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Research on the Pet Industry Based on Multiple Linear Regression Model

Zongyuan Liang*, Jiyan Zhang

School of Computer Science and Engineering, Linyi University, Linyi 276000, China
* **Corresponding author**: Zongyuan Liang (Email: 15725622845@163.com)

Abstract: The Chinese pet industry has a broad international market but also contends with complex international situations and a volatile market environment. Thus, scientifically analyzing and predicting its development trends is crucial. This paper examines recent data trends, using normality tests, correlation analysis, the entropy weight method, time series models, multiple linear regression models, and software like MATLAB, SPSS, and EXCEL to analyze and predict the industry's development and propose strategies. A visual line chart of pet market development was drawn based on data analysis to intuitively assess the situation. Normality and correlation analyses were done, yielding key results. The entropy weight method showed the comprehensive score increasing yearly, suggesting a rising market demand for pet food and related sectors. Leveraging collected data on global pet markets, an ARIMA time series model was built for future predictions. Multiple linear regression and multi-scenario analyses were also carried out, revealing an overall upward trend in the pet industry market.

Keywords: Normality Test, Ridge Regression Model, ARIMA Model, Polynomial Regression Model

1. Introduction

With the development and enhancement of China's comprehensive national power, people's living standards are rising, and their pursuit of a better life is becoming increasingly rich. People's love for pets is also heating up, easing the pressure brought by the fast-paced social life. As an emerging industry, the pet industry has been developing rapidly worldwide in recent years, and the market continues to expand. Various pet foods and brands such as Chun have entered the public eye, reflecting the growing acceptance and demand for pet ownership[1][2].

In recent years, scholars at home and abroad for the pet industry research is mainly focused on the development of the market scale and consumption trends, the existing research pointed out that the pet market presents a 'cat and dog double-drive' characteristics, in the consumption structure, food accounted for a large proportion of about 52.3%, followed by pet medical and supplies[3]. However, the existing research mostly stays in descriptive statistics and lacks in-depth description of the economic and social factors behind the consumption behaviour of the pet market.

This paper aims to fill the gap of existing research through multi-model fusion and multi-dimensional analysis. The collected data on the global pet market covers indicators such as the number of pets, food sales, and consumption specifications. Time series modelling, multiple linear regression and entropy weighting are used to capture short-term fluctuations and long-term development trends in the pet market, and changes in demand for pet food, medical care and other segments are assessed through objective empowerment methods. Breaking away from single-market analysis, the study takes into account both domestic and international factors to simulate the development path of the pet market under different scenarios, and puts forward targeted policy recommendations.

2. Research on pet related indicators

Firstly, the team set eight indicators, including the number of pet dogs, pet dog food market sales ($ billion), average annual consumption of pet dogs alone ($), pet dog food market size ($ billion), the number of pet cats, pet cat food market sales ($ billion), average annual consumption of pet cats alone ($), pet cat food market size ($ billion)[4][5]. It is used as an indicator to analyse the development of the collected data on pet development in the last 5 years and as an impression of the forecasted development of the pet industry in the future.

The team has collected data on the development of the pet industry for the period 2019-2023 based on China's import and export data on pet products, as well as reports from relevant national pet organisations and academic papers, as shown in Figure 1, but some of them are missing in the process of data collection, in order to establish an ideal and appropriate model, we carried out data preprocessing, for which the data were filled with linear fitting, the construction method is as follows:

$$x_t = x_{t-1} + \frac{x_{t+1} - x_{t-1}}{2} \tag{1}$$

x_ts the point in time at which the missing values, x_{t-1} and x_{t+1} are known points in time.

