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## Using an Additive Component Model to forecast the number of mergers and acquisitions in China

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**Abstract.** Research is devoted to the topic of modeling and forecasting seasonal fluctuations in M&A transactions in China to assess the short-term outlook for the movement of this sector, as well as for future studies of M&A market conditions in the PRC. As a forecasting method the authors have chosen a model with an additive component that considers quarterly data on the number of M&A deals in the Celestial Empire for the past 15 quarters. The order of building a model with additive component is calculation of seasonal component values, deseasonalization of data, trend calculation and evaluation of forecast accuracy. Additive model allows smoothing seasonality by separating seasonal component from time series and separating it from trend and residual component. This action is performed by subtracting the seasonal component from the original time series. Thus, seasonality is removed from the time series, and only trend and residual component remain. After extraction of the seasonal component, it can be analyzed separately and used to predict future values of the time series. It is also possible to use smoothing methods, such as moving average or exponential smoothing, to smooth the seasonality and get a smoother trend. The authors also built trend models, namely linear, power, polynomial, exponential and logarithmic trend models and chose the polynomial model that provides the highest coefficient of determination. The resulting model has made it possible to forecast the number of transactions by quarter until the end of 2023, in the aftermath of which the possible reasons for the decline in the number of mergers and acquisitions in China are described.

**Keywords:** mergers and acquisitions, M&A, modeling, forecasting, additive component, trend, China

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## Использование модели с аддитивной компонентой для прогнозирования количества сделок слияний и поглощений в Китае

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**Аннотация.** Исследование посвящено теме моделирования и прогнозирования сезонных колебаний в сфере сделок слияний и поглощений в Китае с целью оценки краткосрочной перспективы движения этого сектора, а также для будущих исследований конъюнктуры рынка сделок М&А в КНР. В качестве метода прогнозирования авторами была выбрана модель с аддитивной компонентой, учитывающая квартальные данные количества сделок М&А в Поднебесной за последние 15 кварталов. Порядок построения модели с аддитивной компонентой представляет собой расчет значений сезонной компоненты, десезонализацию данных, расчет тренда и оценку точности прогноза. Аддитивная модель позволяет сгладить сезонность путем выделения сезонной компоненты из временного ряда и отделения ее от тренда и остаточной компоненты. Данное действие выполняется путем вычитания сезонной компоненты из исходного временного ряда. Таким образом, сезонность удаляется из временного ряда, и остается только тренд и остаточная компонента. После выделения сезонной компоненты ее можно проанализировать отдельно и использовать для прогнозирования будущих значений временного ряда. Также можно использовать методы сглаживания, такие как скользящее среднее или экспоненциальное сглаживание, чтобы сгладить сезонность и получить более гладкий тренд. Авторами были построены трендовые модели, а частности линейная, степенная, полиномиальная, экспоненциальная и логарифмическая трендовые модели и выбрана полиномиальная, обеспечивающая наибольший коэффициент детерминации. Полученная модель позволила спрогнозировать количество сделок по кварталам до конца 2023 г. и описать возможные причины снижения количества сделок слияний и поглощений в Китае.

**Ключевые слова:** слияния и поглощения, М&А, моделирование, прогнозирование, аддитивная компонента, тренд, Китай

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## Introduction

As globalization and the liberalization of international trade have developed, closed economies have begun to form into interacting economies. As a result, large companies not only accelerated consolidation in their industries, but also began to enter national markets in other regions. It was at this point that mergers and acquisitions took a new turn and became a major tool for growth, restructuring, diversification, and entry into new markets, which greatly facilitated the formation of multinational corporations. M&A deals in today's reality are an important tool for business development and achieving strategic goals of companies. Today, the People's Republic of China is not only the factory of the world and the main competitor of the United States in the struggle for the title of the world's first economy, but also one of the leaders in the number of M&A deals. And it is M&A deals that play no small role in the country's growth. For example, Lenovo's August 2022 strategic partnership deal with PCCW Network Services, which marks a major milestone in the company's transformation to a service-oriented company and will expand the company's leadership capabilities in IT solutions. The synergy of the two organizations' capabilities and talents will help the new company expand its reach and competitiveness in the Asia-Pacific markets. Despite this dynamic, the number and value of M&A deals in China has been declining in recent years. That is why the purpose of this study is to comprehensively analyze the trends of M&As in China. To achieve this goal, we propose to examine the main trends and forecast the number of M&A deals in China. The results obtained will provide a deeper understanding of the M&A market conditions in China, as well as an assessment of the future of this industry until the end of the year. The following sections of our study will provide a detailed description of the methodology and data sources used in this paper, the results of the research analysis, and the main conclusions and recommendations.

