due to the large amount of data, different data units in each dataset, and different levels of valid information, this paper does not specifically enumerate, but only provides data sources as shown in Table 2 below.

Table 2. Data Website

Database	Website
China National Bureau of Statistics (NBS)	https://zh.tradingeconomics.com/
National Bureau of Statistics of China	https://www.stats.gov.cn/sj/
A comprehensive global data repository	https://www.statista.com/
Google Trends	https://trends.google.com/trends/

4. Development of China's Pet Industry

In order to better analyze the development of China's pet industry, we have selected three major indicators, namely “pet food”, “pet supplies” and “pet services”, and collected the profits of these indicators over the past five years to further reflect the development. In order to better analyze the development of China's pet industry, we have selected three major indicators, namely “pet food”, “pet products” and “pet services”, and collected the profits of these indicators in the past five years.

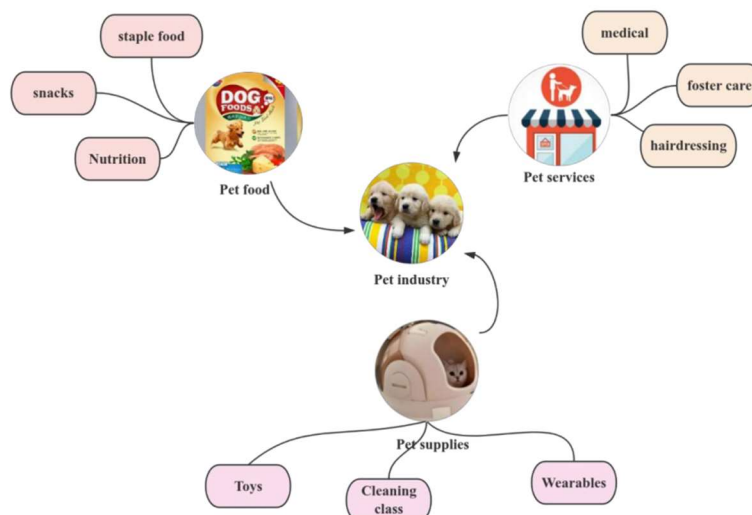


Figure 1. Three major indicators reflecting the development of the industry

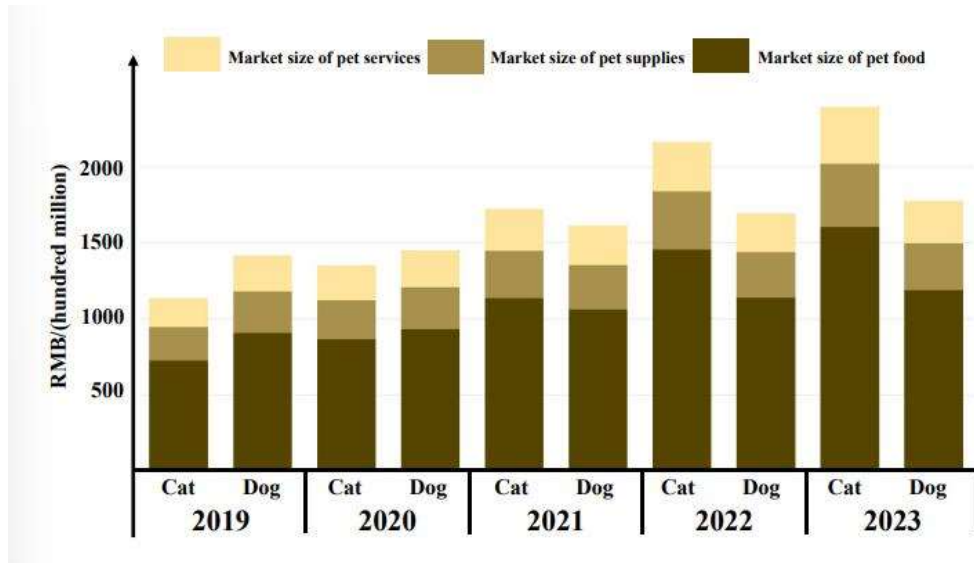


Figure 2. Distribution of profits in the last five years for the three main indicators

Through the profit statistics of the three major indicators in the past five years, the scale of China's pet market has been expanding year by year, and the pet industry has been developing rapidly. As an emerging industry, China's pet industry has maintained a high growth trend since its formation. According to the survey, the scale of China's pet economy industry is expected to reach 592.8 billion yuan in 2023, a year-on-year growth of 20.1%. Although this growth rate has fallen back from 2022, after three years of deposition of the epidemic, China's pet industry has entered a relatively stable state of development [2].

