

Dynamic Analysis of Ruby Price Changes on Future Trends in the Jewelry Market Based on Genetic Algorithm Model

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Abstract: As a precious gemstone, ruby's price fluctuations have an important impact on the jewelry market. However, accurate analysis of ruby price trends and their impact on the future of the jewelry market has been difficult. This article aims to reveal the impact mechanism of ruby price changes on the future trend of the jewelry market through dynamic analysis based on a genetic algorithm model. To achieve this goal, we collected relevant data including supply and demand data, market stability indicators, changes in consumer demand and external factors, and applied genetic algorithm models for analysis. Through the analysis of data and the operation of the model, this article has obtained the trend prediction of ruby prices and the impact of price changes on the jewelry market. The contribution of this study is to provide a dynamic analysis method based on a genetic algorithm model, which can more accurately predict the trend of ruby prices, and provide an in-depth analysis of the factors affecting the price changes on the jewelry market. These research results provide important references for practitioners in the jewelry industry, allowing them to better understand market dynamics and make appropriate decisions. At the same time, this study also provides reference and inspiration for future research on dynamic analysis of trends in the jewelry market.

1. Introduction

As an industry full of charm and potential, the jewelry market has attracted the attention of consumers and investors around the world [1]. With the development of the economy and people's pursuit of beauty, the jewelry market is also growing and evolving[2]. However, accurate prediction and analysis of future trend changes in the jewelry market is a complex and important topic.

In the past few decades, many scholars and researchers have devoted themselves to exploring the laws and trends of future trends in the jewelry market. Chen H's research shows that consumers are affected by customer perception factors when purchasing jewelry products [3]. Consumers are paying more and more attention to the quality, design and uniqueness of jewelry, and are also paying increasing attention to environmental protection and sustainable development. Brand ã A

conducted research based on artist jewelry designers. He found that with the improvement of people's living standards and changes in aesthetic concepts, the demand for jewelry products was developing in a more personalized and diversified direction [4]. These research results provide companies with insights that help them better understand consumer needs and decision-making processes, thereby developing more effective marketing strategies and sales models. Research on macroeconomic factors cannot be ignored either. By studying marketing cases, Kang H R found that economic cycles, inflation, exchange rate fluctuations and other factors had a significant impact on the jewelry market [5]. These research conclusions help companies predict market trends and formulate flexible business strategies to adapt to different economic environments. These studies provide important reference and guidance for practitioners and decision-makers in the jewelry industry, helping them seize opportunities and cope with challenges in fierce market competition.

However, despite certain research results, we still face some challenges and shortcomings. Traditional research methods often can only provide static market analysis and cannot accurately predict and simulate future dynamic changes in the market [6-7]. Therefore, we need to explore a more advanced and comprehensive research method to better understand and predict future trend changes in the jewelry market. To this end, this study aims to introduce a genetic algorithm model and use ruby price changes as a case to conduct a dynamic analysis of future trend changes in the jewelry market. We hope to provide decision-makers and practitioners in the jewelry industry with more accurate and comprehensive market forecasts and analysis, and promote the sustainable development of the jewelry market.

2. Jewelry Market and Ruby Price Changes

2.1. Overview of Jewelry Market

As a unique and complex industry, the jewelry market has always attracted the attention of consumers around the world. Jewelry is not just a decoration, but also a precious asset that symbolizes status, taste and wealth [8]. With the development of the economy and the increase in people's demand for luxury goods, the jewelry market has also experienced significant changes[9]. In terms of identifying changes in jewelry market trends, market participants need to pay close attention to the following aspects. The first is the change in consumer behavior and preferences [10]. Through research and market analysis, understanding the changes in consumer preferences for jewelry design, brand and purchasing channels can help companies seize market opportunities and formulate corresponding marketing strategies [11]. Through comprehensive analysis of market data, industry reports and expert opinions, the development trends and future opportunities and challenges of the jewelry market can be understood. This helps companies make informed decisions and adjust strategies in a timely manner to adapt to market changes [12-13]. Understanding the market overview, paying attention to changes in consumer behavior and preferences, and mastering market trend analysis methods are crucial for companies to succeed in a highly competitive market [14].

2.2. Market Demand and Importance of Rubies

As a rare and precious gemstone, ruby has always been sought after and loved by consumers around the world [15]. Its vivid red color, high degree of transparency and excellent hardness make it one of the most popular gemstones in the jewelry market[16]. Ruby plays an important role in the jewelry market [17-18]. Its beautiful appearance, symbolic meaning and investment value make it one of the most coveted gemstones for many. With the development of the global economy and people's pursuit of luxury goods, the demand for rubies in the ruby market is expected to continue

to grow, bringing more opportunities and challenges to the jewelry industry [19]. Ruby is a rare gemstone with a limited supply. Changes in ruby prices are affected by multiple factors such as supply and demand, color and quality, weight and size, origin, market trends and investment needs, as well as the global economy and exchange rates [20].

