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# Time Series Analysis for Stock Price Forecasting: Evidence from Kansai Design Co., Ltd. (603458)

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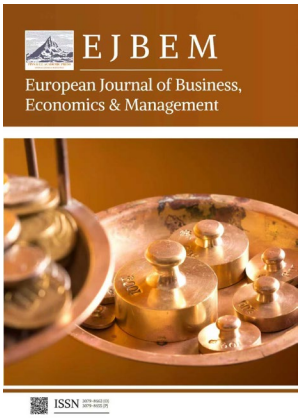


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**Abstract:** Stock price forecasting plays a critical role in investment decision-making, particularly in emerging sectors such as engineering consulting. Kansai Design Co., Ltd. (603458), a state-controlled listed firm, has drawn growing attention with China's ongoing infrastructure expansion. However, few studies have systematically examined its stock price dynamics using rigorous time series methods, leaving a gap in empirical evidence for short-term predictability. This study employs time series analysis to investigate the company's daily stock prices from October 10, 2022, to September 28, 2023. Following the established paradigm of stationarity testing, model identification, parameter estimation, and diagnostic checking, an Augmented Dickey-Fuller test confirmed series stationarity. Autocorrelation and partial autocorrelation analyses indicated the suitability of an autoregressive model. Comparative evaluation of AR (1), AR (2), and AR (3) models demonstrated that AR (1) provided the best fit, consistent with Occam's Razor. Residual diagnostics verified white noise properties, while predictive performance metrics showed high accuracy (RMSE = 0.0519; MAPE = 0.414%). The AR (1) model closely tracked actual prices, with errors mainly driven by random fluctuations rather than systematic bias. These findings highlight the short-term continuity of stock prices and demonstrate the model's practical value as a decision-support tool. The study contributes methodological insights and offers investors evidence-based guidance while emphasizing the importance of integrating quantitative models with fundamental market analysis.

**Keywords:** stock price forecasting; time series analysis; autoregressive model (AR); stationarity; investment decision-making

## 1. Introduction

Kansai Design Co., Ltd. (603458), a state-controlled listed company specializing in engineering consulting services, holds a significant position in transportation, municipal infrastructure, and related sectors. With China's continuous advancement of new infrastructure development, the engineering consulting industry is entering a phase of new growth opportunities, and the company's market performance has drawn increasing attention [1]. This study employs time series analysis to forecast the stock price trends of Kansai Design. Time series analysis is widely recognized as having important applications in the financial domain, while accurate stock price prediction provides essential guidance for investment decision-making. Research on the Chinese stock market has also emphasized the presence of memory effects and highlighted the importance of reliability in forecasting methods. Building on these insights, this study applies an autoregressive model to analyze the stock, aiming to provide investors with a scientific reference for decision-making.

## 2. Analytical Process

### *2.1. Stock Price Chart*

This study selects the daily stock price data of Kansai Design Co., Ltd. (603458) from October 10, 2022, to September 28, 2023, for analysis. The time series chart reveals that during this period, the company's stock price exhibited significant volatility. The fluctuation range was primarily between 9.2 yuan and 10.4 yuan, with the lowest point occurring around October 2022 at approximately 9.2 yuan, and the highest point reaching about 10.4 yuan in August 2023. Overall, the stock price remained relatively stable at around 10 yuan from late 2022 to early 2023. However, starting in March 2023, the stock experienced substantial fluctuations, and particularly after August 2023, it showed a clear downward trend, falling to around 9.4 yuan by the end of September. This volatility pattern indicates that the stock possesses high market sensitivity and may be influenced by multiple market factors.

Figure 1 illustrates the stock price fluctuations of Kansai Design Co., Ltd. over the one-year observation period, highlighting both the peak in August 2023 and the subsequent decline.