With the gradual change of pet-keeping people's emotions towards pets and the gradual deepening of pet-keeping cognition, their consumer spending on pets has also increased, thus promoting the growth of consumption in various subsectors such as pet food, supplies, medical care, health, retail, etc., and China's pet economy industry still has a broad space for growth.

5. Correlation Analysis - Pearson Model

5.1 Selection of Indicators

- **GDP(G_i)**

Gross Domestic Product (GDP) is the total value of production and services produced in China in a year, denoted by G_i . To some extent, pet ownership and the development of the pet industry are closely related to the GDP and the Gross Domestic Product (GDP). According to the College of Zoology, China Agricultural University, when a country's GDP per capita is between 3,000 and 8,000 dollars, the pet industry will develop rapidly [3].

Per Capita Disposable Income

- **Correlation Analysis - Pearson Model(I_i)**

Per capita disposable income refers to the portion of per capita income that is freely disposable after deducting all kinds of taxes and other expenses, and is denoted by I_i . Generally speaking, per capita disposable income is directly proportional to the standard of living, so it can be used as an impact indicator to measure the development of the pet industry.

- **Personal Preference(L_i)**

Individual favoritism refers to how much people like pets like kittens and puppies, and is measured by traffic, which is the ratio of the number of views people collect on cats and dogs pets in a given year to the total number of searches in a given year, denoted by L_i . Defined as (i denotes year i):

$$L_i = \frac{P_{i\text{search}}}{P_{i\text{total}}} \quad (1)$$

• Household Penetration(F_i)

Household penetration rate is the ratio of the number of households with kittens and puppies pets to the total number of households in a given year, and is denoted by F_i . Definition:

$$F_i = \frac{f_{i\text{own}}}{f_{i\text{total}}} \quad (2)$$

5.2 Model Building

The correlation coefficient was first designed by the statistician Karl Pearson as a statistical indicator of the value of the linear correlation commitment between the study variables, usually denoted by the letter r . *Pearson* correlation coefficient is a measure of whether or not two sets of data are on top of a line, and it is used to measure the linear relationship between variables.

$$r = \frac{\sum (x - \bar{x})(y - \bar{y})}{\sqrt{\sum (x - \bar{x})^2 \sum (y - \bar{y})^2}} \quad (3)$$

For the above two variables x , y , according to the size of the final value of r , to determine the relationship between the two, when the value of r is 0, the two variables have no relationship; when x increases, y also increases, the two variables into a positive correlation; when x increases, y decreases, the two variables into a negative correlation; when the larger the absolute value of r , the greater the correlation of the variables.

5.3 Solution of the Model

In order to further study the development of China's pet industry, we chose to use “the number of pets” as an indirect indicator, reflecting the intensity of the development of the pet industry through the number of pets; through the correlation analysis of the indicators and “the number of pets” to get the correlation degree, the results are shown in Figure 3 below. The results are shown in Figure 3 below, and then we analyze the influencing factors of the pet industry.

As can be seen from the heat map, the correlation coefficients of the three indicators of “GDP”, “per capita disposable income” and “household penetration rate” all exceed 0.9, and the correlations of “per capita disposable income” and “household penetration rate” are highly close to 1, indicating that these three factors have a great influence on the development of the pet industry. The correlation coefficients of “per capita disposable income” and “household penetration rate” are highly close to 1, with strong correlation, indicating that these three factors have a great influence on the development of the pet industry; the correlation coefficient of personal preference is 0.67, with a lower correlation than the other three factors, but it is also a strong correlation, and has a great influence on the development of the pet industry. The correlation of personal preference is 0.67, which is lower than the other three factors, but also belongs to the strong correlation, and has a certain influence on the development of pet industry.

