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Relationship Among Stock Market Index and Macroeconomic Indicators: An Empirical Analysis of Post-pandemic Era

Shiqi Zhang[1,a,*]

[1]*Chongqing Nankai Secondary School, 1 South Shapingba Street, Chongqing, 400030, China*
a. huxianming@nks.edu.cn
**corresponding author*

Abstract: There exists a strong correlation between fluctuations in stock prices and the financial and economic circumstances of a nation. Being a fundamental component of stock market analysis, the stock index serves a crucial function in defining the general direction of the stock market, offering a benchmark for market risk, and fostering market confidence. In the post-pandemic era, with the recovery of the stock market and the national economy, whether the connection between macroeconomic indicators and the stock market has changed or not has become an important research topic. The study gathered monthly data from 18 countries characterised by varying degrees of development, geographical location, and cultural heritage throughout the period following the epidemic (January 2023 to June 2024)This study explores the relationship between typical macroeconomic indicators and stock market indexes worldwide. Using the concepts of addition and weighting, this study sorts the degree of closeness between these indicators and the stock index, which enables future researchers to effectively choose suitable macroeconomic indicators by consulting this paper while analysing the stock market. The rank of closeness degree is based on the unemployment rate, exchange rate, inflation rate, and interest rate. Finally, VIF and significance before and after dimensionality reduction were compared to prove the effectiveness of ranking.

Keywords: Stock market, Macroeconomic indicator, Post-pandemic era., Regression analysis.

1. Introduction

Over the last few decades, the stock market has been crucial in facilitating the movement of capital, diversifying risks, enhancing the effectiveness of resource distribution, boosting government receipts, and mirroring national economic realities.

With the outbreak of COVID-19, the world situation has become volatile. In the financial and economic field, the COVID-19 outbreak has caused the stock market to experience significant fluctuations. Followed by the post-pandemic period, characterised by the revival of the stock market and the overall national economy, the relat between the stock market and macroeconomic indicators has become an important research topic. However, according to prior research, most researchers prefer to study the effect of a single factor on the stock market or in a single country but not from a worldwide perspective. That is to say, they somewhat lack the application of contrast. Minimal

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research focuses on how closely different macroeconomic indicators are linked to stock market indexes and how efficiently they are used. To some extent, the lack of information has caused confusion and constant inconvenience to researchers and investors when choosing indicators for stock market prediction research and guiding investment.

In the study, an attempt is made to quantify the degree of closeness between macroeconomic indicators and stock market index price changes. An analysis was conducted using monthly data from stock market indexes and key macroeconomic indicators, including inflation rate, interest rate, unemployment rate, and exchange rate, in 18 nations during the post-epidemic period from January 2023 to June 2024. This study adopted the correlation test, factor analysis, and multiple linear regression methods.

Research into the degree of closeness between macroeconomic indicators and stock market index price changes has significant reasons. First, for ordinary investors, this provides a reference for buying stocks and gaining money effectively. Second, for professional researchers, this can guide the selection of impact factors when they study stock market indexes. Third,it enhances the accuracy of stock market predictions.In addition, this study fills the gap in related fields of stock market research.

The study aims are as follows: First, to understand the connection between inflation rate, interest rate, unemployment rate, exchange rate and stock market index; Second, to rank the closeness degree between these macroeconomic indicators and stock market index.

2. Literature Review

Researchers often reach different conclusions regarding the correlation between macroeconomic indicators and stock market indexes.

In a study by Sahaida Laily Md Hashim, Laliithashree Komarsamy, and Jeyaasree Singaveloo, it was found that only the exchange rate significantly impacted the stock market index, while inflation and interest rates did not have a significant effect [1]. In contrast, N.B. Fernandez and R.C. Li argued that the interest rate is important in determining stock market performance [2]. Oyami Sara suggested that the inflation, interest, and exchange rates significantly impacted the Indonesian stock market [3]. Similarly, a study by Jefry J and Djazuli A. focusing on the Indonesian market arrived at the same conclusion as Oyami Sara [4]. Majeed B.N.'s study on the effect of macroeconomic variables on stock exchange market performance in Iraq concluded that the exchange rate and interest rate have a major impact, while the inflation rate did not [5]. Additionally, establishing the relationship between the stock market index and the unemployment rate is more challenging. Sergi B.S, Harjoto M.A, and Rossi F suggested that unemployment partly drives the effect of BMI on stock market returns and volatility [6].

