Analysis on the Stock Price Fluctuation of China's Communication Equipment Sector in the Post-COVID-19 Era Based on Vector Autoregressive Model

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Abstract--The structure of China's export has been evolving gradually, from the main export of labor-intensive products to high-tech products. As one of the representatives of high and new technology industries and export-oriented industries, the communications equipment industry is experiencing a downturn and fluctuating period after experiencing COVID-19. This phenomenon also reflects the low level of operation of the industry and the lack of investor confidence. Therefore, this paper will combine various financial data with VAR model to analyze the impact of different factors on the stock price of China's communication equipment sector, and put forward corresponding countermeasures for revitalizing the stock price of communication equipment industry in the post pandemic period.

Keywords-stock price; communication equipment sector; Vector autoregressive model;

1 INTRODUCTION

According to the data of the well-known website named “the observatory of economic complexity”, after 2017, for China's main export products, the proportion of mechanical products accounts for about 49%, among which the export of communication equipment accounts for about 9.6%0. In the past five years, many well-known national enterprises of communication equipment have sprung up in China, such as ZTE, Huawei, Fiberhome and Datang. They continue to strengthen the international competitiveness of China's communication equipment products through cutting-edge technology research and development, strict standard setting and network construction, and strive to promote China's domestic brands to the forefront of global innovative brands. However, due to the COVID-19 pandemic and the trade conflict between China and the United States, the communication equipment sector in China has been impacted greatly over the past five years (Yilanci, Veli, Ozgur, et al, 2021)0.

Stock prices reflect the health of the industry and the confidence of investors in it. Although the COVID-19 pandemic in China is effectively controlled and the domestic industries have gradually resumed production, the share price of communication equipment sector is still in doldrums. Dow Theory holds that the closing price is the most important price for the price analysis of candlestick chart. The monthly closing price of the communication equipment sector witnessed a gradual upward trend from 1455.062 in January 2011 to 5047.099 in December

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2015. After that, the share price showed a gradual decline, especially during the COVID-19 epidemic period from 2020 to 2021, when the share price fell below 3000 and the amplitude increased from 7% to 10%0. For discussing what factors affect the fluctuation of the stock price, this study has referred to the following literature.

Dar, A. B., Shah, A., Bhanja, N., & Samantaraya, A, (2014) used wavelet methodology in accordance with the market heterogeneity theory to observe that in many Asian countries including India, Malaysia, Thailand, when the research time is longer than one year, there is a negative correlation between stock market price and stock price0. However, based on the cointegration test, Vector autoregression and multivariate generalized autoregressive conditional heteroskedasticity (MGARCH) models and the monthly data from January 1991 to June 2009, Hua, Z. (2010) found that the long-term equilibrium relationship between RMB real effective exchange rate and stock price was not stable, because in 2005, China carried out the managed floating exchange rate regime based on market supply and demand in the long run0. Thus, there are some bi-direction volatility spillovers effects, which could lead to the insignificance for the direct linear relationships between exchange rate and stock markets.

For the relationship between prices of raw materials and stock prices, Ghosh, I. , Chaudhuri, T. D., E Alfaro-Cortés, MG Martínez, & Rubio, N. G. (2021) found that stock prices are not significantly influenced by raw material prices in the short run, because companies may not be able to upgrade technology to counter increase in raw material prices0. However, in the long run, when technology and scale will come into play, the influence of raw material prices on stock prices can be significant.

Anari, A. , & Kolari, J. (2001) used cointegration methods to examine monthly stock price indexes and goods price indexes between 1953 and 1998, from six industrialized countries including United States, Canada, United Kingdom, France, Germany, and Japan, and finally found negative response of stock prices to an inflation shock in all six countries0. This result was consistent with previous studies of influences of short-run inflation on stock returns (Sergi, Bruno S.& Hsing, Yu., 2010)0. Thus, this paper assumes that the CPI of exporting countries can also affect stock price of China's communication equipment sector.