3. Analysis of Future Trend Changes in the Jewelry Market Based on Genetic Algorithm Model

3.1. Overview of Genetic Algorithms

Genetic algorithm is an optimization algorithm that simulates the natural evolution process and is often used to solve complex problems. Its design is inspired by Darwin's theory of evolution, and it gradually searches and optimizes the solution space of the problem by simulating mechanisms such as selection, crossover, and mutation in nature. Genetic algorithms have the characteristics of strong adaptability and good global search capabilities, and are widely used in optimization problems, machine learning, data mining and other fields. It can handle complex search spaces and multi-objective optimization problems, and is suitable for situations where the problem does not have a clear analytical solution or is difficult to solve.

3.2. Ruby Price Change Model

The goal of this article is to predict ruby price trends and analyze the factors influencing price changes. In order to achieve this goal, it is first necessary to collect relevant data, including price history data, market data and influencing factor data. The data is then preprocessed, including cleaning, handling missing values, and selecting features. Determining the input and output of the model, the input can include time series data, market data and influencing factor data, the output can be the predicted value of ruby price or related price change indicators. In order to optimize and train the model, this article designs a fitness function, which is the root mean square error (RMSE) of the prediction error. The root mean square error formula is as follows:

$$RMSE = \sqrt{\frac{\sum (Y_i - \bar{Y}_i)^2}{n}} \quad (1)$$

In formula (1), n is the number of samples; Y_i is the actual observed value; \bar{Y}_i is the predicted value of the model.

The fitness function is used to measure the quality of an individual. By selecting individuals with higher fitness as the parent generation, excellent characteristics can be passed on and the fitness of the overall population can be improved. Chromosome coding uses a binary representation of ruby characteristics and parameters, such as color and weight. In the optimization process of the genetic algorithm, an initial population is first generated, in which each individual represents a candidate solution. Individuals in the population are then evolved through operations such as selection, crossover, and mutation. The selection operation selects excellent individuals as parents according to the fitness function, the crossover operation generates new individuals, and the mutation operation introduces randomness. Through these steps, a ruby price change model based on genetic algorithm was established, and model training and optimization were performed to predict and analyze the ruby price change trend. By setting the termination conditions to reach the maximum number of iterations, the optimal solution is obtained, analyzed and interpreted, and the performance and feasibility of the model are evaluated. It can be compared with actual data for error analysis and trend analysis. Based on the feedback from the result analysis, the model is

adjusted, including parameter settings of the genetic algorithm, changes in the chromosome encoding method, increasing or optimizing the fitness function, etc.

3.3. Dynamic Analysis of Ruby Price Changes

3.1.1. Data Collection

In order to achieve dynamic analysis of ruby price changes, we adopted the following methods to collect data. First, we collected historical data on ruby prices through professional market research institutions, including price records over the past few years or decades. We also collect market data, such as supply and demand, trading volume and price indexes, to understand overall market trends and dynamics. Figure 1 shows relevant ruby transaction data.



Figure 1: Ruby transaction data

From Figure 1, we can find that the price index is mostly stable around 120, the trading volume is between 45-60, and the price is mostly floating around 1,000. The index may indicate that the overall market price trend is relatively stable, with no obvious large increases or decreases. Trading volume fluctuating within a certain range may reflect the activity of the market, and higher trading volume usually means that the market is more active.

After data collection, data cleaning was performed to deal with possible outliers and missing values to ensure the accuracy and reliability of the data. Through the above data collection methods, we have obtained rich ruby price data, market data and influencing factors data.

3.1.2. Data Prediction and Analysis

This article uses TensorFlow in Python to load the already built ruby price change model. The model will be calculated based on the characteristics of the input data and the weights of the model, and generate corresponding prediction results. Forecast results include ruby price forecasts, price trends, volatility, etc. The formula for calculating volatility is as follows:

$$P = \frac{|A - B|}{A} \tag{2}$$

In formula (2), P is the volatility value, A is the actual price, and B is the predicted price. After making the predictions, we can analyze and interpret the results. Evaluating the model's accuracy and performance by comparing it to actual ruby price data. Table 1 shows the supply and demand and price forecast trends of rubies.