3. Research Methodology

In order to assess the closeness degree among inflation rate, interest rate, unemployment rate, exchange rate, and stock market index, the study used the qualitative research approach.

3.1. Sample

The study selected monthly data from 18 countries with different levels of development, geographical background, and cultural background in the post-pandemic era from January 2023 to June 2024. All secondary data came from mainstream databases Trading Economics and Wind.

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3.2. Variables

In Keswani S, Puri V and Jha R's study, they chose eight factors to study Indian stock prices[7, 8], while this study condensed the following four independent variables: inflation rate, interest rate, unemployment rate, and exchange rate, while the stock market index was designated as the dependent variable.

3.2.1. Stock Market Index

The study employs the stock index as the dependent variable, which is derived from the average computation and dynamic comparison of the stock trading prices of selected representative firms in the stock market. It provides a thorough representation of the dynamics of the stock market.

3.2.2. Inflation Rate

Inflation rate is the pace at which the overall price level increases during a specific time-frame, which reflects the degree of inflation, often measured by the growth rate of the price index.

3.2.3. Interest Rate

The interest rate selected for the study is an established benchmark interest rate. The benchmark interest rate is the official interest rate set by the central bank of each country to regulate deposits, loans, discounts, and other transactional activities of commercial banks. The benchmark interest rate is a widely used reference variable in the financial market, used to establish other interest rates or financial asset prices. Additionally, Terra F H B, and Gomes C's study mentioned that mark-ups added to the central bank benchmark interest rate determine market rates [9].

3.2.4. Unemployment Rate

The unemployment rate is a metric that quantifies the percentage of individuals in the labour market of a country or region who are without employment. It serves as an indicator of the economic condition and the overall stability of the labour market. Elevated levels of unemployment might signify an economic deceleration or recession characterised by the underutilisation of labour resources, whilst low levels of unemployment often suggest a thriving economy with an abundance of work opportunities. Hence, the unemployment rate functions as a crucial economic statistic closely monitored by policymakers, economists, and the general public.

3.2.5. Exchange Rate

Based on Avdjiev S, Bruno V and Koch C's viewpoint :dynamic changes in exchange rates can impact economic activity not just through the conventional commerce channel, but also through a finance channel [8].The study determined the benchmark exchange rate of each country in relation to the US dollar. Given that the US dollar exchange rate had no correlation with the US, the study opted to utilise the US dollar index instead for examining the US variables.

The United States dollar exchange rate refers to the valuation of the United States dollar in relation to the currencies of other nations. The exchange rate is a valuation denominated in US dollars relative to the currencies of other nations. Given its status as the main reserve currency worldwide, the US dollar is commonly employed in worldwide commerce, foreign exchange reserves, international debt, and financial activities. The extensive utilisation of the US dollar renders it highly significant in the global financial market and has a direct impact on the stability and progress of the worldwide economy. The significant function of the US dollar exchange rate in the global economy is not only

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to facilitate international economic transactions but also to serve as a crucial benchmark for countries' economic policy adaptation.

3.3. Model Selection

Correlation analysis, factor analysis, and multiple linear regression were selected based on the research's comprehension.

3.4. Model Building

In order to explore the relationship between macroeconomic indicators and stock market indexes, this study constructs models as follows.

3.4.1. Factor Analysis

The basic formula of factor analysis can be expressed in Equation (1).

$$Z_i = a_{1i}F_1 + a_{2i}F_2 + \cdots + a_{mi}F_m + \varepsilon_i \quad (1)$$

Where Z_i represents the i th observed variable. It can be any variable the study wants to analyze. a_{1i}, a_{2i}...a_{mi}: are called factor loads, indicating the degree of association between the observed variable i and the individual factors. The greater the absolute value of the factor load, the closer the relationship between the observed variable and the factor. F_1,F_2,…F_m represent potential factors. They are imaginary variables in the model that explain correlations between observed variables. These factors cannot be directly observed , but their existence and influence can be estimated through factor analysis. ε_i represents the special factor and is the part of the i th observed variable that the underlying factor cannot explain. The special factors are usually assumed to be random variables with zero mean and independent of each other.

3.4.2. Multiple Linear Regression

A statistical technique known as multiple linear regression is employed to examine the linear association between two or more independent variables (explanatory factors) and one dependent variable (response variable). Its general form is given by Equation (2).

