The Impact of Macro Factors on Stock Indexes

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Abstract: This paper aims to discuss the impact of macro factors, including Exchange rate, Consumer Price Index (CPI), Exports value, Interest rate, Money Supply (M2), Producer Price Index (PPI), Total reserves, and Economic Policy Uncertainty index (EPU). Some macroeconomic factors have impacts on stock returns, while others may have little effects. The first part is to discuss the methods used in this research and the purpose of the next part is to introduce data and database. The third part is the most important, which introduces the process of quantitative analysis and discussion of the results. Finally, a conclusion is given.

Keywords: macro factors, stock returns, quantitative analysis, exchange rate, CPI, exports value, interest rate, M2, PPI, total reserves, EPU

1. Introduction

The stock market is critical to economic development by giving its position as a mediator between borrowers and lenders[1] and its movement is influenced by both rational and irrational investor behavior[2]. From an economic standpoint, the stock market is becoming increasingly important in recent decades, promoting the development of the industry and company because it allows businesses to raise capital swiftly and provide a trading platform for securities[3]. It has also played a significant role in the development of China since the establishment of the Shanghai Stock Exchange in 1990. Until now, the Chinese stock market has been one of the most important markets in the world, making significant contributions to the global financial market in terms of raising capital, optimizing industrial structure, and enhancing social resource allocation efficiency.

According to Mugambi and Okech, a market index is an aggregate value created by adding the total values of multiple equities and comparing them to a base value. It is normally seen as a sensitive signal reflecting the economic development status, to some extent, it totally could represent the overall economic development level of a country. Investors could also get estimates of future market patterns by looking at the market index.

2. Method

The method used in this paper is named OLS, which fits the data by finding a suitable straight line. Because of its long history and ease of computing, it is frequently used in numerous conceivable regression approaches. However, outliers, non-normality, multicollinearity, and missing data may have an adverse impact on the OLS estimate of regression weights in multiple regression[4].

In terms of observations, the multiple linear regression model is represented as $y_t = \alpha_t + \beta_n x_{nt} + u_t$, where y_t is a $1 \times t$ matrix of observed response values, x_t is a $n \times t$ matrix of predictor variables, α_t and β_n are two matrices of $1 \times t$ and $n \times 1$, u_t is the random error term. The goal of regression analysis is to discover unknown parameter estimates. The least squares criterion is used to get the best estimate of β_n using the OLS, which minimizes the sum of squared distances between the actual observation and the regression surface[4]. This model needs to satisfy 4 assumptions about unobservable error terms, which are (1) the errors have zero mean, (2) the variance of the errors is constant and finite over all values of x_t, (3) the errors are statistically independent of one another, (4) No relationship between the error and corresponding x variate.

Based on the OLS regression method and collected data, the equation of multiple linear regression could be expressed as:

$$y_t = \beta_0 + \beta_1 x_{1t} + \beta_2 x_{2t} + \beta_3 x_{3t} + \beta_4 x_{4t} + \beta_5 x_{5t} + \beta_6 x_{6t} + \beta_7 x_{7t} + \beta_8 x_{8t} + u_t$$

Where:

y_t: Stock market index returns at time t;

x_1: Exchange rate;

x_2: Consumer Price Index (CPI);

x_3: Exports value;

x_4: Interest rate;

x_5: Money Supply (M2);

x_6: Producer Price Index (PPI);

x_7: Total reserves;

x_8: Economic Policy uncertainty index (EPU);

u_t: Random disturbance term.

This article uses STATA software to establish a multiple linear regression model.

3. Data and Hypotheses

The Shanghai Stock Exchange Index mentioned in this paper is taken from Yahoo Finance, and the rest of the country's macro data comes from the National Bureau of Statistics of China and Fred.

Market index: The Shanghai Composite Index (SZZZ) is an important factor in judging the quality of the Chinese securities market. There are two major securities markets in China which are Shanghai Stock Exchange, and Shenzhen Stock Exchange respectively. The main reason for choosing SZZZ as the explained variable is that the Shanghai and Shenzhen stock markets have the same social and economic environment, and their trading systems and listed company structures are highly homogenous. Therefore, the Shanghai Stock Exchange Index is used separately as an indicator to evaluate the Chinese securities market. Moreover, the composite index can comprehensively reflect the changes in the price of stocks listed on the exchange and has a close relationship with the operation of the macroeconomy. To explore the association between the market index and macroeconomic variables, in this research, stock index data are collected monthly.

Exchange rate - The exchange rate of RMB against the US dollar is a measure of relative economic strength, and it also has a direct impact on the economies of various countries by affecting the value of imports and exports. Empirical studies affirm that exchange rates have significant effects on stock indexes, although there is no conclusion on the positive or negative impact.