Therefore, this paper will use econometric software EViews to construct the Vector autoregressive model (VAR) and analyze the factors that affect the stock price fluctuation of China's communication equipment industry, and explore how to revitalize the communication equipment industry in the post-COVID-19 era.

2 DATA ANALYSIS

2.1 VAR model and Variable Selection

Vector autoregressive model (VAR) is proposed by Sims in 1980. It is usually used to predict interconnected time series systems and analyze the dynamic impact of random disturbances on variable systems, so as to explain the impact of various economic shocks on the formation of economic variables (Carter hill, William E. et al, 2011)0. In each equation of the model, endogenous variables regress the lagged values of all endogenous variables in the model, so as to estimate the dynamic relationship of all endogenous variables. Therefore, VAR model is widely used to predict and analyze the dynamic influence of random disturbance on the system.

The model is expressed as equation (1):

$$Y_t = C + \Phi_1 Y_{t-1} + \Phi_2 Y_{t-2} + \ldots + \Phi_p Y_{t-p} + \varepsilon_t \quad (1)$$

C stands for n×1 dimensional constant vector, and $\varphi_i (i = 1,2,\ldots p)$ represents n×n dimensional autoregressive coefficient matrix. ε_t stands for n×1 dimensional vector white noise and satisfies the following equations:

$$E(\varepsilon_t) = 0$$
$$E(\varepsilon_t \varepsilon_t{}') = \Omega$$
$$E(\varepsilon_t \varepsilon_s{}') = 0, s \neq t$$

Where Ωrepresents n×n dimensional positive definite matrix.

Financial market measures include exchange rate, interest rate and money supply. In order to prevent the multicollinearity problem, this paper selects the exchange rate of US dollar to RMB and the money supply of RMB as independent variables. The United States is now China's largest exporter of products and also the largest importer of information and communication technology goods. The fluctuation of the exchange rate between us dollar and RMB has a profound impact on China's communication equipment industry.

In addition, this analysis considers the impact of the production price index (PPI) in China and the consumer price index (CPI) of major exporting countries on stock price, because the rise of PPI will increase the purchasing cost of enterprises. Under the premise that the rise of raw material prices cannot be effectively passed on to consumers, the profits of enterprises will decrease or even lose money. Besides, the CPI of exporting countries has a direct influence on the product price and purchase volume.

Finally, this analysis will measure the social money supply with the broad money supply. Broad money supply refers to cash circulating outside the banking system, plus corporate deposits, household savings deposits and other deposits. It covers all monetary forms that may become a real purchasing power. It usually reflects the change of aggregate social demand and the pressure state of inflation in the future.

This paper uses the multiple regression model to take the stock price of China's communication equipment industry as the dependent variable and connect it with the following five independent variables through a mathematical formula. As can be seen in **Table 1,** the data for the five independent variables in this analysis are from January 2011 to March 2021.

Table 1. Explanation and data Source of selected variables

Variables	Explanation	Data Source
MON_t	Broad money supply	National Bureau of Statistics of China
PPI_t	Monthly Producer Price Index in China	
$EXCPI_t$	Consumer price index of the United States	
EX_t	Monthly exchange rate of US dollar to RMB	Ifind database
$STOCK_t$	Monthly closing stock prices of Chinese communication equipment sector	

In order to avoid the problem of heteroscedasticity, this analysis takes logarithm of the above variables and obtains the results including: Ln $STOCK_t$, $LnEX_t$, LnMON_t LnPPI_t , Ln$EXCPI_t$

The analysis constructs the multiple regression model as equation (2):

$$LnSTOCK_t = c + \beta_1 LnEX_t + \beta_2 LnMON_t + \beta_3 LnPPI_t + \beta_4 LnEXCPI_t + \varepsilon \quad (2)$$

Where C is constant, and ε is the error term.