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n + \varepsilon \quad (2)$$

Where Y is the dependent variable. X_1,X_2,…X_n are the independent variables. β_0 is the intercept term. β_1, β_2…. β_n is the regression coefficient and represents the degree of influence of the respective variables on the dependent variable. ε is the error term and represents the part of the variation the model fails to account for. Multiple linear regression models can be used to predict and explain the relationship between variables and perform hypothesis testing.

3.4.3. Methods of Close Degree Comparison

The study selected two comparative methods to support each other. One is a simple addition, and the other is a weighting calculation. In this study, macroeconomic indicators in the commonalities table are extracted and added together when factor analysis is performed. In order to judge the closeness degree of variables, the research stipulated that the weight of the highest degree of closeness is 40%, the second 30%, the third 20%, and the fourth 10%. The final result is obtained by multiplying the number of close rankings of each variable in 18 countries by the corresponding weighting coefficient and summing each item.

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4. Empirical Analysis

4.1. Descriptive Statistics

Based on the stock market indices of 16 countries that Khan K, Zhao H, and Zhang H selected in their study of the impact of the COVID-19 on stock markets, this study replaced and expanded them with descriptive statistics [10]. Finally, the study selects the main stock indexes of 18 countries which are suitable for the study. The BURCAP to represent Argentina, the S&P 300 to represent Australia, the BOVESPA to represent Brazil, the FTSE 100 to represent Britain, the S&P/TSX to represent Canada, the ISPA to represent Chile, the SSE Composite Index to represent China, the EGX30 to represent Egypt, the DAX30 to represent Germany, the HSI to represent Hong Kong, China, the FTSE/MIB to represent Italy, the Nikkei225 to represent Japan, the KOSPI to represent Korea, the INMEX to represent Mexico, the OSEBX to represent Norway, the MOEX to represent Russia, the REITS to represent Singapore, the FTSE/JSE to represent South Africa, the DJIA to represent the United States.

4.2. Correlation Analysis

The correlation between the variables in the 18 countries was also tested. The results showed that there is a high significance among all variables. Taking China as an example, the significance values between almost all variables are below 0.05, and most of them are even below 0.01. (Table 1)

Table 1: Significance in Chinese Market (2-tailed)

	China SSECI	Inflation rate	Interest rate	Unemployment rate	Exchange rate
China SSECI		0.028	<0.001	0.027	0.011
Inflation rate	0.028		0.109	0.005	<0.001
Interest rate	<0.001	0.109		0.008	0.015
Unemployment rate	0.027	0.005	0.008		<0.001
Exchange rate	0.011	<0.001	0.015	<0.001	

4.3. Factor Analysis

In order to derive the closeness of each macroeconomic indicator for the stock market index, the performance of 4 independent variables in 18 countries was reduced in dimension. When doing the dimensional reduction, the main table the study focused on is the communalities table.

4.4. Deriving a Degree of Closeness

Table 2: Extraction of Each Macroeconomic Indicator

countries	Inflation Rate	Interest Rate	Unemployment Rate	Exchange Rate
Argentina	0.993	1	0.999	0.996
Australia	0.953	0.973	0.996	1
Brazil	0.998	0.905	0.924	0.998
Britian	0.943	0.911	0.996	0.994
Canada	0.885	0.971	0.996	1
Chile	0.994	0.97	0.997	0.99
China	0.942	0.995	0.988	0.85

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Table 2: (continued).

Egypt	0.999	0.965	0.993	0.981
Germany	0.988	0.905	0.924	0.988
Hong Kong	0.998	0.964	0.976	0.996
Italy	0.955	0.987	0.987	1
Japan	0.958	0.968	0.998	0.886
Mexico	0.915	0.995	1	0.925
Norway	0.947	0.957	0.999	0.997
Russia	0.987	0.941	0.985	0.989
Singapore	0.937	0.997	0.955	0.998
South Africa	0.987	0.975	1	0.996
the United States	0.982	0.974	0.999	1
Addition	17.361	17.353	17.712	17.584

The first idea is addition. The extractions of each macroeconomic indicator were extracted from the commonalities table and then added together. (Table 2)

The order is:$17.712 > 17.584 > 17.361 > 17.353$

Then comes the second idea of weighting calculation.