Table 1: Ruby supply and demand and forecast price trends

	23/9/1	23/9/2	23/9/3	23/9/4	23/9/5
Supply demand	Adequate	Balance	Lack	Balance	Adequate
Price movement	Descend	Descend	Rise	Descend	Descend

From Table 1, we can see that if supply and demand are sufficient and balanced, the model predicts a downward price trend; while in the case of shortage of supply and demand, the price trend is predicted to increase, which is consistent with the basic supply and demand relationship. When supply is abundant, the supply of a good exceeds demand in the market, which can cause prices to fall. Oversupply increases competition, and sellers may lower their prices to attract buyers. Conversely, when supply is tight, there is not enough supply of goods on the market to meet demand, which can cause prices to rise. An imbalance between supply and demand can lead to competition among buyers, who may be willing to pay higher prices to obtain the goods they want.

In order to better analyze the ruby-related data under the genetic algorithm, this article also conducted error and trend analysis. The trend analysis data is shown in Figure 2.



Figure 2: Trend analysis data

From the trend analysis in Figure 2, we can see that the predicted price and actual price trends are roughly consistent. However, there is still a certain margin of error in the price. When predicting market prices, models may consider a variety of factors, such as supply and demand, market trends, historical data, etc. Although the model can provide predictions about price trends, due to the complexity and uncertainty of the market, the prediction results may be somewhat different from the actual prices. Price errors may be caused by a variety of factors, such as market changes, news events, policy adjustments, etc. These factors may have an impact on market supply and demand and prices, resulting in differences between actual prices and forecast prices. Figure 3 shows the prediction accuracy, mean square error and volatility data after data calculation.

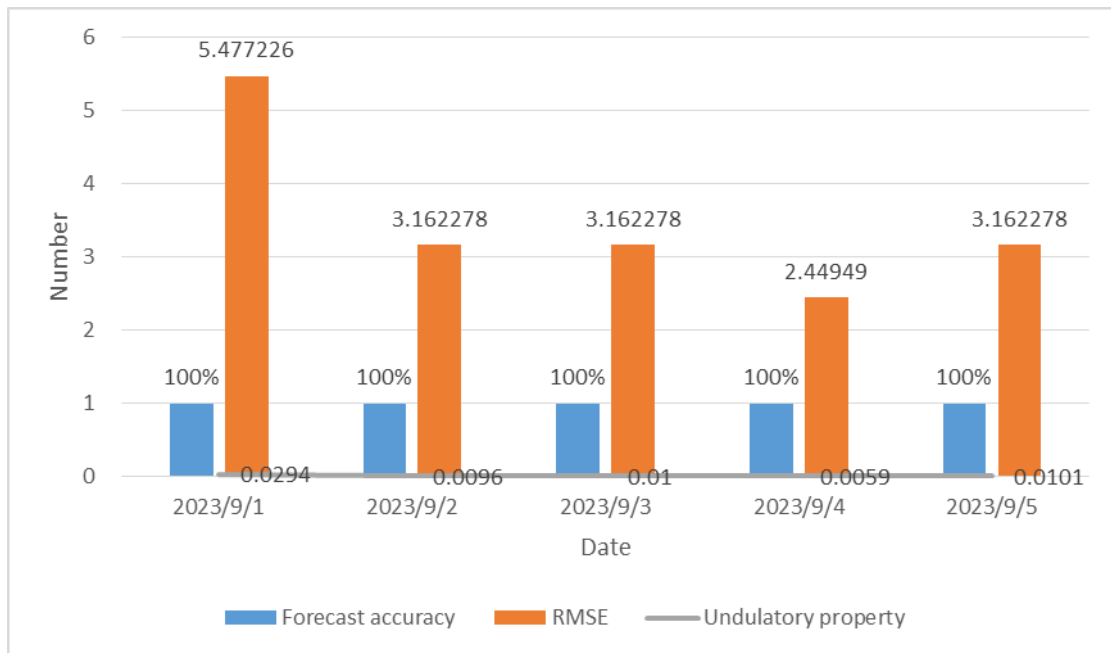


Figure 3: Evaluation data

Based on the calculation results in Figure 3, we can draw the following conclusions from the data analysis: the prediction accuracy is 100%, which means that the predictions made are completely consistent with the actual observations. A high accuracy indicates that the model performs well in predicting ruby prices. Volatility refers to the range of changes in price or data, with the highest volatility being only 0.0294 and the lowest being 0.0096. Lower volatility indicates relatively stable price movements. In this case, the fluctuation range of ruby prices is smaller, indicating that the market is relatively stable. The mean square error is a measure of the difference between the predicted value and the actual observed value, with the highest mean square error being only 5.477226. A lower mean square error indicates a smaller difference between predictions and actual observations. In this case, the mean square error is low, indicating that the difference between the model's predictions and the actual observations is relatively small.