**Figure 1.** Time Series Chart of Kansai Design Co., Ltd. (603458) Stock Prices (October 2022-September 2023).

### *2.2. ADF Test*

The study conducted a stationarity test on the stock price data of Kansai Design Co., Ltd., employing the Augmented Dickey-Fuller (ADF) test method [2]. The test results show that at the 1% significance level, the ADF test statistic is -3.4676, which is smaller than the critical value of -3.4574, with a corresponding p-value of 0.0097, which is significantly less than 0.01. This indicates that the null hypothesis can be rejected at the 1% significance level, that is, the hypothesis of a unit root in the series can be rejected. The result confirms that the stock price series is stationary and does not require differencing. From the regression equation results, the lagged term coefficient is -0.087922, and the constant term is 0.868581, both of which have p-values of 0.0006, statistically significant. The R-squared of the model is 0.047902, indicating relatively weak explanatory power, which is consistent with the characteristics of the "weak-form efficient market" in financial markets. These results provide a reliable statistical foundation for subsequent time series modeling.

Figure 2 presents the ADF test outcome, clearly supporting the stationarity of the stock price series at the 1% significance level.

Null Hypothesis: PRICE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=14)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -3.467660 | 0.0097 |
| Test critical values: | 1% level | -3.457400 | |
| | 5% level | -2.873339 | |
| | 10% level | -2.573133 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(PRICE)
Method: Least Squares
Date: 11/10/24 Time: 19:01
Sample (adjusted): 10/11/2022 9/28/2023
Included observations: 241 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| PRICE(-1) | -0.087922 | 0.025355 | -3.467660 | 0.0006 |
| C | 0.868581 | 0.250274 | 3.470518 | 0.0006 |

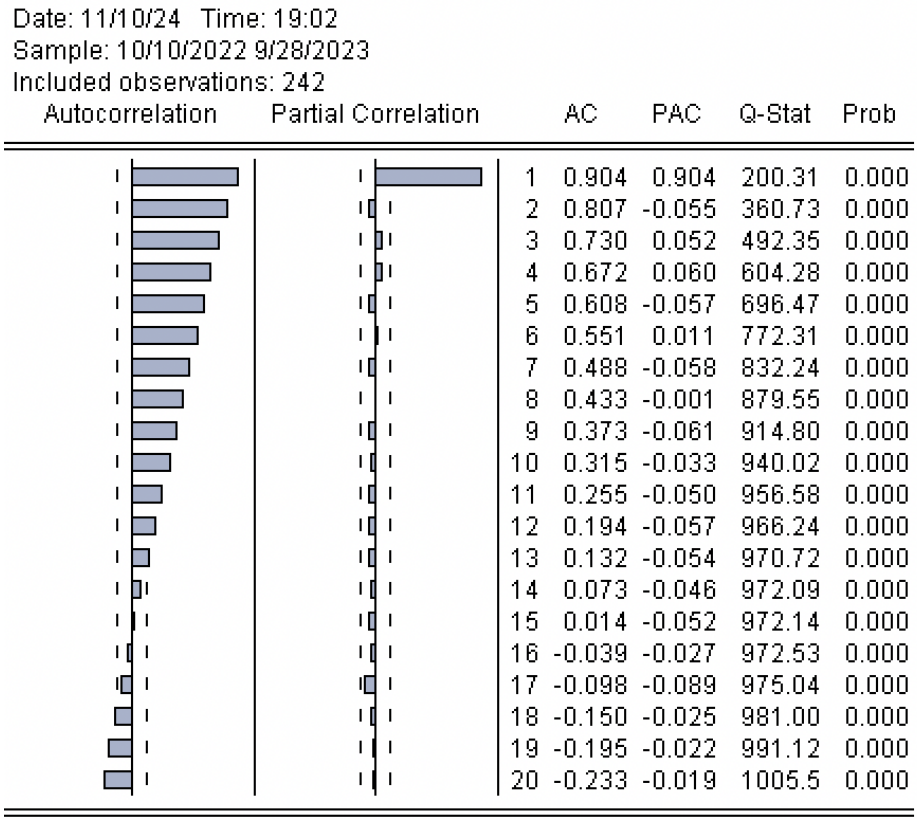
| | | | |
|---|---|---|---|
| R-squared | 0.047902 | Mean dependent var | 0.001079 |
| Adjusted R-squared | 0.043919 | S.D. dependent var | 0.115002 |
| S.E. of regression | 0.112448 | Akaike info criterion | -1.524380 |
| Sum squared resid | 3.022072 | Schwarz criterion | -1.495460 |
| Log likelihood | 185.6878 | Hannan-Quinn criter. | -1.512729 |
| F-statistic | 12.02467 | Durbin-Watson stat | 1.924666 |
| Prob(F-statistic) | 0.000622 | | |