Table 3: Weighting Calculation

Macroeconomic Indicators / Times of each Price	First	Second	Third	Last	Result
Inflation Rate	4	2	5	7	3.9
Interest Rate	2	4	4	8	3.6
Unemployment Rate	6	5	7	0	5.3
Exchange Rate	6	6	4	4	5.2

The order is: $5.3 > 5.2 > 3.9 > 3.6$

According to the two ideas of addition and weighting, the closeness degree between each indicator and the stock market index was evaluated. From the two table, it is clear that the order of closeness degree from high to low is Unemployment rate, Exchange rate, inflation rate, and interest rate. Additionally, it is delightful that the two different kinds of calculations corroborate each other perfectly. (Table 2, Table 3)

4.5. Regression and Modification

First, the research conducted a regression analysis of 4 indicators on the stock index. After finding that the interest rate has the least closeness degree, the study deleted this indicator and rebuilt the regression model with the remaining three indicators.

Table 4 shows that the regression coefficient cannot effectively explain whether the macroeconomic indicators are positively or negatively correlated with the stock market index due to the lack of data.

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Table 4: Regression coefficient

	Constant	Constant	Inflation rate	Inflation rate	Interest rate	Interest rate	Unemployment rate	Unemployment rate
Nation	3 indicators	4 indicators	3 indicators	4 indicators	3 indicators	4 indicators	3 indicators	4 indicators
Argentina	420887.12	1891352.07	1326.42	-105.66	569163.61	24230.64	-261463195.9	-252353249
Australia	20221.83	20156.89	742.47	-725.24	-179.58	-177.61	-7256.65	-7298.35
Brazil	123378.36	42294.91	434.61	1965.5	-14249.1	-4877.74	528433.18	845447.3
Britian	8663.36	8092.7	-27.63	96.81	607.3	485.36	-2624.06	646.29
Canada	-1280.49	-1537.05	34.07	9.09	147.41	179.14	2135.2	3598.35
Chile	61765.29	25471.77	-543.36	-202.6	-3060.31	-118.86	-1428341.37	15107476.05
China	-303.91	-992.97	34.07	59.96	138.85	-156.47	19016.48	2975.39
Egypt	180068.2	137221.53	48.75	-12.75	-65940.18	-53383.79	-205748.17	31933.31
Germany	-753.65	-2067.33	-33.97	-48.91	-94.32	105.58	2688.07	3369.66
Hong Kong	326783.75	-101329.83	88.75	-1126.84	4762.07	-8536.77	-2526713.5	1542171.1
Italy	66775.49	64899.4	21.52	-50.4	-7789.77	-7642.72	19518	21994.19
Japan	92078.61	71591.04	-2226.36	-2919.56	-209.67	-1993.04	-7374851.03	-3367634.38
Mexico	-918.58	185.68	113.67	104.29	-163.81	-161.9	72199.52	71465.2
Norway	1189.03	1118.22	-55.44	-59.82	72.85	73.05	266.63	387.01
Russia	6827	5576.08	6.45	-10.99	-511.72	-335.03	-203522.42	162321.17
Singapore	-2236.9	-2423.21	26.34	23.28	-0.56	-23.94	3764.04	3945.2
South Africa	-30757.43	-9847.19	-1076.48	-1550.65	2877.06	2880.01	1507125.34	1361002.28
U.S	82194.99	85801.08	-302	-438.95	7667.06	7876.51	-707.56	-713.45

4.6. Robustness Test

Through the regression modelling comparison before and after removing the interest rate factor, it is easy to find that the VIF and sig. are reduced.

4.6.1. Variance Inflation Factor

VIF is an index used to measure whether there is multicollinearity between independent variables. In the regression analysis, when there is a high correlation between independent variables, the VIF value will increase, indicating multicollinearity problems in the data. Greater values of the VIF indicate a greater correlation between the independent variables, which can result in imprecise calculation of the regression coefficient.

Decreasing the VIF weakens the correlation between the independent variables and reduces the impact of multicollinearity. In this case, the regression coefficient estimation of the model will be more accurate, improving the model's predictive power and explanatory power.

In Figure 1, the VIF ratio of most four indicators is greater than 50%. That is to say, the VIF of 4 indicators is more significant than that of 3 indicators, which further shows that after dimensionality reduction to 3 indicators, the reduction of multicollinearity makes the model more accurate.