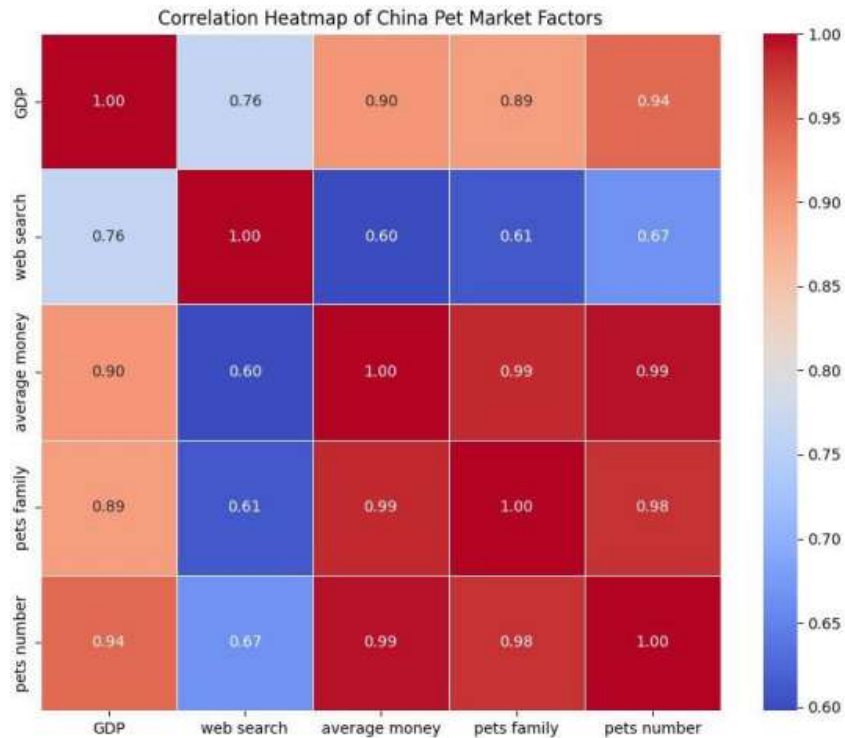


Figure 3. Heat map of impact factors

It can be seen that “GDP”, “disposable income per capita”, “household penetration rate” and “personal preference level” will all have an impact on the development of the pet industry. According to the survey, China's per capita GDP reaches RMB 80,976 in 2021, which is much higher than the upper limit of the growth of the pet industry, further boosting the development of China's pet industry. Meanwhile, household disposable income provides a solid material foundation for pet ownership. Since 2016, the per capita disposable income of China's residents has been growing steadily year by year, and the consumption capacity of the residents has been increased accordingly, which provides a broad growth space for the development of the pet consumption market, and is beneficial to the rapid growth of the industry's market size.

6. GWO-ARIMA Model Predicts Trends

6.1 Modeling of Multiple Linear Regression

Multiple linear regression is a complex model in regression analysis that considers the effects of multiple input variables on output variables. The expression underlying the regression equation is:

$$f(x) = \beta x + b \tag{4}$$

Where: x is the input vector, which contains multiple features (independent variables); $f(x)$ is the output or response of the model (target variable for prediction); β is the feature weights; and b is the intercept or bias of the model. Therefore, we build the model based on the above four indicators as follows:

$$f(x) = \beta_1 + \beta_2 G_i + \beta_3 I_i + \beta_4 L_i + \beta_5 F_i \tag{5}$$

As a result, the regression coefficients for each indicator can be obtained as shown in Table 3 below:

Table 3. Regression Coefficients for Indicators

Regression Coefficient	
β_1	-40.120693
β_2	10.815275
β_3	-7.549667
β_4	-1.117824
β_5	51.555167

After obtaining the regression coefficients of each indicator, the new regression equation can be obtained:

$$f(x) = -40.120693 + 10.815275G_i - 7.549667I_i - 1.117824L_i + 51.555167F_i \quad (6)$$

6.2 GWO-ARIMA Modeling

The GWO-ARIMA model combines the GWO algorithm and the ARIMA model to better capture the features and patterns of the time series data, thus improving the accuracy and reliability of the forecast.

• GWO

Gray wolves belong to the group-living canids, which are at the top of the food chain and strictly abide by the hierarchy of social domination, GWO mimics the predatory strategy of gray wolf packs by aiming at wolf tracking, encircling, pursuing, and attacking the prey to achieve the optimal search. α 、 β 、 δ 、 ω represent the optimal, suboptimal, third-best, and other solutions, respectively.

• ARIMA

The differential autoregressive moving average model is a combination of the autoregressive model AR, the moving average model MA, and the differencing method, which gives the differential autoregressive moving average model ARIMA(p 、 d 、 q), where p is the number of autoregressive terms, q is the number of moving average terms, and d is the number of differencing done when the time series becomes smooth.

