

Dynamic Linkages Between Exchange Rate and Stock Prices: Evidence from Sino US Trade War

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Abstract: This paper examines the causal relationship between RMB exchange rates and stock prices during the Sino US trade war. We analysis the goods market hypothesis and portfolio balance approach, then the representative transmission mechanisms are detailed analyzed. The empirical analysis is carried on by getting the daily data of the intermediate rate of RMB against US dollar and Shanghai Composite Index for the period March 23, 2018 to January 17, 2020. The empirical result shows there is not co-integration between them but co-integration between the return rate of them, and a causal relation from stock yield to return rate of exchange. The findings are supported by various testing methods, including Granger causality tests, impulse response, and variance decomposition analysis.

1. Introduction

With the development of the internet, relationships between every country are closer, and the interpenetration of each department in the financial market is also stronger. Since the collapse of Bretton woods system, US dollar has not been the center of international monetary system, with the floating exchange rates system has become the first choice for most country which break the mode of exchange rate. Since then, the dynamic linkage between exchange rate and stock value emerged, and the stock bubble burst in Japan after signing the Plaza Accord prove that. In the 1980s, oppression some capitalist countries, Japan carried out a floating exchange rate system, leading the appreciation of yen, which attracted a flood of international capital poured into Japan. Consequently, Japanese stock was soaring. However, when the international venture capital left quietly, the stock bubble burst, and Nikkei Stock Average slumped, then Japan suffer a protracted downturn. With the Chinese economic boom, the public worries whether China would follow Japan's example, suffering the downturn because of the burst of the economic bubble[1] . Meanwhile, as the Chinese economic boom, Sino US trade surplus continues to expand. To balance the trade surplus, the American government launched the trade war in 2018. Since the broke out of the trade war, Chinese enterprises have been hard hit because of the increased tariff, thus the stock market suffers a downturn. Besides,

the yuan fell below 7 to dollar. Whether a causal relation exists between them during the Sino-US trade war has become a hot topic.

The coordinated development between them has a positive influence on stability of financial markets and steady growth of the national economy. The empirical analyze of orientation relational between them during the Sino-US trade war is conducive to release regulatory measures timely for unusual volatility in currency market and stock market, then steady them. Moreover, it could apply some reference to investor.

2. Literature

Since Franck & Young (1972) study the relationship between them via simple regression firstly, thousands of scholars have studied this question. Reviewing the available research, we could easily find that it could divide into three progressive categories according to empirical analyse.

2.1. Correlation

Raj Aggarwal (1981) via simple regression with monthly data, pointing out the positive relationship between the real dollar exchange rate and stock yield.[2], Solnik Bruno(1987) and Apte Prakash (2001) agree with Aggarwal[3][4];and there are other opinions. Ajayi Richard A & Mougoue Mbodja (1996) argue against Aggarwal. They via Vector Error Correction Model pointing out a negative correlation is exist in 8 different developed countries from 1985 to 1991[5]. Moreover, Naeem Muhammad & Abdul Rashid (2002) fail to find any relationship between the research variables in South Asian countries from1994 to 2000[6]. Chinese scholars study this question from different kinds of currencies. Lei Gao (2005) shows the negative correlation both between Shanghai B and yuan-dollar exchange rate and yuan-HongKong dollar contemporaneously with vector autoregressive system[7]; Yanyun Chen&Daxiong He(2006) suggest a positive correlation between both stock value and nominate exchange of yuan-dollar, and yuan-yen exchange rate, but no correlation for yuan-Euro[8]. In conclusion, in different periods and different countries, we cannot generalise the correlation of the variables.

2.2. Co-integration Relations

Husam Rjoub(2012) suggest a co-integration between nominal Turkish lira exchange rate and the local stock market with Jonhensan test[9]; Ting Liu(2012) via E-G test, Shihan Hu(2018) via Jonhensan test and Yang Xiang(2017) via vector autoregressive system all find stable long term co-integration between our research variables[10][1][11]. However, Shusong Ba & Min Yan(2009) fail to find any co-integration between them according to Vector autoregressive multivariate EGARCH model of the period of 2005 to 2008 in China[12]. Besides, some scholars study this from different currencies and periods. For example, Biqiong Zhang &Yue Li (2002) found the significant long term co-integrations between Shanghai A, Shenzhen A and HSI and RMB exchange rate, but did not find any significant long term relation between B-share and H-share and exchange rate[13]. Wenjin Dai (2019) find the co-integration between exchange rate and Shanghai Composite Index before the RMB reform disappears after it[14].