And as the Figure 2 indicated: after dimensionality reduction, most of VIF has negative growth, and the highest negative growth rate is about -80%

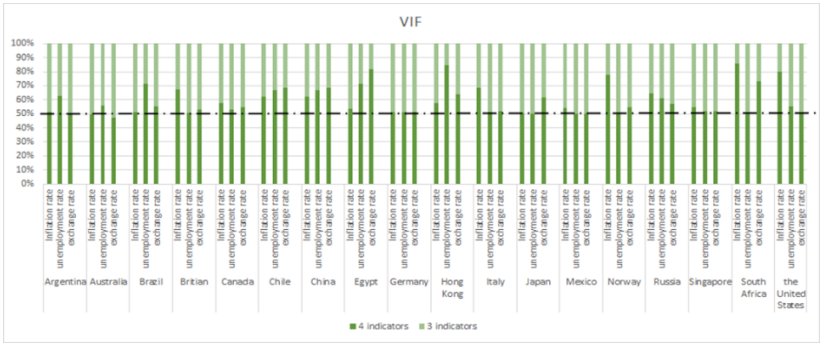

Figure 1: Percentile pile bar chart of VIF

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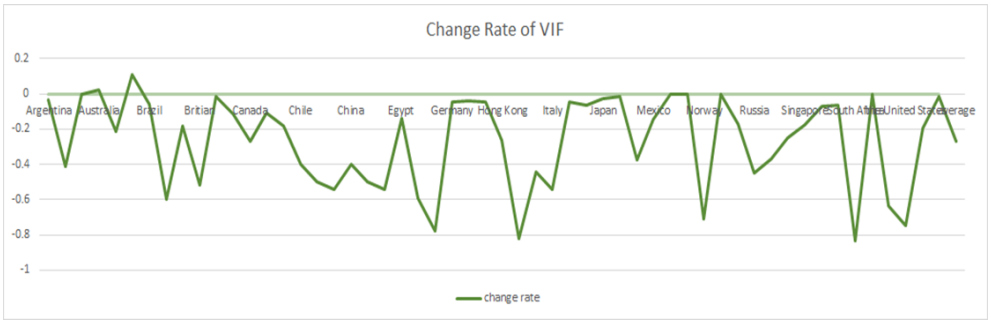

Figure 2: Linear chart of VIF change rate

4.6.2. Statistical Significance

Also, sig. has reduced a lot, which implies an increase in statistical significance. Significance is an essential indicator for measuring the reliability and accuracy of statistical inference. The significance of the improvement lies in that by setting a reasonable significance level; researchers can more accurately evaluate the reliability of statistical inference, avoid major mistakes, and , thus, improve the credibility and validity of research conclusions. Because some of them are too extreme, the study only selected data with a change rate of ±200%

Figure 3 shows that the numerical significance value is more than 50% and has a more significant proportion than that of the three indicators, indicating that the significance has been improved in a more significant part of the countries and indicators.

Figure 4 shows that a large amount of the change rate is negative, supporting the table above.

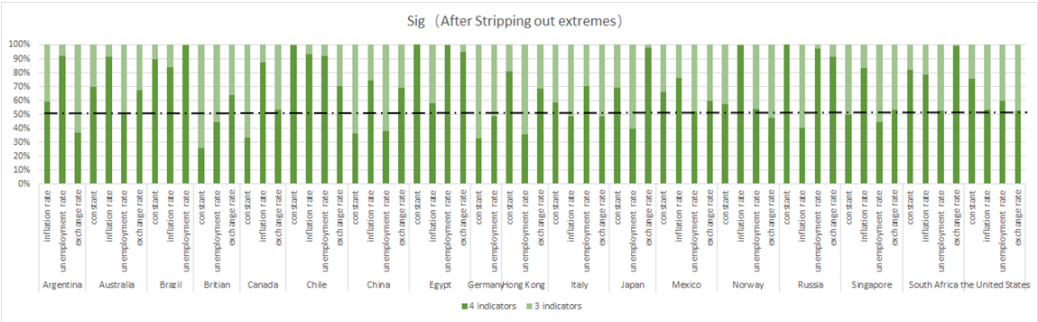

Figure 3: Percentile pile bar chart of Sig.