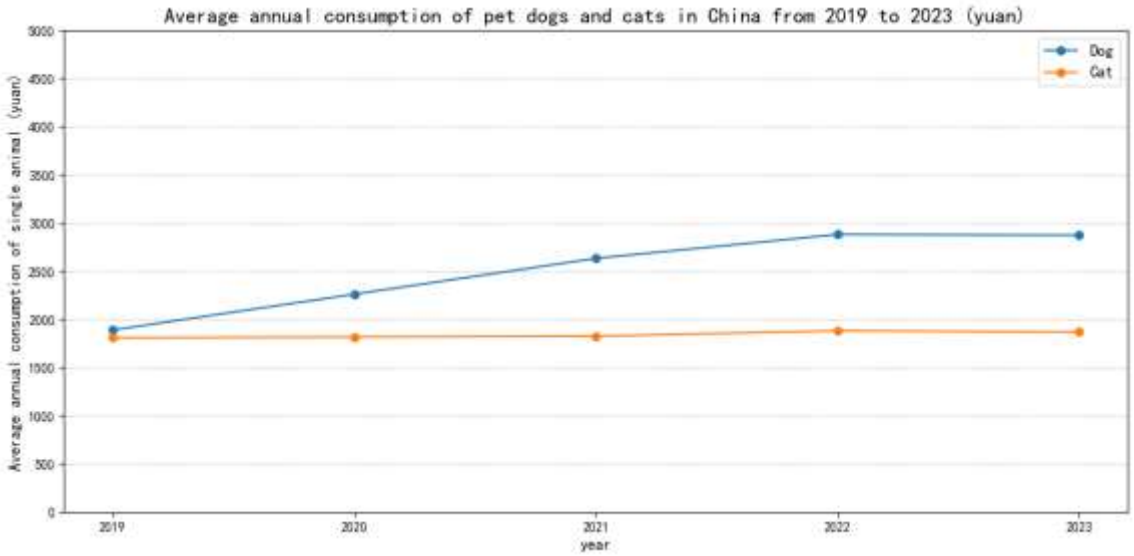


Figure 1. Average annual consumption of pet dogs and cats in China

Based on the analysis of the historical data of the pet development industry, the team found that with the continuous development of time, the economic benefits of the pet industry show a gradual upward trend and rapid development. Through investigation and research, the team found that the reason may be due to the continuous improvement of social life, people's lives have been satisfied, for owning pets as their spiritual support for the increasingly strong demand.

2.1. Analysis and judgment

With the data collected, we have analysed the development of the pet industry accordingly for the last 5 years i.e. 2019-2023, during which the pet industry has shown an upward trend, but has been developing more slowly and with a lower share of the market[6][7], and have come up with the following development pattern chart as shown in Figures 2 and 3:

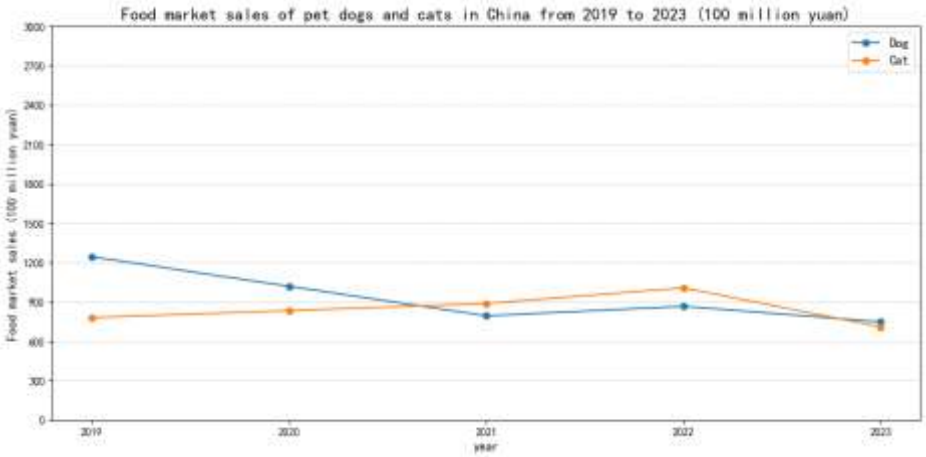


Figure 2. Changes in Consumption Scale of Pet Cats and Dogs in the Year of the Dog