2.3. Causal Relation

Granger test could find the guiding factor, and the results could divide into three categories: no causal relation, single causal, and bidirectional causal. Abdalla Issam & Murinde Victor(1997) using Grange

test with data for the period of 1985 to 1994 in India, point out a causal relation from exchange rate to stock value [15]; Clive W.J.Granger(2000) via Granger test, Apte Prakash(2001) via Generalized autoregressive conditional heteroscedasticity EGARCH model, and Lu Sui & Lijuan Sun (2015) via vector autoregressive system all suggest the same result[16][4][17]; What is more, Qingling Yang(2007) via E-G test, Naishu Yu&Pengtu Yu(2018) and Fengxia Tan(2019) and Anqi Liu(2018) via Granger test all document this single causal relation in different periods in China[18][19][20][21]. However, Ming-Shiun Pan (2007) using Granger test and vector autoregressive system find the unidirectional causal relation from stock prices in Korea, and bidirectional causal relation in Hong Kong[22]. Apart from studying different countries, scholars also study different periods in the same country. Mohsen Bahmani-Oskooee (1992) fail to find a co-integration between the effective exchange rate and S&P 500 of the period 1973 to 1988, but a short term bidirectional causal relation between them is found[23]. Weilun Deng (2012) finds the unidirectional causal relation from Shanghai B from 2005 to 2007, but the relation swap of the period of 2007 to 2011[24].

Most scholars agree that the causal relation would change after financial crisis. Clive W.J.Granger(2000) points out that there are significant relations between the variables in 7 countries or regions after the 2007 Asian financial crisis where there are no relations before it[16]. However, Ming-Shiun Pan(2007) and Panayiotis F. Diamandis & Anastassios A. Drakos (2010) point out the opposite result that the causal relation disappears after the financial crisis[22][25]. Liang-Chun Ho & Chia-Hsing Huang (2015) suggest that the causal relations disappear, appear and remain after the 2008 subprime crisis in the brics[26]. Xingrao Sun (2010) points out that the unidirectional causal relation turns into bidirectional after the 2008 subprime crisis[27]. What is more, the exchange rate reform would change the relationship. Xuedong Bao (2010) document the positive relation between this two factors swap into negative after the exchange rate reform with ARCH model[28]; Juan Hong & Chanbo Guo (2009) show a unidirectional causal relation from exchange rate after the exchange reform where there is no relation before it[29].

Reviewing the available studies, we could find that vector autoregressive system is the top choice for most scholar's empirical tests, analyzing the stationary with the ADF unit root test, verifying the co-integration with the E-G test or Johansen test. After examining the causal relation with the Granger test, the vector autoregressive system is built for variance decomposition and impulse response. The existing research has accumulated abundant achievement, providing important reference, but most of them analysis the foreign countries without systemic research in Chinese market. In fact, regime of exchange rate, open degree of capital market, background of political and economical, or even the length of period would impact the result. Whether the existing achievement suit for Chinese market is dubious. What is more, the study of causal relation between these variables started late in China, and most exist researches are discussing and comparing the relationship before and after the RMB reform in 2005. There are few types of research of relation for period of Sino US trade war which is this paper discussing.

3. Theoretical Research

3.1. Model

There are two typical models about the orientation relationship between exchange rate and stock value. One is the goods market hypothesis, which is the flow-oriented model (Rudiger Dornbusch & Stanley Fischer, 1980), suggesting local stock value would be affected by fluctuation in exchange rate through multinational corporations. The other is portfolio balance approach, which is the stock-

oriented model (Jeffrey Frankel, 1983), suggesting exchange rate would be affected by fluctuation in stock prices through capital flow.

3.1.1. Flow-Oriented Model

Rudiger Dornbusch & Stanley Fischer suggested the goods market hypothesis in 1980, pointing out that fluctuation in the exchange market affects the competitiveness of multinational firms and international trade balance, hence influence the corporation profit and corporate value, which impact the stock market[30]. On one side, due to international trade, multinational firms would hold some assets or liabilities dominated in foreign currencies. When the local currency depreciates, assets holding denominated in foreign currencies will appreciate, increasing corporate profits, and so does in stock prices; liabilities holding denominated in foreign currencies will increase, burdening firms, which will impact the corporate profitability, leading the stock price decrease[22]. However, exporting firms will benefit from depreciation because foreign demands will increase while the goods are cheaper, which are positive for stock values; on the other hand, the value of exporting firms will decrease while the local currency appreciation. In Contract, the value of importing firms will increase while the local currency appreciates because of the increasing cost and vice versa. More importantly, even the value of domestic corporations would be affected by the movement of local exchange rate. As long as any parts of corporate demand and supply are affected by the exchange rate movement, including purchase raw material from multinational corporations or sale goods to them, the profitability of domestic would also be affected.

3.1.2. Stock-Oriented Model

Jeffrey Frankel suggested the portfolio balance approach in 1983, pointing out that fluctuation in stock would change the exchange rate by adjusting investors' portfolio, which leads capital flow[31]. Investors are always favour of high yield asset and pour their money into the high yield market. If capital could flow freely internationally, a booming stock market will attract foreign investors, increasing demand of local currency, appreciating the local currency. However, when a bear market appears, foreign investors will scramble to offload share, which would boom demand for foreign currencies, depreciating local currency, and domestic investors would invest in other higher yield countries, increasing demand of foreign currencies because for capital outflow.

3.2. Transmission Mechanism

Scholars summary different transmission mechanisms between exchange rate and stock value, including interest rate, money supply, the balance of international trade, capital flow in and flow out, psychological expectation, and so on. All this could be summed out as three categories: interest rate, money supply, and expected return. This paper will explain the typical transmission mechanism.