**Figure 2.** Results of the Augmented Dickey-Fuller (ADF) Test for Stock Price Stationarity.

*2.3. Correlation Analysis and Sequence Identification*

The study performed autocorrelation (ACF) and partial autocorrelation (PACF) analyses on the stock price series of Kansai Design Co., Ltd. to identify potential time series patterns [3]. From the autocorrelation function plot, ACF values gradually decreased as the lag order increased, with the first-order autocorrelation coefficient being the largest at 0.904. The values remained positive until the 15th order (0.014) before turning negative. The partial autocorrelation function shows that, except for the first-order PACF (-0.055), the PACF values at other orders were relatively small, fluctuating mostly within the range of ± 0.08. The probability values corresponding to the Q-statistics for all lag orders were 0, indicating significant autocorrelation in the series. The characteristic of a gradually decaying ACF and a sharp cutoff of PACF after the first order suggests that this stock price series may be suitable for an autoregressive model (AR model) [4]. Particularly, the most significant first-order autocorrelation indicates that today's stock price is most strongly correlated with the previous day's price [5].

Figure 3 displays the ACF and PACF plots, revealing the strong first-order autocorrelation that supports the AR (1) model choice.




| | AC | PAC | Q-Stat | Prob |
|---|---|---|---|---|
| 1 | 0.904 | 0.904 | 200.31 | 0.000 |
| 2 | 0.807 | -0.055 | 360.73 | 0.000 |
| 3 | 0.730 | 0.052 | 492.35 | 0.000 |
| 4 | 0.672 | 0.060 | 604.28 | 0.000 |
| 5 | 0.608 | -0.057 | 696.47 | 0.000 |
| 6 | 0.551 | 0.011 | 772.31 | 0.000 |
| 7 | 0.488 | -0.058 | 832.24 | 0.000 |
| 8 | 0.433 | -0.001 | 879.55 | 0.000 |
| 9 | 0.373 | -0.061 | 914.80 | 0.000 |
| 10 | 0.315 | -0.033 | 940.02 | 0.000 |
| 11 | 0.255 | -0.050 | 956.58 | 0.000 |
| 12 | 0.194 | -0.057 | 966.24 | 0.000 |
| 13 | 0.132 | -0.054 | 970.72 | 0.000 |
| 14 | 0.073 | -0.046 | 972.09 | 0.000 |
| 15 | 0.014 | -0.052 | 972.14 | 0.000 |
| 16 | -0.039 | -0.027 | 972.53 | 0.000 |
| 17 | -0.098 | -0.089 | 975.04 | 0.000 |
| 18 | -0.150 | -0.025 | 981.00 | 0.000 |
| 19 | -0.195 | -0.022 | 991.12 | 0.000 |
| 20 | -0.233 | -0.019 | 1005.5 | 0.000 |

**Figure 3.** Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) of the Stock Price Series.

*2.4. AR Model Selection and Evaluation*

The study determined the optimal forecasting model by comparing autoregressive models (AR models) of different orders [6]. In the analysis, AR (1), AR (2), and AR (3) models were systematically compared based primarily on the Akaike Information Criterion (AIC) and Schwarz Criterion (SC). The results show that the AR (1) model has an AIC value of -1.490973 and an SC value of -1.447721, clearly outperforming the AR (2) model (AIC: -0.825411, SC: -0.782160) and the AR (3) model (AIC: -0.508857, SC: -0.465606). The coefficient significance tests of all three models yielded p-values of 0, indicating statistical significance of the parameters. Notably, as the model order increased, both AIC and SC values rose, suggesting that adding complexity did not improve predictive performance. According to the principle of Occam's Razor, the simplest model should be chosen when performance is similar. Therefore, the AR (1) model is not only optimal in terms of statistical criteria but also adheres to the principle of parsimony. This result is consistent with the earlier findings from ACF and PACF analyses, further confirming the suitability of the first-order autoregressive model for this stock price series.