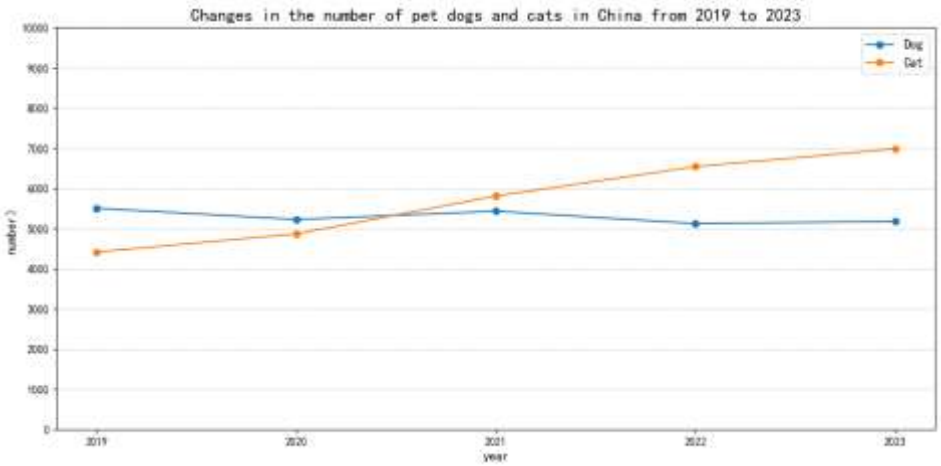


Figure 3. Changes in the development of the pet cat and dog food market

The development of the number of pet dogs is slightly on a downward trend and is gradually leveling off, while the number of pet cats is rapidly increasing year by year, gradually occupying a dominant position in the pet market,as shown in Figure 4.

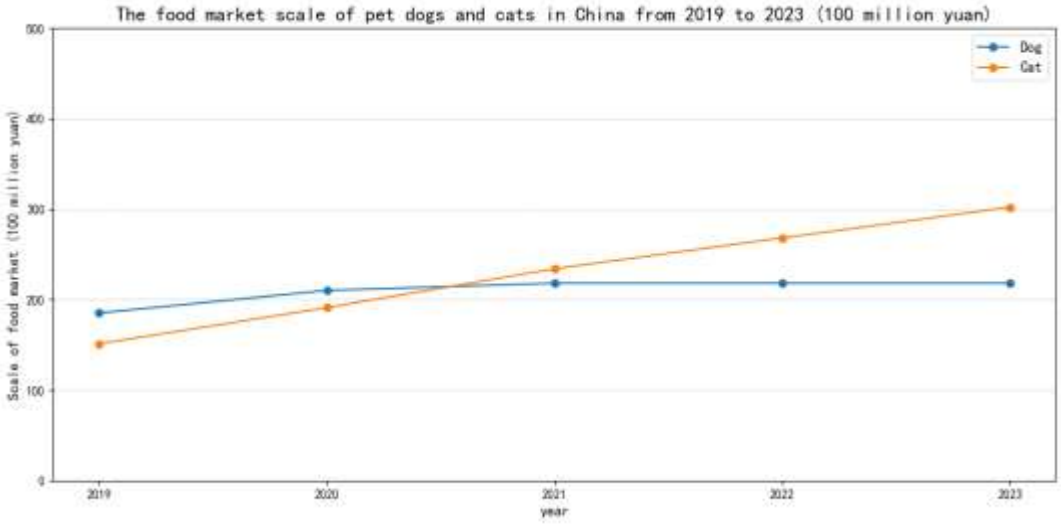


Figure 4. Changes in the size of the pet cat and dog consumption market

Overall, the pet market industry shows an upward trend during the period 2019-2023, in which the number of pet cats increases year by year until 2022, the number of pet dogs decreases slightly, and both show a decreasing trend from 2022-2023. Relatively speaking, pet cats gradually occupy the big head of market pet sales.