Consumer Price Index (CPI) - The Consumer Price Index (CPI) is a relative figure that reflects the pattern and magnitude of price changes in consumer goods and services purchased by residents over a given time period. Through this index, it is possible to observe and analyze the impact of retail prices of consumer goods and price changes of service items on the actual living expenses of residents.

Exports value – Refers to the total value of Chinese export commodities. The significance of this indicator is that it could optimize the allocation of resources, save labor, improve the economic efficiency of enterprises, and strengthen the country's economic strength. Accepting the competitive pressures and challenges of the international market may promote domestic enterprises to continuously update their technology, improve labor productivity and the international level of products.

Interest rate - The interest rate is the ratio of interest paid to the amount borrowed (principal) over a given period. It is the most important aspect in determining a company's capital cost, as well as a deciding factor in corporate financing and investment.

Money Supply (M2) - Refers to cash circulating outside the banking system plus corporate deposits, resident savings deposits, and other deposits. It usually reflects changes in total social demand and future inflationary pressures.

Producer Price Index (PPI) – PPI is a measure of the amount and pattern of changes in industrial product ex-factory pricing. It is a crucial economic indicator that shows price changes over time. It is also used to design applicable economic policies and compile national economic accounts.

Total reserves - It refers to the national reserve, that is, the important material reserve established by the country to guarantee the needs of social reproduction, economic development strategy, and national defense development strategy.

Economic Policy Uncertainty index (EPU) - Mainly used to reflect the economic and policy uncertainty of the world's major economies. According to empirical evidence, the EPU index has a significant inverse relationship with actual macroeconomic variables and even has an explanatory effect on the large fluctuations in the stock market.

Based on the eight variables proposed above, the hypotheses are as follows:

H_0: Exchange rate, CPI, Exports value, interest rate, M2, PPI, total reserves, EPU has significant impacts on the stock market.

H_1: Exchange rate, CPI, Exports value, interest rate, M2, PPI, total reserves, EPU has no significant impacts on the stock market.

4. Literature Review

Garg and Kalra analyzed a study from 1991 to 2017 to determine the relationship between macroeconomic factors and Indian stock market values[3]. Their research showed that GDP, exchange rate, foreign reserve, and gold prices have positive impacts on BSE Sensex, while inflation and unemployment rate have a negative influence by using Pearson correlation.

Laichena and Obwogi researched the long-term effects of macroeconomic factors on the East Africa capital market[5]. Fisher interest rate theory, purchasing power parity theory, the classical theory of growth, and arbitrage pricing theory (APT) were used in the research. The study revealed that the East Africa stock market is positively influenced by inflation and GDP while it is negatively affected by interest rate and exchange rate. It is different from the results of Garg and Kalra's research, owing to the disparity in economic markets in India and East Africa.

Mugambi and Okech have reached different conclusions from the above two authors[1]. They aimed to research the relationship between GDP, inflation, interest rates, exchange rates, and returns of listed banks by using the OLS model. The results showed that there is no significant relationship between GDP and stock returns of listed banks. Inflation has positive impacts on bank stock returns while the study findings also show a negative and significant correlation between interest rates, exchange rates, and bank stock returns.

Jabarin, Nour, and Atout have taken monthly closing value for the index at Palestine and Amman Stock Markets from 2011 to 2017[6]. They used the APT model to analyze the relationship between stock prices and macroeconomic factors. The results show that GDP and CPI significantly affect the return of the Palestinian composite index, while the industrial production index and trade balance are not significant.

5. Data Analysis

5.1 Descriptive Statistics

```
. sum
```

Variable	Obs	Mean	Std. dev.	Min	Max
Date	235	18201.3	2069.187	14641	21762
Indexprice	235	2445.396	886.3803	1060.738	5954.765
exchangerate	235	7.19712	.826889	6.0509	8.2796
CPI	235	87.02273	12.67877	68.97241	108.9
Exportsvalue	235	120714.7	66764.76	19169.63	270040.2
interestrate	235	3.108936	.3197638	2.7	4.14
M2	235	76242.75	56249.65	12158.3	193549.2
PPI	235	1.512511	4.176898	-8.2	10.1
totalreser~e	235	2049.139	1336.097	159.4911	4010.834
EPU	235	109.7265	85.46785	10.11133	649.0725

Figure 1: Descriptive statistics

Figure 1 summarizes the descriptive statistics for explanatory variables collected from Fred, providing some characteristics, such as mean, standard deviation, min, and max of the database.

From the results, almost every explanatory variable has shown a large fluctuation in the past 20 years. The maximum value of the index price is close to 6 times the minimum value, and the value of M2 and export value is about 20 times. There are variables, such as exchange rate, PPI, and CPI, have little change, but it have great impacts on the national economy.