Table 2. Multiple regression result

Dependent Variable: LNSTOCK Method: Least Squares Sample: 2011M01 2021M03 Included observations: 123				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	20.57	21.03	0.98	0.33
LnEX	1.83	0.66	2.77	0.01
LnMON	4.33	0.31	14.10	0.00
LnPPI	11.07	4.37	2.53	0.01
LnEXCPI	-23.41	2.15	-10.87	0.00
R-squared: 0.79; Adjusted R-squared: 0.78; S-F-statistic: 109.80; Prob(F-statistic): 0.00				

What **Table 2** shows are that the R-squared of the model is around 0.79, which means that the model has a high fitting degree. The F-statistic is 109.80, and the corresponding p-value is 0.00, which means that the model is significant as a whole. Also, all the independent variables including $LnEX_t$, LnMON_t LnPPI_t , Ln$EXCPI_t$ have passed the P-Value test, so the multiple regression model can be concluded as the equation (3):

$$LnSTOCK_t = c + 1.83LnEX_t + 4.33LnMON_t + 11.07LnPPI_t - 23.41LnEXCPI_t + \varepsilon \quad (3)$$

The multiple regression model only focuses on analyzing the impact of various factors on stock price, but does not depict the dynamic relationship between stock price fluctuation and its influencing factors from different aspects, which is not conducive to quantifying the impact of various influencing factors on stock price from multiple angles. However, VAR model can make up for this shortcoming and deeply analyze the dynamic relationship between influencing factors and stock price, and clarify the action mechanism of main influencing factors of stock price and quantify their contribution.

2.2. Stationarity test

Table 3. Unit root test results

Variables	ADF test value	5% significance	1% significance	P-Value	conclusion
$LnEX_t$	-2.813	-3.447	-4.036	0.195	nonstationary
$LnMON_t$	-3.341	-3.451	-4.044	0.065	nonstationary
$LnPPI_t$	-5.267	-3.447	-4.036	0.000	stationary
$LnEXCPI_t$	-2.377	-3.448	-4.036	0.3895	nonstationary
$LnSTOCK_t$	0.358	-1.943	-2.584	0.7866	nonstationary
$\Delta LnEX_t$	-6.360	-1.943	-2.584	0.000	stationary

$\Delta LnMON_t$	-2.168	-2.888	-3.491	0.219	nonstationary
$\Delta LnEXCPI_t$	-8.212	-2.886	-3.486	0.000	stationary
$\Delta LnSTOCK_t$	-10.257	-1.943	-2.584	0.000	stationary
$\Delta^2 LnMON_t$	-9.138	-3.452	-4.044	0.000	stationary

Before model regression, the analysis used the ADF test to test the unit root of time series. As shown in the **Table 3**, we found that $LnPPI_t$ rejected the null hypothesis at a significance level of 1%. Besides, $LnEX_t$, $LnEXCPI_t$ and $LnSTOCK_t$ reject the null hypothesis at the significance level of 1% for the first difference, and $LnMON_t$ rejects the original hypothesis at the significance level of 1% for the second difference. Therefore, the cointegration test can be carried out.

2.3 Cointegration test

Table 4. Selection criteria of VAR lag order

Lag	LogL	LR	FPE	AIC	SC	HQ
0	1030.962	NA	1.23E-14	-17.8428	-17.7235	-17.7944
1	1869.266	1589.132	8.83E-21	-31.9872	-31.27116*	-31.6966
2	1927.195	104.7773	4.99e-21*	-32.55992*	-31.2471	-32.02706*
3	1944.125	29.1489	5.78E-21	-32.4196	-30.5101	-31.6445
4	1969.572	41.6004*	5.80E-21	-32.4274	-29.9211	-31.4101
* indicates lag order selected by the criterion						
LR: sequential modified LR test statistic (each test at 5% level)						
FPE: Final prediction error						
AIC: Akaike information criterion						
SC: Schwarz information criterion						
HQ: Hannan-Quinn information criterion						

Before the establishment of the VAR model, we need to first determine the appropriate lag order. **Table 4** indicates the order of lag determined according to various information standards. FPE, AIC and HQ choose 2 as the lag order. Then 2 is the lag order of the VAR model.