2.2. Mathematical modeling

2.2.1. Normality test

The normality test was first performed for the imported data by using the Anderson-Darling normality test, the Anderson-Darling statistic A2 was used to measure the difference between the data and the normal distribution[8-11]. The calculated statistic was compared with the critical value at the given level of significance, as shown in Tables 1 and 2.

Table 1 Pet cat normal distribution test

Type	Test Data
Statistic	0.21041062706729985
Critical Values	0.72 0.82 0.984 1.148 1.365
Significance Levels	15. 10. 5. 2.5 1.

Table 2 Pet dog normal distribution test

Type	Test Data
Statistic	0.32715185501395005
Critical Values	0.72 0.82 0.984 1.148 1.365
Significance Levels	15. 10. 5. 2.5 1.

The processed data basically conforms to the normality test, as shown in Figure 5.

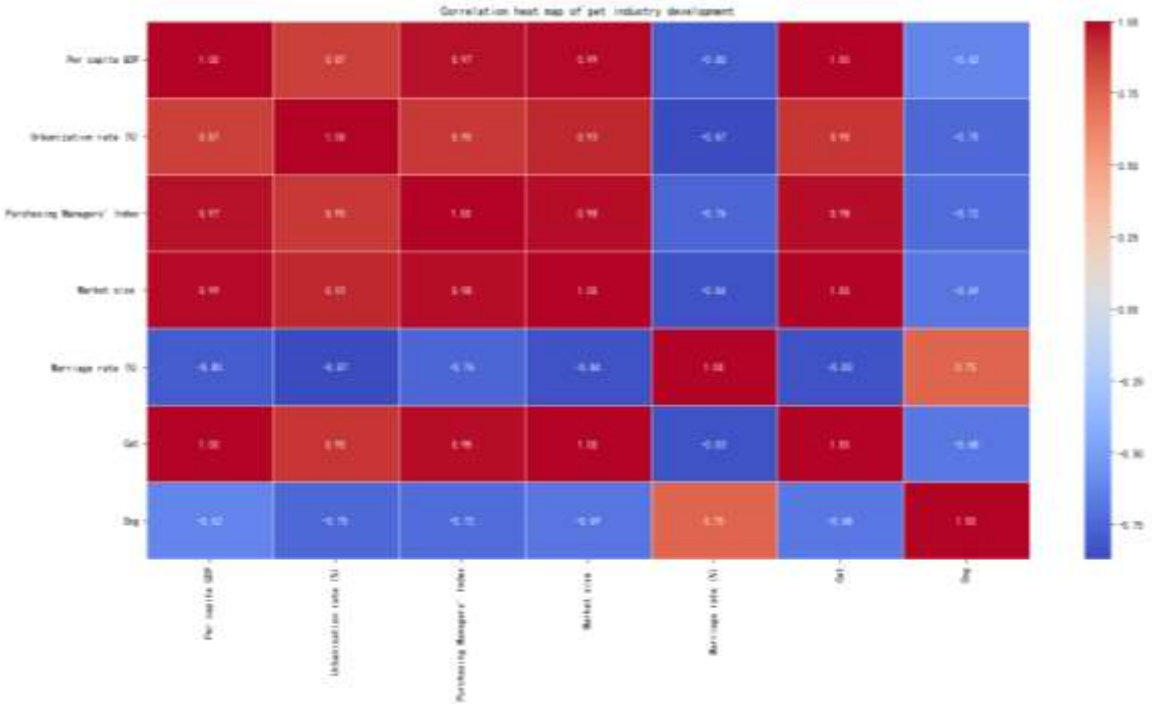


Figure 5 Heat map of the relevance of pet industry development

2.2.2. Linear regression prediction

A linear regression model was fitted to predict the composite scores for the next three years (2024 - 2026) based on the yearly data collected from the pet market development data file as features and the composite score data as the target variable.

Normalizing the composite data to avoid adverse effects of different magnitudes of data on model training.