Table 1 summarizes the comparison of AR models, showing that AR (1) provides the most favorable AIC and SC values, validating its selection as the optimal model.

**Table 1.** Comparison of AR Models Based on Akaike Information Criterion (AIC), Schwarz Criterion (SC), and Coefficient Significance.

| Model | Akaike Info Criterion | Schwarz Criterion | Coefficient Significance |
|---|---|---|---|
| AR (1) | -1.490973 | -1.447721 | 0 |
| AR (2) | -0.825411 | -0.782160 | 0 |
| AR (3) | -0.508857 | -0.465606 | 0 |

*2.5. Residual Plot Analysis of the AR (1) Model*

The study conducted a residual plot analysis of the selected AR (1) model, visually illustrating the deviations between the model's predictions and actual values. The residual plot shows that residuals were mainly distributed between -0.3 and 0.4, with most fluctuations within ± 0.1, indicating relatively controllable prediction errors. Specifically, from October to November 2022, larger negative residuals were observed, with the maximum close to -0.3; in June 2023, the most notable positive residual reached approximately 0.4. During January to February 2023, residuals remained relatively stable with small fluctuations, suggesting better predictive performance in this period. Overall, residuals did not display obvious systematic bias or time dependence, indicating that the AR (1) model captured the main features of stock price changes. However, the larger residual fluctuations observed in mid-2023 may imply market anomalies not fully explained by the model [7]. These residual analysis results provide important evaluation evidence of predictive capacity while also revealing limitations in specific periods.

Figure 4 illustrates the residual distribution of the AR (1) model, indicating that errors were generally stable within a narrow range.