3.4. Analysis of Influencing Factors

Based on the above data, we can derive the influencing factors related to ruby prices. According to the results in Table 1, when supply and demand are sufficient and balanced, the model predicts a downward price trend; while when supply and demand are in short supply, the price trend is predicted to increase. Therefore, the relationship between supply and demand is one of the important factors affecting ruby prices. If supply exceeds demand, competition in the market will increase, causing prices to fall; when supply is insufficient, prices may rise. According to the stability of the price index and trading volume in Figure 1, we can see that the market as a whole is relatively stable. Market stability can reduce price volatility and make prices relatively stable. A stable market environment helps consumers and investors form price expectations, thereby affecting market supply and demand and price trends. Although the predicted price and actual price trends in the trend analysis in Figure 2 are roughly consistent, there is still a certain error. This may be due to changes in consumer demand. Therefore, changes in consumer demand for rubies are one of the important factors affecting prices. For example, if consumer demand for rubies increases, prices may rise; conversely, if demand decreases, prices may fall. In addition to supply and demand and consumer demand, external factors such as macroeconomic conditions, exchange rate fluctuations,

policy changes, etc. may also have an impact on ruby prices. For example, an economic boom may stimulate people's willingness to buy jewelry, thereby pushing up prices; while an economic recession may lead to a decrease in consumer purchasing power, putting pressure on prices.

Factors affecting ruby prices include supply and demand, market stability, changes in consumer demand, and external factors. These factors interact to determine price trends in the ruby market. When conducting dynamic analysis, it is necessary to comprehensively consider these factors and pay close attention to market changes and trends to make accurate predictions and decisions.

4. The Impact of Ruby Price Changes on Future Trends in the Jewelry Market

4.1. Impact of Ruby Price Changes on the Jewelry Market

Ruby is one of the important gemstones in jewelry, and its price changes have an important impact on the entire jewelry market. The supply and demand relationship of ruby is a key factor affecting its price. If supply decreases or demand increases, the price of rubies may increase. Conversely, if supply increases or demand decreases, ruby prices may fall. The stability of ruby prices is crucial to the development of the jewelry market. Large price fluctuations may lead to increased market uncertainty, affecting consumer purchasing decisions and industry stability. Changes in ruby prices may affect consumer demand for ruby jewelry. If prices rise, consumers may look for substitutes or reduce purchases, affecting market demand. On the contrary, lower prices may stimulate consumer interest in purchasing ruby jewelry. Movements in ruby prices may also be affected by external factors.

Changes in ruby prices have an important impact on the jewelry market. Factors such as supply and demand, market stability, changes in consumer demand and external factors interact to determine the price trend in the ruby market. Participants in the jewelry industry should pay close attention to changes in ruby prices and make appropriate adjustments and decisions based on market conditions.

4.2. Analysis of Future Trends of the Jewelry Market

Based on data analysis and market trend observation, we can predict the future trends of the jewelry market. With the development of society and people's pursuit of personalization, consumers' demand for jewelry will become more diverse. They will seek unique, personalized designs and materials that showcase their personality and taste. With the increasing awareness of environmental protection and sustainable development, consumers are paying more and more attention to the source and manufacturing process of jewelry. Sustainable jewelry will be favored by more consumers, which will push the jewelry industry toward a more environmentally friendly and socially responsible direction. With the rapid development of the Internet and e-commerce, the jewelry industry will also become increasingly digital. Online sales channels will become one of the main sales methods, and consumers will purchase jewelry products online more frequently. In a highly competitive market, brand power and quality will become important factors for consumers to choose jewelry. Well-known brands and high-quality products will be more popular, and consumers will be more inclined to buy guaranteed products.

5. Conclusion

This study aims to predict the trend of ruby prices through dynamic analysis based on a genetic algorithm model, and analyze the factors that influence price changes on the jewelry market. In order to achieve this goal, we collected relevant data and applied genetic algorithm models for

analysis, aiming to reveal the rules of ruby price changes and its impact mechanism on the jewelry market. This article provides a forecast for ruby price trends and provides an in-depth analysis of the factors that impact price changes on the jewelry market. Through data analysis and model operation, we found that supply and demand relationships, market stability, changes in consumer demand and external factors are the main influencing factors. Through this model, we can achieve dynamic analysis of future trend changes in the jewelry market. This article provides an important reference for practitioners in the jewelry industry, allowing them to better understand market dynamics and make decisions accordingly. At the same time, our research also provides reference and inspiration for future research on dynamic analysis of trends in the jewelry market.