The fit of the model was trained using the fit method using the prepared year characteristics (X) and the normalized composite score target variable using a linear regression model with the following equation:

$$y = \beta_0 + \beta_1 x + \in \tag{2}$$

Included among these, β_0 denotes the intercept term, β_1 is the coefficient corresponding to the characteristic (year), ε the error term[10].

Based on the input year characteristics X and the normalized composite score target variable to fit the optimal β_0 and β_1. Therefore, the specific linear regression equation is determined, after which the predicted scores are restored to the range of values of the original data using the inverse normalization operation to obtain the true predicted composite score values s shown in Table 3.

Table 3 Predicted composite scores

Predicted year	Predicted composite score
2024	0.84
2025	0.95
2026	1.07

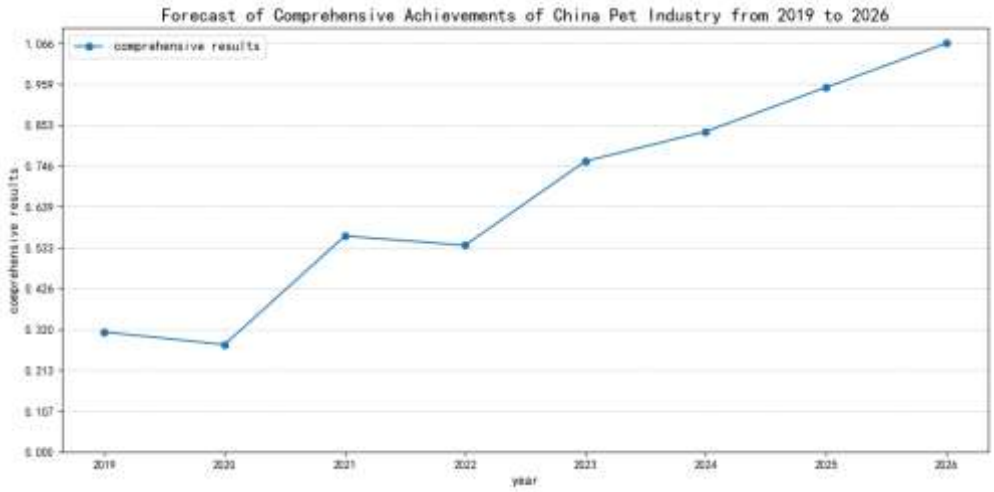


Figure 6 Trends in composite score projections

As shown in Figure 6, for the analysis of the factors influencing the pet market, including pet food market sales, pet food market size, etc, the trend of the above mentioned composite scores can be obtained, the development of the pet industry in the next three years will be on an upward trend.

3. Conclusions

In response to the continued development of the pet industry, the team launched this forecasting study. Based on the historical data of the pet industry, we establish relevant forecasting models to forecast the development of the industry, and make planning recommendations for the development of the actual pet industry.

Research for this project comprehensively utilizes data processing and visualization methods, as well as various machine learning related models and methods, to construct an analysis framework for predicting the output value and export value of China's pet food industry based on global pet market data. Through analyzing historical data trends, model construction and training, and presenting prediction results, it explores the future development trend of China's pet food industry. Analyze the development of the pet industry and related industries through four modeling problems and formulate corresponding strategies. Based on the collected data process, establish corresponding models for prediction. In the past five years, the overall development of China's pet market has shown an upward trend, which has been influenced by major factors such as tariff policies, urbanization development, changes in people's mentality, and GDP and economic development. Therefore, this article establishes multiple regression prediction models, ARIMA time series prediction models, and other types of prediction models to predict the future development of the pet market. The study found that the future development of the pet market may be affected by international factors and have a downward trend.

At the same time, there are some shortcomings in the research process, such as the ambiguity in the identification of predictive indicators, which makes the model's prediction results inaccurate; and the mining of the correlation between global and Chinese pet food data is not perfect. In the future, the team will continue to collect more comprehensive data on the global pet food industry, build an evaluation model, and dig deeper into the relationship between the global market and the development of the Chinese market.

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