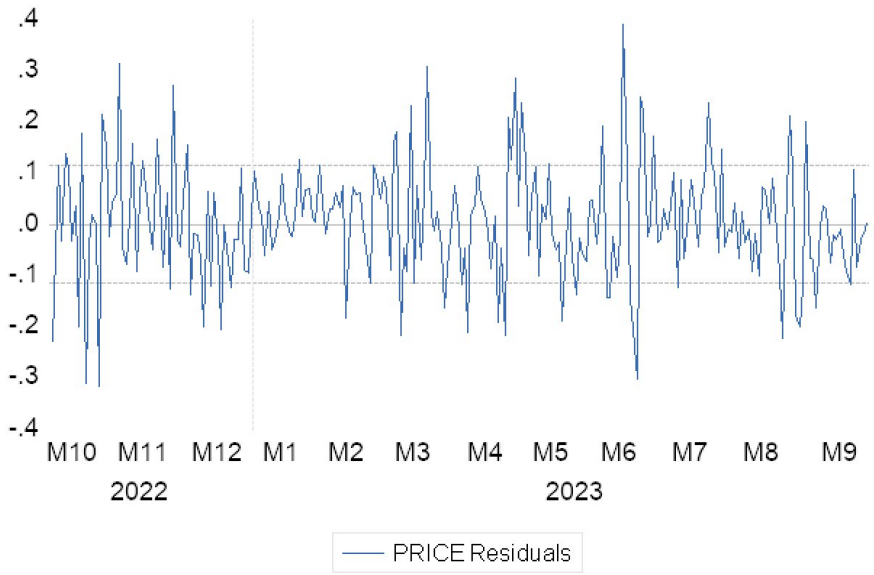


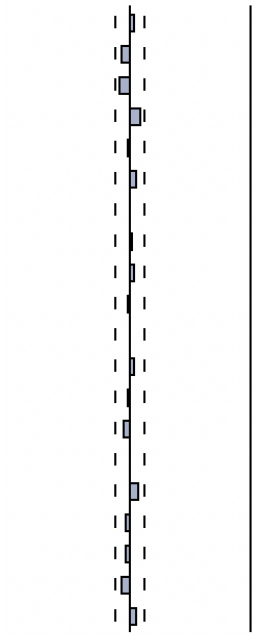

**Figure 4.** Residual Plot of the AR (1) Model for Kansai Design Co., Ltd. Stock Prices.

*2.6. Residual Serial Correlation Test*

The study applied autocorrelation and partial autocorrelation tests to the residual sequence of the AR (1) model to evaluate whether the model adequately captured temporal dependencies [8]. The results show that autocorrelation in the residual sequence was significantly reduced. Numerically, all autocorrelation coefficients were small, with the first-order autocorrelation at only 0.026, much lower than the original series' 0.904. Subsequent autocorrelation coefficients mostly fluctuated within ± 0.1. The partial autocorrelation function showed similarly favorable characteristics, with the maximum at -0.090 for the third lag. Importantly, the probability values (Prob) of the Q-statistics exceeded the 0.05 significance level starting from the second lag (0.242), gradually increasing to 0.911 at the 20th lag. These results indicate that the residual sequence no longer exhibited significant autocorrelation, suggesting that the AR (1) model successfully extracted the primary information from the time series. In particular, all Q-statistic probability values were much greater than the significance level, strongly supporting the white noise hypothesis of the residuals and further validating the AR (1) model's suitability and effectiveness [9].

Figure 5 shows the residual autocorrelation and partial autocorrelation, confirming that the residuals approximate a white noise process.

Date: 11/10/24 Time: 19:23
Sample: 10/10/2022 9/28/2023
Q-statistic probabilities adjusted for 1 ARMA term



| Autocorrelation | Partial Correlation | | AC | PAC | Q-Stat | Prob |
|---|---|---|---|---|---|---|
| | | 1 | 0.026 | 0.026 | 0.1711 | |
| | | 2 | -0.070 | -0.071 | 1.3692 | 0.242 |
| | | 3 | -0.094 | -0.090 | 3.5395 | 0.170 |
| | | 4 | 0.083 | 0.084 | 5.2372 | 0.155 |
| | | 5 | -0.012 | -0.030 | 5.2731 | 0.260 |
| | | 6 | 0.054 | 0.059 | 6.0093 | 0.305 |
| | | 7 | -0.008 | 0.001 | 6.0253 | 0.420 |
| | | 8 | 0.020 | 0.017 | 6.1261 | 0.525 |
| | | 9 | 0.028 | 0.042 | 6.3275 | 0.611 |
| | | 10 | -0.019 | -0.030 | 6.4180 | 0.697 |
| | | 11 | 0.007 | 0.021 | 6.4313 | 0.778 |
| | | 12 | 0.027 | 0.023 | 6.6154 | 0.829 |
| | | 13 | -0.015 | -0.025 | 6.6764 | 0.878 |
| | | 14 | -0.051 | -0.041 | 7.3444 | 0.884 |
| | | 15 | -0.005 | -0.008 | 7.3500 | 0.920 |
| | | 16 | 0.077 | 0.068 | 8.8869 | 0.883 |
| | | 17 | -0.035 | -0.050 | 9.2133 | 0.904 |
| | | 18 | -0.035 | -0.020 | 9.5285 | 0.922 |
| | | 19 | -0.070 | -0.060 | 10.837 | 0.901 |
| | | 20 | 0.044 | 0.029 | 11.352 | 0.911 |