## Literature review

A few research papers have been written on the topic of M&A in the PRC and the use of trend models, however, there are few of them as a tool for forecasting the M&A market.

The results of P.M. Mozias (2020) research indicate that foreign investment plays a significant role in China's development. They contribute to economic growth, transfer of advanced technologies and improvement of production processes. However, the author also draws attention to the obstacles faced by Chinese enterprises in overseas investment, such as difficulties in obtaining debt financing and discrimination against non-state-owned enterprises. This points to the need to develop domestic financial markets and create a more level playing field for all enterprises. In summary, the author's study emphasizes the importance of foreign investment and cross-border M&As for China and

its desire to diversify and expand its economic base. However, to realize the full potential of foreign investment and M&As, it is necessary to overcome the obstacles faced by Chinese enterprises and create a more favorable investment environment. This will allow China to further develop and strengthen its position in the international arena.

J. Borthwick, S. Ali, S. Pan (2020) in their paper discuss the impact of policy uncertainty on M&As in China and confirm its negative impact on this segment. Moreover, based on analysing the M&A market in China from 2003 to 2017, the authors conclude that the probability of M&A deals will continue to decrease in the following years due to the increasing level of policy uncertainty in the Middle Kingdom.

The research paper by Du Chunyu (2022) reveals the main expansion trends of large Chinese companies in the United States and confirms the possibility of developing this trend by the joint venture business model. The author found that this model can greatly simplify business for Chinese companies overseas, allowing them to share risks and costs with foreign partners, reducing financial and operational barriers. Moreover, Du Chunyu concluded that joint ventures could open access to new markets and customers, attract talent, and improve business management for Chinese companies. Overall, the author argues that the business model of joint ventures offers Chinese companies the opportunity to reduce risk and expand their opportunities in overseas markets. However, the specific outcomes may vary depending on the terms of co-operation.

The study by A.A. Shelukhin (2016) emphasizes the contribution of foreign investment and M&A deals to China's economic development. He notes that Chinese companies are interested in stable investments and access to consumer markets of developed countries. In addition, they are looking to acquire advanced technology and management techniques to compete effectively in the global market. However, the author also points out that cultural differences, lack of experience and training of numerous human resources, and integration issues can be barriers to the successful implementation of these investment projects. The author's main conclusion on this issue is that foreign investment and mergers and acquisitions can be an important factor in the development of the Chinese economy, but the successful implementation of these projects requires in-depth analyses and understanding of foreign markets, experience, and training, as well as efforts in integration and preserving the rights and capabilities of local governance.

The work of J. Fan, A. Maity, Y. Wang, and Y. Wu (2013) is a valuable contribution to the study of the application of additive trend models for M&A forecasting. The authors used a generalised nonparametric additive model as a flexible method to estimate the impact of several covariates on the overall outcome through a link function. They assumed that the influence of each covariate is nonparametric and additive. However, in practice, information about the shape of regression functions may be available from pilot studies or exploratory analyses. In such cases, the authors proposed an estimation method that uses prior information as a parametric guide to fit an additive model. They assumed a parametric family for each regression function using prior information, removed these parametric trends, estimated the remaining non-parametric functions

using a non-parametric generalized additive model and generated final estimates by adding back the parametric trend. Moreover, the authors studied the asymptotic properties of the estimators and found that a good guide significantly reduces the asymptotic variance of the estimators without changing the asymptotic variance of the unguided estimator. They evaluated their method through a simulation study and demonstrated its effectiveness by applying it to a real M&A dataset.

In the article E.A. Polischuk, M. Hasanov (2022) concluded about the effectiveness of using an additive trend model for data subject to seasonal fluctuations. The model built by the authors allows to develop a strategy that can reduce the impact of seasonality and develop sustainable demand in this area.