2.4 VAR stability condition check

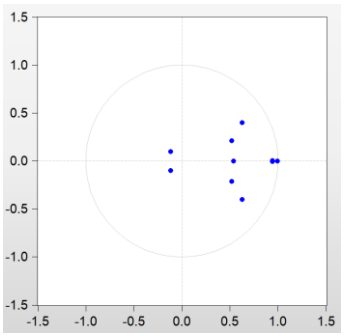


Figure 1. Inverse Roots of AR Characteristic Polynomial

Table 5. Roots of Characteristic Polynomial

Endogenous variables: $LnEX_t$, LnMON_t LnPPI_t , Ln$EXCPI_t$	
Exogenous variables: C	
Lag specification: 1 2	
Root	Modulus
0.995011	0.995011
0.942831 - 0.002879i	0.942836
0.942831 + 0.002879i	0.942836
0.625722 - 0.401378i	0.743393
0.625722 + 0.401378i	0.743393
0.519409 - 0.211822i	0.56094
0.519409 + 0.211822i	0.56094
0.535503	0.535503
-0.115864 - 0.096746i	0.150944
-0.115864 + 0.096746i	0.150944

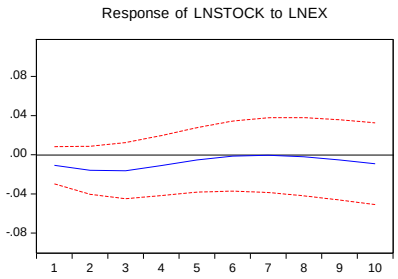
The stability of the difference equation is the convergence of the data generated by the difference equation. For general order differential equations，its characteristic equation is ：

$$\lambda^p - \alpha_1\lambda^{p-1} - \alpha_2\lambda^{p-2} - \cdots - \alpha_p = 0 \qquad (4)$$

If the coefficients in the differential equation are known, the roots of the characteristic equation (4) can be obtained and become the characteristic roots. The size of these characteristic roots determines the stability of the corresponding difference equation system. Therefore, if all the roots of the characteristic equation (4) fall into the unit circle, the coefficients of the difference equation are stable.

The results of the model are shown in the **Figure 1**, and all the roots of the characteristic polynomial are inside the unit circle, and all of the modules in **Table 5** are less than 1, which means this VAR model can be considered stable.

2.5 Impulse response analysis



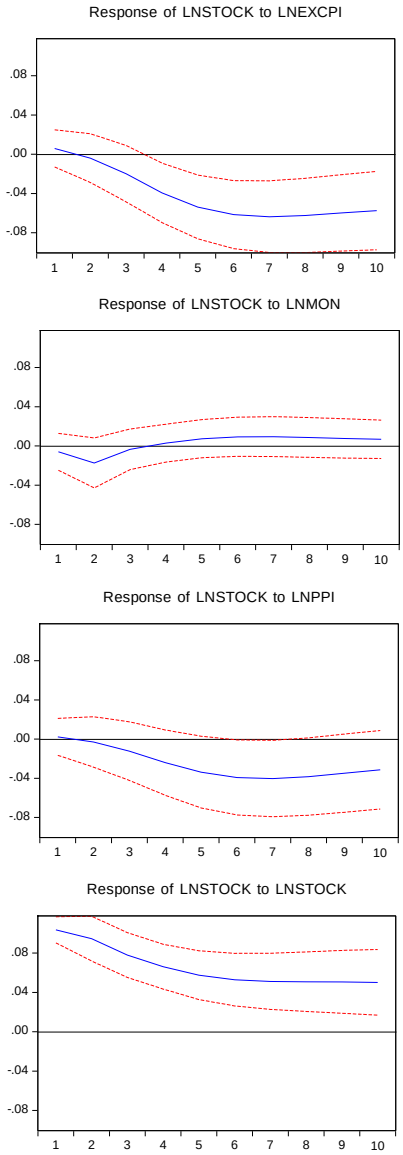


Figure 2. The impulse response of $LnSTOCK_t$ to other variables.