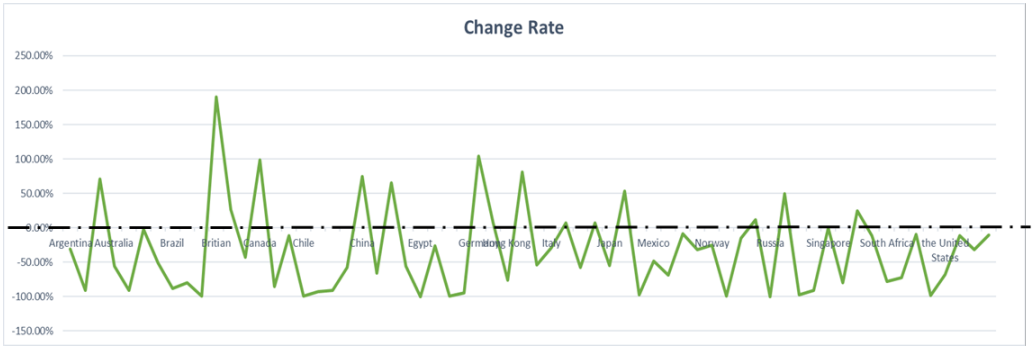

Figure 4: Linear chart of Sig. change rate

In conclusion, the positive changes in the two factors are undoubtedly accurate in the researchers' statistical regression results.

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4.7. Summary of Results

In summary, worldwide, generally speaking, in view of the poor performance of interest rates in factor analysis and regression analysis, the study finally concluded that it is not recommended to use interest rates as independent variables to study stock market indexes. The study supports the other three indicators as performing relatively well and can be considered for retention.

4.8. Limitations

The first limitation is that, on one hand, only one and a half years of data were selected for the study. Because the epidemic has caused significant damage to the stock market and brought great destructiveness, the data from 2020 to 2022 are not so efficient and cannot be selected. There is a limited amount of data available. On the other hand, because only monthly data was selected, the precision of the study cannot be so high.

So, the implications for further study are: first, more extended periods of data can be selected after the epidemic's impact becomes weaker; second, higher frequency data, such as daily or weekly, is worth attention.

The second point of limitation is the undesirable change in the R square.

From the Figure 5, it is strange that after deleting the interest rate indicator, the R square did not rise as expected but remained unchanged, even declined, which further exploration in further studies.

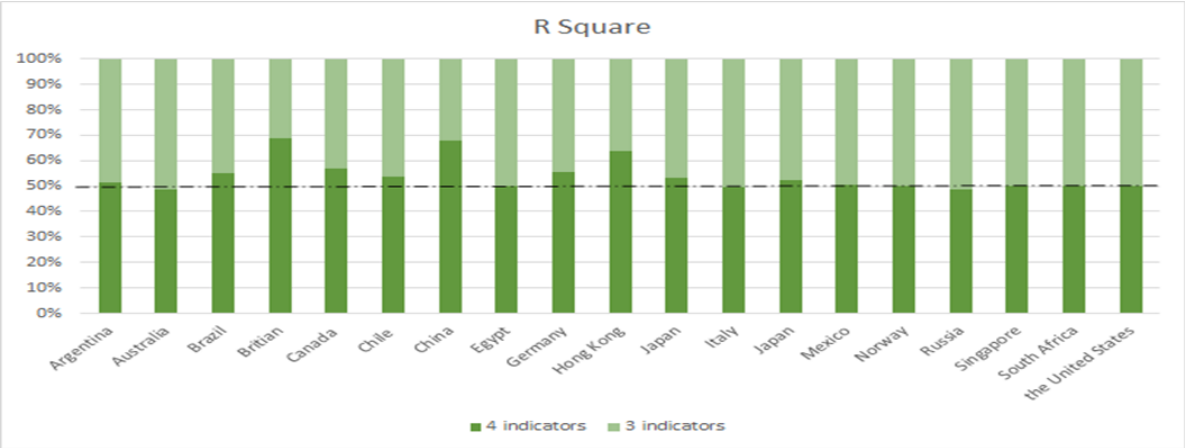

Figure 5: Percentile pile bar chart of R square

The last point is the lack of indicators. In the study, only four indicators were selected. However, after adding more macroeconomic indicators, the results might be different.

5. Conclusions

This study explores the relationship between the macroeconomic indicators and the stock market index of 18 countries in the post-pandemic era (from January 2023 to June 2024).

In a short period, all four macroeconomic indicators have a certain degree of influence on the stock market's volatility. However, there is no doubt that their specific degree of influence is different. In other words, their degree of closeness is different, so our final ranking of the closeness degree of the four indicators on the stock market index is as follows: Unemployment rate, exchange rate, inflation rate, and interest rate

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