The work of B.D. Fulcher (2013) is a valuable contribution to the study of the application of additive trend models for forecasting. The authors discuss the role, relevance, and application of additive model in the context of forecasting. They point out that additive trend models are an effective forecasting tool to analyze and predict time series. The authors emphasize that an additive model has advantages in that it can quickly adapt its structure and parameters to changing conditions. This allows it to be used for forecasting in a variety of situations where trends and seasonality need to be considered. They also note that the relevance of the additive model stems from its ability to capture and analyze the systematic components of time series variation. The additive model allows the time series to be partitioned into trend, seasonal and residual components, which helps researchers to better understand and explain the dynamics of the data. Overall, the authors emphasize that the additive model is a useful tool for time series analysis and forecasting, especially when trends and seasonality need to be considered.

The article by T. Reyes (2018) “focuses on analyzing the seasonality of M&A deals. Using data from 1994 to 2016, the author confirmed the seasonality of the number of M&A transactions both by day of the week and by month.” The author concluded that Monday is the most popular day to announce deals. This can be explained by the fact that company representatives often meet on weekends to plan a deal announcement while stock markets are closed for the weekend to reduce the possibility of information leakage. As the week progresses, the number of announcements decreases.

The work of S.K. Vissa and M. Thenmozhi (2022) was also devoted to the study of seasonality of the number of M&A deals in the US state of Georgia from 2010 to 2014. The author proved the seasonality of the number of deals based on the collected data and concluded that the dynamics of deals remains approximately stable, nevertheless the 3rd and 4th quarters are also the largest periods in terms of the number of deals.

### **Research methods**

Since the M&A industry is subject to seasonality, the authors decided to use a trend model with an additive component to forecast the indicator. The additive model smoothers seasonality by extracting the seasonal component from the

time series and separating it from the trend and the residual component. This is done by subtracting the seasonal component from the original time series. In this way, the seasonality is removed from the time series and only the trend and residual component remain. Once the seasonal component is extracted, it can be analyzed separately and used to predict future values of the time series. Smoothing techniques such as moving average or exponential smoothing can also be used to smooth out the seasonality and produce a smoother trend. In general, an additive model allows for more accurate analysis and forecasting of time series, considering their seasonality and other systematic components of change.

An additive component model is a model in which the variation in the values of a variable is described as a sum of components. An additive forecasting model can be represented in the form of a formula:

$$F_t = T_t + S_t + \varepsilon_t, \quad (1)$$

where  $F$  — forecast model of indicator values or trend function;  $T$  — trend component;  $S$  — seasonal component;  $\varepsilon$  — random component or forecast error, which is the effect of many relatively weak secondary factors;  $t$  — number of time period ( $t = 1, 2, 3, n$ ). Periods are quarterly data.

The algorithm for building a trend model with an additive component consists of several steps:

1. Calculation of the values of the seasonal component. To eliminate the influence of the seasonal component, the centred moving average method is used:

$$\tilde{x}_t = \frac{\frac{1}{2}x_{t-2} + x_{t-1} + x_t + x_{t+1} + x_{t+2}}{4}. \quad (2)$$

The difference between the actual value of the number of M&A transactions and the centred moving average is the value of the seasonal component and the error. Next, it is necessary to distribute the seasonal component estimates by year and calculate the average value for each quarter for all selected years. The adjusted seasonal component for each quarter is calculated as follows:

$$S = \frac{\bar{x} - \sum \bar{x}}{4}, \quad (3)$$

where  $\bar{x}$  is the average value of seasonal component estimates for the quarter;  $\sum \bar{x}$  is the sum of the average values of each quarter.

The sum of seasonal components for 4 quarters should be equal to zero, if this condition is not fulfilled, the values of seasonal components should be adjusted.

2. Deseasonalisation of the data and calculation of the trend. It is necessary to distribute the values of the adjusted seasonal component by quarters and then subtract them from the actual values:



$$Q - S = T + E. \quad (4)$$

Based on the results of the obtained values of the deseasonalised series it is necessary to build a few trend models (linear, steppe, exponential, logarithmic) and choose the model that provides the highest approximation accuracy ( $R^2$ ). To determine the trend component ( $T$ ), the ordinal number of the quarter should be substituted into the obtained equation instead of ( $x$ ).