It can be seen from **Figure 2.** that the impact of $LnEX_t$ on $LnSTOCK_t$ is relatively small, and tends to be stable from the fifth stage, while the rise of $LnEXCPI_t$ and $LnPPI_t$ will lead to the decline of $LnSTOCK_t$, and the impulse impact will gradually increase after the second stage. The effect of $LnMON_t$ pulse on $LnSTOCK_t$ is positive and tends to be stable from the third stage

3 CONCLUSION

First, according to the transmission mechanism of the exchange rate to stock price, if the exchange rate of a country's currency falls, the stock price of export-oriented enterprises will rise. However, the impulse response results run counter to the finding mentioned by Dar, A. B., Shah, A., Bhanja, N., & Samantaraya, A, (2014). For this reason, the J-curve theory makes a reasonable explanation: if the information about the decrease of export foreign currency price after the devaluation of domestic currency cannot be immediately understood by importers, or after the importers realize that the devaluation of currency causes price changes, they need a certain time to identify whether the price changes are significant before they can make a decision on whether to change the import quantity (Backus, DK; Kehoe, PJ; Kydland, 1994)0. Therefore, the impact of exchange rate changes on the stock price has a certain time lag.

Second, after the third period, the increase in the money supply will increase the stock price, because communication equipment manufacturers can obtain higher loan lines to expand their business scale. This phenomenon also means expansionary monetary policy has a positive effect on the impact of stock price.

Third, the rise of PPI will increase the purchasing cost of enterprises. Under the premise that the price rise of raw materials cannot be effectively transferred to consumers, the profits of enterprises will decrease.

Last, the higher the CPI of the exporting country is, the higher overseas sales price of communication equipment will be. Therefore, the sales volume will decline, and the profit and stock price of the enterprise will be adversely affected.

4 RECOMMENDATIONS

Influenced by COVID-19 pandemic, the production resumption of communication equipment enterprises in China has been delayed, which has aggravated the pressure of start-up enterprises in the shortage of capital chain. Meanwhile, the outbreak of the pandemic has also directly caused the concussion between the RMB and foreign exchange rate, resulting in large fluctuations in the share price of the communications equipment industry. Combined with the above quantitative analysis and potential international competition crisis, this paper puts forward the following countermeasures and suggestions.

First, it is necessary to strengthen scientific and technological research and development, increase the use of value, durability and safety of communication products, and enhance the value of domestic brands. Intelligent manufacturing should be used to promote the transformation and upgrading of industrial technology, and promote the fundamental transformation of the industrial mode and enterprise form of manufacturing industry.

Second, improving the RMB exchange rate mechanism and gradually relaxing the control of capital. On the one hand, we should gradually reduce the central bank's direct intervention in the foreign exchange market, respect the rules of the foreign exchange market, allow the exchange rate fluctuations to follow the supply and demand of funds in the foreign exchange market, let the foreign exchange supply serve the development of real industries, and improve the freedom and convenience of international trade and investment. On the other hand, the

country needs to resolve financial risks and maintain the health of China's financial system. We will promote the integration of financial science and technology with the foreign exchange market.

Third, expanding the international market for the export of communication equipment products and avoid over dependence on a few exporting countries. The economic fluctuation, trade policy, tariff policy of exporting countries will directly affect the export of our products. In order to reduce the adverse impact of such uncertainties on China's communication equipment industry, we cannot rely on a few major exporters in transition. Under the guidance of “one belt, one road” strategy, China should open up new markets abroad and encourage enterprises to establish an international marketing network. At the same time, the government needs to promote the effectiveness of foreign trade policies, so as to optimize China's international trade.

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