Modeling steps for the ARIMA model:

- (1) Perform a smoothness test on the plot of the sequence to observe whether the sequence is smooth or not, and for non-smooth time series to be transformed into a smooth sequence by first performing a d -order difference.
- (2) After the first step, a smooth time series has been obtained. The smooth time series should be obtained its own correlation coefficient ACF, and partial autocorrelation coefficient PACF, and the optimal order p and q should be obtained by analyzing the autocorrelation and partial autocorrelation diagrams or through AIC/BIC search.
- (3) From the above obtained values of p 、 d 、 q , the ARIMA model is obtained, and then the model test of the obtained model is started [4].

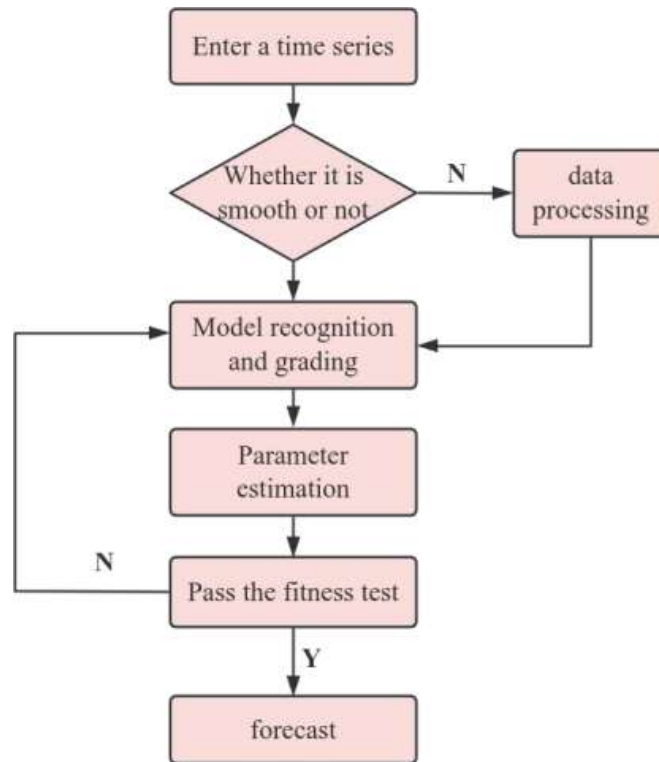


Figure 4. ARIMA Model Flowchart

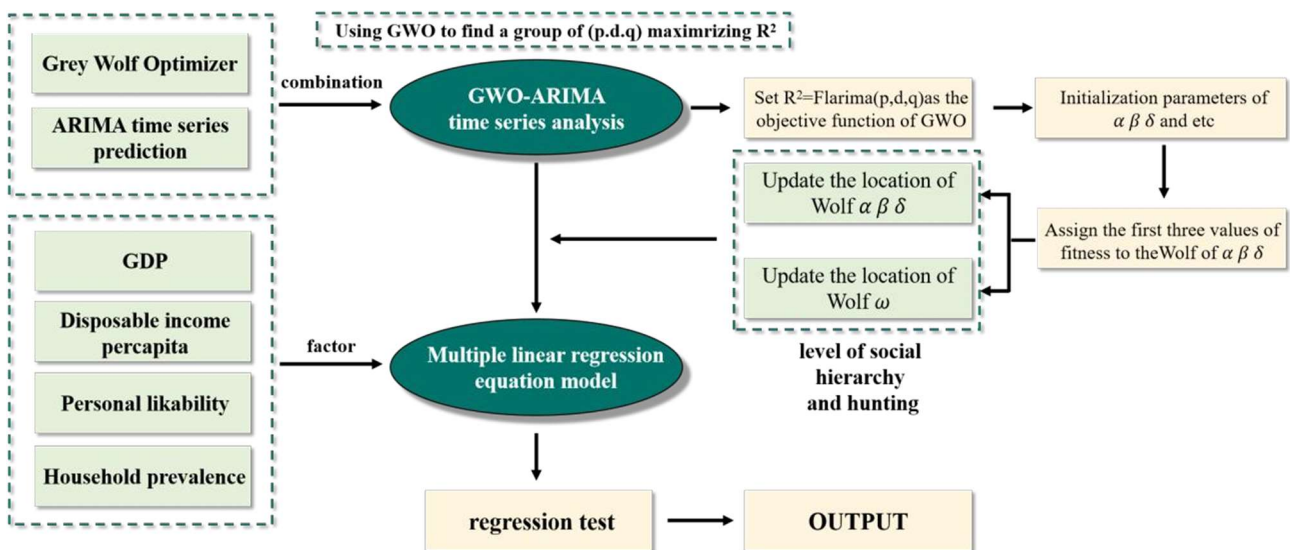


Figure 5. GWO-ARIMA Flowchart

6.3 Projected Results

According to the multiple linear regression model based on four indicators, namely “GDP”, “disposable income per capita”, “personal preference” and “household penetration rate”, the total profit of the pet industry in the past five years is defined and calculated as the evaluation index of the industry development. The multiple linear regression model based on four indicators defines and calculates the total profit $f(x)$ of the pet industry in the past five years as the evaluation index of the industry development, and predicts the development of the industry in the next three years according to the GWO-ARIMA model as shown in Figure 6 below.

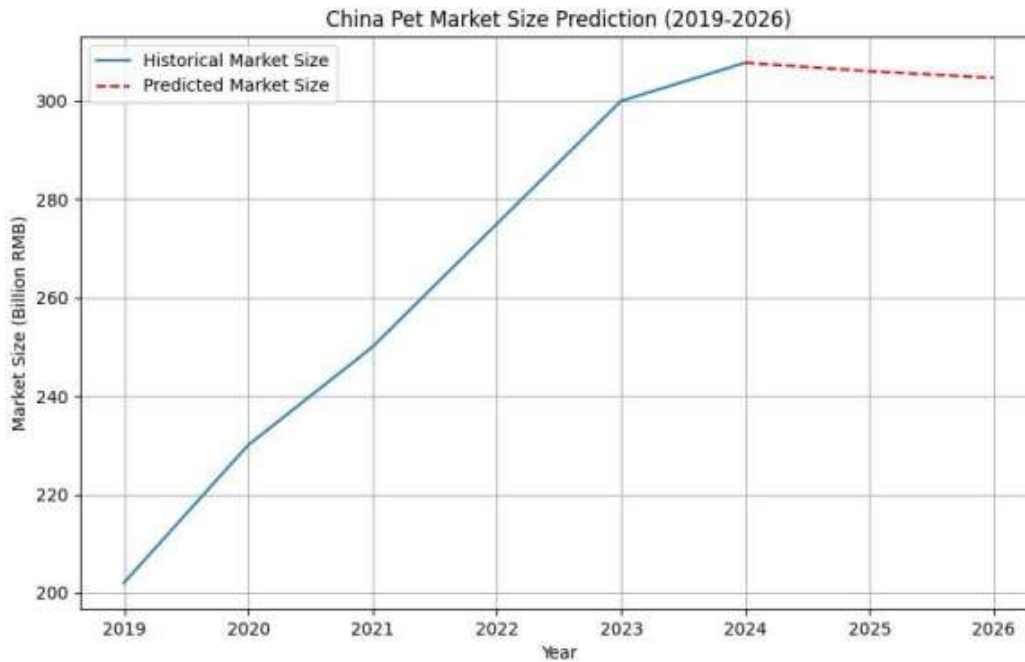


Figure 6. Predictions from the GWO-ARIMA model

From the forecast results, it can be seen that the development of the pet industry will maintain a high growth rate from 2019-2023, the development trend is relatively stable, but the growth rate will slow down from 2023-2024, and it is predicted that the market size of the pet industry will steadily expand from 2024-2026, but the growth rate may continue to decline; this is related to the intensification of competition in the market, the changes in consumer demand and the increase in pressure on corporate innovation, but the overall remains on an upward trend with favorable development prospects.

7. Conclusion

According to the research results, China's pet industry as an industry with great development potential will continue to grow in the next three years, the market size will further expand, but the growth rate will slow down or decline, which is related to a variety of factors.

With the development of the industry, the competition within the industry has gradually intensified, which to a certain extent may cause the growth rate to slow down; secondly, although the increasing number of singles and the elderly provides some growth potential for the pet industry, this growth momentum may weaken over time [5]. For this reason, it is necessary for companies to ensure the sustainable development of the pet industry by diversifying their market layout, optimizing their supply chain management, strengthening their branding and other strategies in accordance with changes in consumer demand.

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