3. Evaluation of forecast accuracy. Forecast accuracy is assessed by the amount of error (error) between the actual and forecasted value of the indicator under study, to assess the accuracy of the forecast the following indicators are calculated:
  - a) Mean absolute deviation ( $MAD$ ), which shows by how many units of measurement the forecast deviates on average in a greater or lesser direction.

$$MAD = \frac{\sum_{t=1}^n |\Delta_t|}{n} = \frac{\sum_{t=1}^n |y_t - \hat{y}_t|}{n}. \quad (5)$$

where  $n$  is the number of time series levels for which the forecast value was determined,  $\hat{y}_t$  is the forecast value of the indicator,  $y_t$  is the actual value.

- b) Mean approximation error ( $MAPE$ ) characterises the amount by which the theoretical levels calculated by the model, on average, deviate from the actual ones.

$$MAPE = \frac{1}{2} \sum_{t=1}^n \left| \frac{y_t - \hat{y}_t}{y_t} \right| \times 100 \%. \quad (6)$$

- c) The average percentage error ( $MPE$ ) shows forecast offsets, that is, it allows you to get information about whether the forecast is overestimating or underestimating.

$$MPE = \frac{1}{2} \sum_{t=1}^n \frac{(y_t - \hat{y}_t)}{y_t} \times 100 \%. \quad (7)$$

## Results and discussion

Let us consider the process of model building, considering the data on the number of M&A deals in China for the last 15 quarters (Table 1). The data analysis allowed us to verify that the number of M&A deals has a pronounced cyclical pattern. The quarters with the lowest number of deals are the first and second quarters, with the highest values occurring in the fourth quarter. Due to this finding, the authors confirmed the existence of trend-seasonal time series for the following sample.

Table 1

**Calculation of the estimated seasonal component  
of the number of M&A deals from Q1 2019 to Q1 2023**

<i>t</i>	Actual number of transactions, Q	Total for 4 quarters	Moving average for 4 quarters	Centered moving average	Estimate of the seasonal component
1 Q 2019	959				
2 Q 2019	1042	4276	1069		
3 Q 2019	1023	4000	1000	1034.5	-12
4 Q 2019	1252	3887	971.75	985.875	266
1 Q 2020	683	3921	980.25	976	-293
2 Q 2020	929	3947	986.75	983.5	-55
3 Q 2020	1057	4208	1052	1019.375	38
4 Q 2020	1278	4242	1060.5	1056.25	222
1 Q 2021	944	4136	1034	1047.25	-103
2 Q 2021	963	3777	944.25	989.125	-26
3 Q 2021	951	3437	859.25	901.75	49
4 Q 2021	919	3153	788.25	823.75	95
1 Q 2022	604	2932	733	760.625	-157
2 Q 2022	679	2902	725.5	729.25	-50
3 Q 2022	730	2977	744.25	734.875	-5
4 Q 2022	889				
1 Q 2023	679				

Source: compiled by the authors based on results of quarter amount of M&A deals in China in Institute for Mergers, Acquisitions & Alliances. Retrieved April 10, 2023, from [imaa-institute.org](http://imaa-institute.org)

To reduce the influence of the seasonal component, it is proposed to use the moving average method, in which the actual levels of the dynamic series are replaced by the calculated levels, which have much lower variability. The average value was calculated for groups of data formed for a certain period, with a shift by one quarter. As a result of applying the calculated values, the fluctuations of the dynamic series will be smoothed and deprived of the seasonal component, as well as centered to exclude the irregular component and highlight the main trends and cycles. Using this methodology, the seasonal component was estimated, considering the errors.

Then, to average the seasonal variable, the authors calculated average values for each quarter over the last 3 years. The result of the sum of mean values equal to zero indicates the finality of the studied components and implies that they do not need any refinement or adjustment. The authors then proceeded to the second step of the additive trend model construction — data deseasonalisation (Table 2).