5.2 Correlation Analysis

This part mainly conducts three tests on the independent variables, which are multicollinearity, heteroscedasticity, and autocorrelation tests to make them conform to the assumptions of the OLS model.

5.2.1 Multicollinearity

To evaluate the problem of multicollinearity, which occurs when two or more independent variables are substantially correlated. The variances and standard errors of OLS estimates are increased as a result of multicollinearity. High variances usually indicate that the estimations are sloppy and unreliable[1].

This research test eight independent variables, checking the correlation coefficient between each variable by using stata. The Figure 2 indicates that there is no multicollinearity between most variables, but a few correlation coefficients are too high such as the coefficient between M2 and CPI reached 0.9729. To solve the problem of multicollinearity, the three variables, CPI, export value, and total preservers are removed. After adjustment, there is almost no multicollinearity among the independent variables. The two most relevant variables are M2 and the exchange rate, with a correlation of -0.76.

```
. correlate Indexprice exchangerate CPI Exportsvalue interestrate M2 PPI totalreserverse EPU
(obs=235)
```

	Indexp~e	exchan~e	CPI	Export~e	intere~e	M2	PPI	totalr~e	EPU
Indexprice	1.0000								
exchangerate	−0.5136	1.0000							
CPI	0.5305	−0.8800	1.0000						
Exportsvalue	0.5304	−0.9157	0.9729	1.0000					
interestrate	0.1416	−0.1027	−0.0365	0.0564	1.0000				
M2	0.4761	−0.7653	0.9729	0.9152	−0.1660	1.0000			
PPI	−0.0201	0.2475	−0.1441	−0.1148	0.2401	−0.1503	1.0000		
totalreser~e	0.4958	−0.9764	0.9360	0.9594	0.0386	0.8493	−0.2264	1.0000	
EPU	0.2965	−0.4672	0.7049	0.6363	−0.2011	0.7577	0.0245	0.5327	1.0000

Figure 2: Multicollinearity

5.2.2 Heteroscedasticity

To detect whether the model has heteroscedasticity, the Breusch-Pagan/Cook-Weisberg test is used in the research to test for heteroskedasticity. This test could be completed in three distinct ways: Breusch-Pagan/Cook-Weisberg, N*R2 version of the score test, and F-statistic. Through the tests in Figures 3 to 5, it is found that from the three methods, the P-value is less than 0.05, that is, the null hypothesis H_0 is rejected. The test results of these three methods all indicate that the model has heteroscedasticity.

```
. estat hettest, rhs


Breusch—Pagan/Cook—Weisberg test for heteroskedasticity
Assumption: Normal error terms
Variables: All independent variables


H0: Constant variance


    chi2(5) =  58.99
Prob > chi2 = 0.0000
```

Figure 3: Heteroscedasticity 1

```
. estat hettest, iid rhs

Breusch—Pagan/Cook—Weisberg test for heteroskedasticity
Assumption: i.i.d. error terms
Variables: All independent variables

H0: Constant variance

    chi2(5) =  15.65
Prob > chi2 = 0.0079
```

Figure 4: Heteroscedasticity 2

```
. estat hettest, fstat rhs

Breusch—Pagan/Cook—Weisberg test for heteroskedasticity
Assumption: i.i.d. error terms
Variables: All independent variables

H0: Constant variance

F(5, 229) =   3.27
 Prob > F = 0.0072
```

Figure 5: Heteroscedasticity 3

5.2.3 Autocorrelation

In this study, two methods are used to test whether the model has autocorrelation, namely Durbin-Watson (DW) test, and Breusch–Godfrey test.

Figure 6 is the result of the DW test, it could be observed that DW=0.109. Since the DW value is in the range of 0 to 4, it is considered that the model does not have autocorrelation when it falls near 2. After checking the table, it is found that 0.109 falls on the rejection domain, which means that the model has autocorrelation.

```
. estat dwatson

Durbin—Watson d-statistic(  6,   235) =  .1093595
```

Figure 6: Durbin-Watson test

Another method named Breusch–Godfrey test is also used in this study. Figure 7 indicates that the P-value is extremely low, indicating that the null hypothesis is rejected, and the model contains autocorrelation. The lag coefficient is set to 10 throughout the testing process, which is based on empirical evidence.

```
. estat bgodfrey, lags(10)

Breusch—Godfrey LM test for autocorrelation
```

lags(p)	chi2	df	Prob > chi2
10	214.711	10	0.0000

```
H0: no serial correlation
```

Figure 7: Breusch–Godfrey test

5.3 Newey – West Procedure

The Newey-West procedure is widely used in regression of time series data in an attempt to overcome the autocorrelation and heteroskedasticity of the error terms in the model. According to empirical study, the lag coefficient could be easily defined as a quarter of the observations[7]. The lag coefficient in this model is $235^{1/4}$, which is 3.91, and is roughly equal to 4.