**Figure 5.** Autocorrelation and Partial Autocorrelation of Residuals from the AR (1) Model.

*2.7. Evaluation of Forecasting Performance*

The study used the AR (1) model to forecast the stock prices of Kansai Design Co., Ltd. for the period from September 22 to 28, 2023, and conducted a detailed evaluation of its predictive performance. The prediction plot indicates that the model's predicted values (blue line) are closely aligned with the actual values (green line), with the two lines nearly overlapping. The prediction interval (red dashed lines) represented the 95% confidence interval based on ± 2 standard errors. In terms of accuracy metrics, the model performed well: the root mean square error (RMSE) was 0.051934, and the mean absolute error (MAE) was 0.039135, indicating small deviations from actual values. The mean absolute percentage error (MAPE) was 0.414132%, reflecting low relative error. The Theil Inequality Coefficient was 0.002754, close to 0, further confirming strong predictive capacity. Error decomposition showed the bias proportion at 0.029737, the variance proportion at 0.097907, and the covariance proportion as high as 0.872355. This distribution indicates that forecast errors were mainly due to random fluctuations rather than systematic bias, an ideal error structure [10]. The symmetric MAPE was 0.415183, close to the MAPE, suggesting a relatively symmetric error distribution. Overall, these results demonstrate that the AR (1) model has strong predictive capacity for short-term stock price movements of the company.

Figure 6 compares the predicted and actual stock prices, showing their close alignment within the 95% confidence interval.

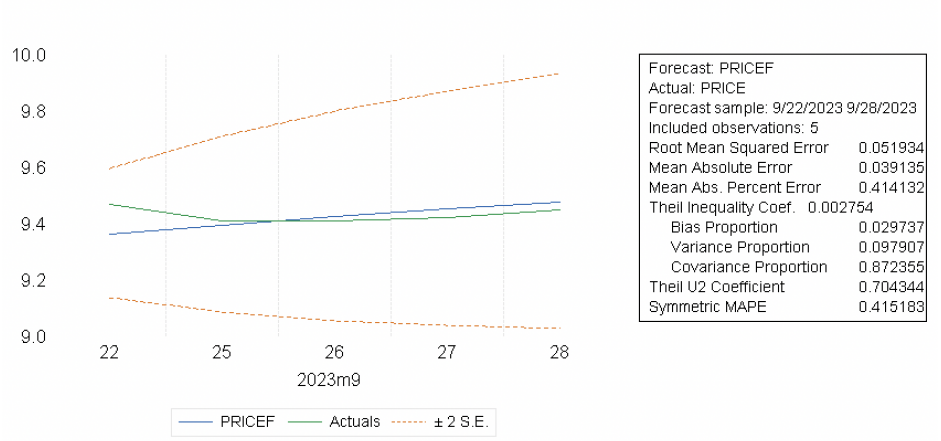



**Figure 6.** Forecasted vs. Actual Stock Prices Using the AR (1) Model (September 22-28, 2023).

*2.8. Day-By-Day Comparison of Predicted and Actual Values*

The study conducted a detailed day-by-day comparison of AR (1) model predictions for September 22-28, 2023. The numerical results reveal interesting changes in forecasting performance over time. On the first forecast day (September 22), the model's predicted value was 9.36 yuan, compared with the actual value of 9.47 yuan, resulting in the largest error of -0.11 yuan, indicating slight underestimation. However, starting from the second day (September 25), prediction accuracy improved markedly, with errors quickly converging to a narrow range: on September 25, the predicted value was 9.40 yuan, differing from the actual value of 9.41 yuan by only -0.01 yuan; in the following three days, forecast errors remained between 0.02 and 0.03 yuan, specifically, September 26 predicted 9.43 yuan (error 0.02), September 27 predicted 9.45 yuan (error 0.03), and September 28 predicted 9.48 yuan (error 0.03). Notably, except for the first day, all subsequent prediction errors were within 0.03 yuan, indicating that after adjusting for the initial bias, the model demonstrated stable and reliable predictive capacity. Especially in the final days, the small magnitude and consistency of errors further validate the AR (1) model's good fit to short-term stock price movements.

Table 2 provides the day-by-day comparison of predicted and actual stock prices, highlighting the minimal forecast errors after the initial day.