Table 2

**Calculation of seasonally adjusted values for the number of M&A deals in China**

Year	1 Q	2 Q	3 Q	4 Q	
2019			-12	266	
2020	-293	-55	38	222	
2021	-103	-26	49	95	
2022	-157	-50	-5		
Total	-552.9	-130.9	70.5	583.1	Sum
Average value	-184.3	-43.6	17.6	194.4	-15.9
Adjusted seasonal component, S	-180.3	-39.6	21.6	198.4	0.0

Source: compiled by the authors based on results of quarter amount of M&A deals in China in Institute for Mergers, Acquisitions & Alliances. Retrieved April 10, 2023, from [imaa-institute.org](http://imaa-institute.org)

The authors constructed linear, steppe, polynomial, exponential and logarithmic trend models since the deseasonalised series data and chose the polynomial model that provides the highest approximation accuracy:

$$T = -0,7934x^2 - 9,6382x + 1097,2. \quad (8)$$

The coefficient of determination ( $R^2$ ) was 0.61. Consequently, the number of mergers and acquisitions in China can be explained by 61 % percent using a polynomial trend model.

Table 3

**Calculation of deseasonalization and forecasted values of the number of M&A deals in China**

t	Actual volume of transactions, Q	Deseasonalized number of transactions, Q - S = T + E	Seasonal component, S	Trend value, T	Forecast value, F
1 Q 2019	959	1139.3	-180.3	1086.8	906
2 Q 2019	1042	1081.6	-39.6	1074.8	1035
3 Q 2019	1023	1001.4	21.6	1061.1	1083
4 Q 2019	1252	1053.6	198.4	1046.0	1244
1 Q 2020	683	863.3	-180.3	1029.2	849
2 Q 2020	929	968.6	-39.6	1010.8	971
3 Q 2020	1057	1035.4	21.6	990.9	1012
4 Q 2020	1278	1079.6	198.4	969.3	1168
1 Q 2021	944	1124.3	-180.3	946.2	766
2 Q 2021	963	1002.6	-39.6	921.5	882
3 Q 2021	951	929.4	21.6	895.2	917
4 Q 2021	919	720.6	198.4	867.3	1066
1 Q 2022	604	784.3	-180.3	837.8	658
2 Q 2022	679	718.6	-39.6	806.8	767
3 Q 2022	730	708.4	21.6	774.1	796
4 Q 2022	889	690.6	198.4	739.9	938
1 Q 2023	679	859.3	-180.3	704.1	524
2 Q 2023			-39.6	666.7	627
3 Q 2023			21.6	627.7	649
4 Q 2023			198.4	587.1	785

Source: compiled by the authors based on results of quarter amount of M&A deals in China in Institute for Mergers, Acquisitions & Alliances. Retrieved April 10, 2023, from [imaa-institute.org](http://imaa-institute.org)

Based on the results of the performed calculations based on the additive trend model, the authors made the following conclusions about the forecast accuracy:

- On average, the predicted number of M&A deals deviates from the actual number of deals either upward or downward (MAD) by 79 deals.
- The mean approximation error (MAPE) is 9 %, indicating a high accuracy of the additive model.
- The mean percentage error (MPE) is close to zero and amounts to  $-0.8\%$ , which means a slight overestimation of the index by  $0.8\%$ .

Thus, we can conclude that the M&A momentum in China will continue to decline in 2023, totaling 2,741 deals, down 161 respectively ( $-5.6\%$ ) from last year.

## Conclusion

Despite the growing macroeconomic performance of the Middle Kingdom, the number of M&A deals has been declining in the country since its all-time high in the mid-2010s. The main reason for this is likely to be deeper or institutional reasons. One is legal constraints: Chinese lawmakers have implemented a series of sweeping regulatory changes that have created a more complex business environment and affected market optimism. These regulatory changes have made it more difficult for Chinese companies to transact with foreign companies, and policymakers, especially in the United States, have become more cautious and even hostile to acquisitions by Chinese companies, especially in strategically important sectors. Preserving national security also plays a large role in this dynamic: the number of deals abroad, and especially in the United States, declined significantly over the period under review due to countries' fear of Chinese capital. Geopolitical tensions also have a major impact on the cooling of the M&A market due to an increasingly uncertain economic outlook internationally, leading to a weakening of investor confidence. The findings of this paper can help to assess the short-term outlook in the M&A market and for a comprehensive analysis of this market segment in the future.

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