Figure 8 indicates that the relationship between macro factors and stock index price by using newey-

west procedure. Regression result shows that the exchange rate has significant and negative effects on index price, while M2 has significant and positive effects. And the P-value of interest rate, PPI, EPU is quite large, which means that the result is not significant.

```
. newey Indexprice exchangerate interestrate M2 PPI EPU, lag(4)

Regression with Newey–West standard errors      Number of obs     =        235
Maximum lag = 4                                  F(  5,      229) =      15.48
                                                 Prob > F          =     0.0000


                           Newey–West
      Indexprice | Coefficient  std. err.       t    P>|t|     [95% conf. interval]

    exchangerate |   -307.2614   148.2596    -2.07    0.039    -599.3887   -15.13419
    interestrate |    381.4722    309.902     1.23    0.220    -229.1516    992.096
              M2 |   .0054569   .0025867     2.11    0.036     .0003601   .0105538
             PPI |    15.20347    16.4792     0.92    0.357    -17.26677   47.67372
             EPU |   -.7656284   1.044244    -0.73    0.464    -2.823182   1.291925
           _cons |    3115.785   1697.219     1.84    0.068    -228.3769   6459.947
```

Figure 8: The relationship between macro factors and stock index price

In order to determine the accuracy of the entire model, the variables that have been eliminated are further tested. Figure 9 shows that the P-value of 0.5 is greater than 0.05, that is, the null hypothesis cannot be rejected, and the coefficients of the above variables are considered to be 0 at the same time.

```
. test(interestrate PPI EPU)

 ( 1)  interestrate = 0
 ( 2)  PPI = 0
 ( 3)  EPU = 0

       F(  3,   229) =     0.79
            Prob > F =    0.5023
```

Figure 9: Further test

5.4 Data Discussion

According to the data, the exchange rate has a significant negative impact on the stock index with a coefficient of -307.26, which leads to a different conclusion with Kirui, Wawire and Onono[8]. The fundamental reason for this is that China is a large exporting country, creating and selling goods all over the world. The lower exchange rate may encourage commodity trading, resulting in higher earnings for manufacturing companies and a rise in stock prices.

Unlike the exchange rate, M2 has a significant positive impact on the stock price index. On the one hand, increasing currency issuance could increase consumer spending, which promotes the development of service and industrial industries. On the other hand, an increase in M2 may significantly boost capital inflows into the stock market, which have a direct impact on stock price increases.

PPI has no significant relationship with the impact of stock indexes. Mainly because of the policy of the Chinese government, namely credit control[9]. This policy imposes some restrictions on the consumption and borrowing of residents and enterprises, which help to keep some macroeconomic indexes such as PPI within a reasonable range, so the impact on stock prices is not significant.

There is no relationship between interest rates and stock index prices which is different from the conclusion obtained by the Alam and Uddim[10]. In six of the fifteen countries their studied, interest rates showed a negative correlation with stock prices. The explanation for this is complex, but probably stems from the strict manipulation of interest rates in China, which means that interest rates do not fluctuate as much as predicted.

Another insignificant variable is EPU, according to empirical evidence, the EPU may be able to explain the large changes in the stock price index, but in this model, the index is more likely to undergo smooth changes. It is hard for EPU to explain stock price changes during this range.

6. Limitation

The target of the study is to discuss the relationship between macro factors with the stock market index, which covers only eight macroeconomic factors. It is difficult to explain the entire stock market in terms of eight macro factors because the stock market is very complex, and it is closely linked to many macro variables, international relations, policies and trading volumes. It is not convincing enough to explain the stock price index only with the macro factor as an indicator.

In addition, some key macro data that may have great impacts on stock prices, such as Gross Domestic Product and total tax revenue, are missing, because these data are counted once a year in China.

7. Conclusion

In this research, OLS model is used to examine some major macro variables that may have an impact on stock index prices. There are eight variables exchange rate, CPI, exports value, interest rate, M2, PPI, total reserve, and EPU are discussed in the study. Through OLS model analysis, exchange rate and M2 have significant effects on the stock market, while interest rate, PPI, and EPU have no significant impacts on the stock market. At the same time, exports value, CPI, and total reserves are removed because they have multicollinearity with the exchange rate and M2.

Due to the impact of exchange rates and M2 on stock indexes, the central bank has the responsibility to issue corresponding monetary policies to maintain these macro factors in an appropriate range to counter the market risk brought by index price changes. At the same time, investors may also reduce their investment risks by analyzing these macro factors.

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