**Table 2.** Day-by-Day Comparison of Predicted and Actual Stock Prices for Kansai Design Co., Ltd. (September 22-28, 2023).

| Date | Predicted Value | Actual Value | Error |
|---|---|---|---|
| 9/22/2023 | 9.36 | 9.47 | -0.11 |
| 9/25/2023 | 9.40 | 9.41 | -0.01 |
| 9/26/2023 | 9.43 | 9.41 | 0.02 |
| 9/27/2023 | 9.45 | 9.42 | 0.03 |
| 9/28/2023 | 9.48 | 9.45 | 0.03 |

## 3. Summary of Forecasting Research and Investment Strategy Analysis

This study conducted a comprehensive and systematic time series analysis of the stock price data of Kansai Design Co., Ltd. (603458) from October 10, 2022, to September 28, 2023, yielding a series of valuable findings and conclusions. Financial time series analysis requires strict adherence to the process of stationarity testing, model identification, parameter estimation, and diagnostic testing, and this study followed that scientific paradigm [11].

The analysis first observed from the time series chart that stock prices fluctuated between 9.2 yuan and 10.4 yuan, showing a clear downward trend after August 2023. The

ADF test confirmed the stationarity of the series at the 1% significance level (ADF statistic -3.4676, p-value 0.0097), providing the foundation for subsequent modeling. This result is consistent with the general observation that the daily return series of most A-share listed companies exhibit stable statistical properties [12].

In the correlation analysis, the ACF displayed a gradual decay pattern, with the first-order autocorrelation coefficient as high as 0.904, while the PACF largely cut off after the first order. This characteristic clearly indicated the suitability of the AR (1) model. In the model selection stage, by comparing AIC values (AR (1): -1.490973) and SC values (AR (1): -1.447721) across different AR models, the AR (1) model was ultimately determined to be the most appropriate.

Residual analysis indicated a good model fit, with residuals mainly distributed within ± 0.1. The residual serial correlation test confirmed that the residuals constituted a white noise process, suggesting strong predictive reliability. In evaluating predictive performance, the model demonstrated excellent forecasting ability: the RMSE was only 0.051934, the MAPE just 0.414132%, and the Theil Inequality Coefficient close to zero (0.002754). Moreover, forecast errors were primarily driven by random fluctuations (covariance proportion 0.872355) rather than systematic bias.

Based on the above analysis, the study provides the following investment recommendations for Kansai Design Co., Ltd.: first, from a technical analysis perspective, the stock exhibits strong short-term price continuity, offering opportunities for short-term trading [13]. Investors may use AR (1) model predictions as trading references, particularly for trend-following operations when trends are clearly identified. Second, considering the high predictive accuracy, it is recommended that investors use the model as an auxiliary decision-making tool, especially for short-term trading decisions ranging from intraday to five days. Third, given the significant fluctuations observed in mid-to-late 2023, investors are advised to combine model results with fundamental market information and maintain close attention to the macroeconomic environment and industry dynamics [14].

However, the study also reminds investors of the following points: the model's predictive capacity is mainly effective in the short term and may be limited for medium- to long-term trends; abnormal fluctuation periods, as seen in the residual analysis, warrant caution in applying predictions during volatile market conditions; and although the model performed well during the sample period, uncertainties in financial markets persist, and risk controls should be maintained without overreliance on a single forecasting tool [15].

Finally, this study recommends that in practice, investors treat model predictions as one component of decision-making, integrating them with other technical indicators and fundamental analysis to build a more comprehensive investment decision framework. It is also advised to periodically re-estimate and update model parameters to adapt to changing market conditions and maintain predictive accuracy.

## 4. Conclusion

This study systematically analyzed the stock price data of Kansai Design Co., Ltd. over the past year and successfully constructed an AR (1) model with strong predictive performance. The results show that the stock exhibits significant short-term price continuity and that the model achieves high predictive accuracy, providing valuable references for investors. However, given the complexity of financial markets, investors are advised to combine model predictions with fundamental market information and establish a complete risk management framework. Future research may consider incorporating more external factors to further enhance predictive performance. At the same time, the analytical framework and methods of this study may also serve as a reference for stock price forecasting research on other listed companies.

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