References

- [1] Ratakam P, Petison P. *From means to end: Understanding the millennial mind when buying luxury jewelry brands. Journal of Global Fashion Marketing*, 2023, 14(1): 35-47.
- [2] Thomsen L, Hess M. *Dialectics of association and dissociation: spaces of valuation, trade, and retail in the gemstone and jewelry sector. Economic Geography*, 2022, 98(1): 49-67.
- [3] Chen H, Prompanyo M. *The Impact of Customer Perceived Value of Contemporary Art Jewelry on Purchase Behavior: A Case of Beijing, China. Modern Economy*, 2021, 12(6): 1082-1091.
- [4] Brandão A, Ramos S, Gadekar M. *Artist jewelry designer entrepreneurship: does it only glitter or is it also gold? Journal of Research in Marketing and Entrepreneurship*, 2021, 23(2): 251-267.
- [5] Kang H R. *A case study on metaverse marketing of jewelry brand. Journal of Digital Convergence*, 2022, 20(1): 285-291.
- [6] Kurt D. *Obesity and compensatory consumption: Evidence from jewelry shopping. Psychology & Marketing*, 2022, 39(1): 101-110.
- [7] Zahid R, Jaleel J, Mehmood M A, et al. *Factors Influencing Purchase Intentions towards Fashion Jewellery: An Exploratory Study. Pakistan Journal of Humanities and Social Sciences*, 2022, 10(1): 135-148.
- [8] Negev M, Berman T, Goulden S, et al. *Lead in children's jewelry: the impact of regulation. Journal of Exposure Science & Environmental Epidemiology*, 2022, 32(1): 10-16.
- [9] Pang W, Ko J, Kim S J, et al. *Impact of COVID-19 pandemic upon fashion consumer behavior: focus on mass and luxury products. Asia Pacific Journal of Marketing and Logistics*, 2022, 34(10): 2149-2164.
- [10] Chen Q. *Exploring the Development Prospects of International Brands in the Chinese Jewellery Market: Tiffany as an Example. Journal of Economics, Finance and Accounting Studies*, 2023, 5(2): 20-24.
- [11] Qishen Z, Binyan W, Hao Liu, et al. *Overview of the International Ruby Jewelry Auction Market and Analysis of Its Price Influencing Factor. Journal of Gems & Gemmology*, 2021, 23(3): 63-71.
- [12] Mo M O, Weizhang L, Lei Luo, et al. *Analyzing the Laboratory-Grown Diamond Market Development Trend from the Study of International Laboratory-Grown Diamond Brand Building. Journal of Gems & Gemmology*, 2021, 23(6): 74-83.
- [13] Fening P A, Agyei I K, Bruce T. *The Impact of Covid-19 Pandemic on the Traditional Gold Jewellery Industry in Ghana: The Gold Price Factor. Neuroquantology*, 2022, 20(17): 131-141.
- [14] Christodoulides G, Wiedmann K P. *Guest editorial: a roadmap and future research agenda for luxury marketing and branding research. Journal of Product & Brand Management*, 2022, 31(3): 341-350.
- [15] Zaware N. *Gold Retailing in India: The Marketing Inferences from Consumers for Retailers. Vidyabharati International Interdisciplinary Research Journal*, 2021, 12(2): 181-191.
- [16] Feng H. *Research on Innovative Marketing of Baltic Amber Jewellery in China Market. Humanities and Social Sciences Latvia*, 2022, 30(1, 2): 93-107.
- [17] Kaspın S. *Identifying Factors Leading to Gold Losses during the Fabrication Process and Assessing Its Impact on the Smes Jewellery Industry. Turkish Journal of Computer and Mathematics Education (TURCOMAT)*, 2021, 12(7): 975-985.
- [18] Çitir B, Cebeci U, Tuncer Ö. *Application of Quality Function Deployment with Different Consumer Behavior of Generations in Jewelry Sector. Technology*, 2021, 7(1): 75-92.
- [19] Yuridhista R, Ariska D, Xin D, et al. *Analysis of Development in the Creative Industry with the Existence of the Craft Sector in Pearl Jewelry in the City of Mataram. Journal Markcount Finance*, 2023, 1(3): 182-195.
- [20] Pankiw S A, Phillips B J, Williams D E. *Luxury brands' use of CSR and femvertising: the case of jewelry advertising. Qualitative Market Research: An International Journal*, 2021, 24(3): 302-325.