3.2.1. Interest Rate

Rate parity and Gordon model could explain the transmission from exchange rate to interest rate to stock prices[20]. Uncovered interest rate parity suggests that expected changes in exchange rate are equal to the difference between interest rate. Currency in the country with higher interest is expected to depreciate, and currency in the country with lower interest rate is expected to appreciate, which show transmission between interest rate and exchange rate. Gorgon model suggests a negative relationship between stock price and interest rate. An expectation of local currency would decrease

the interest rate. Thus, investors prefer to invest in capital market. As an important part of capital market, stock market becomes more popular, and local stock prices increase.

What is more, the wealth effect shows transmission from stock prices to interest rates firstly, then to exchange rate. More asset people hold, consuming desire is stronger. A booming stock market increase investors' asset, stronger their consuming desire, thus demand for currency increase.

3.2.2. Trade Balance

Trade balance transmission between the variables by supply-demand relationship. Competitive of exporting firms will become stronger when the local currency depreciates because of lower selling prices which increases the foreign demand, leading to more market shares, and so do the corporate profits, thus the value of exporting firms rises. On the other side, operating costs in importing firms will increase while the local currency depreciates, which will reduce the profit, and so do the corporate value. Whether the stock prices will increase or decrease depending on the quota of exporting firms and importing firms. What is more, investors holding wealth will increase while booming stock market, and according to the wealth effect, this will simulate the demand of foreign luxury, and so does foreign currencies, which will devalue local currency[10].

3.2.3. Capital Flow

Capital flow will transmission the change between the variables. Expected return will decrease while local currency devalues, and foreign investors will transfer their capital to other countries with a higher return rate because of avoiding risk or chasing "hot money". Meanwhile, the central bank will buy local currency and sell foreign currencies to prevent the exchange rate from abnormal change caused by numerous local currency is sold in the international market, which decreases money in circulation that can be invested in stock market. Excess supply and scant demand would reduce the value of stock values[32]. On the contrary, numerous capital would flow in while a booming stock market, which would increase demand for local currency hence appreciate it.

4. Empirical Analysis

4.1. Testing Methodology

We choose vector auto-regressive (VAR) system to complete the empirical analysis. Vector auto-regressive (VAR) model could provide insights on the dynamic interactions among the variables, which is suitable for the regression of real economic time series. We establish a P-order model with two variables:

$$Y_t = C_1 + \sum_{i=1}^p a_{1i} Y_{t-i} + \sum_{i=1}^p b_{1i} X_{t-i} + \varepsilon_{y,t} \quad (1)$$

$$X_t = C_2 + \sum_{i=1}^p b_{2i} X_{t-i} + \sum_{i=1}^p a_{2i} Y_{t-i} + \varepsilon_{x,t} \quad (2)$$

Where Y_t and X_t are stock prices time series and exchange rate time series, C_1 and C_2 are parameter vectors, a_{1i} , a_{2i} , b_{1i} and b_{2i} are coefficient matrixs, and $\varepsilon_{s,t}$ and $\varepsilon_{e,t}$ are error vectors. It could expand to :

$$\begin{pmatrix} S \\ E \end{pmatrix} = \begin{pmatrix} C_1 \\ C_2 \end{pmatrix} + \begin{pmatrix} a_{11} & b_{11} \\ a_{21} & b_{21} \end{pmatrix} \begin{pmatrix} S_{t-1} \\ E_{t-1} \end{pmatrix} + \begin{pmatrix} a_{12} & b_{12} \\ a_{22} & b_{22} \end{pmatrix} \begin{pmatrix} S_{t-2} \\ E_{t-2} \end{pmatrix} + \dots + \begin{pmatrix} a_{1p} & b_{1p} \\ a_{2p} & b_{2p} \end{pmatrix} \begin{pmatrix} S_{t-p} \\ E_{t-p} \end{pmatrix} + \begin{pmatrix} \varepsilon_{s,t} \\ \varepsilon_{e,t} \end{pmatrix} \quad (3)$$

Where S_t and E_t are stock prices time series and exchange rate time series, C_1 and C_2 are parameters, $\varepsilon_{s,t}$ and $\varepsilon_{e,t}$ are error vectors, and other variables are all coefficient.

Since the development of Shanghai stock exchange is more mature and the market size is bigger than Shenzhen, which could represent the dynamic of Chinese stock market better. We choose the closing prices of Shanghai Composite Index and mark it with SZ. As for exchange rate, we choose the intermediate rate of RMB against dollar (direct quotation) represents exchange rate since it is used in currency market and bank quotation because of straightforward, and we mark it with USDCNY. In order to eliminate the possible heteroscedasticity of the time series and reflect the interaction between our research variables more stably, we get the natural logarithms of them and mark them with LNUSDCNY and LNSZ, then get the first-order difference logarithm time series which represent nature logarithm of return rate of exchange rate (DLNUSDCNY) and nature logarithm of stock yield (DLNSZ).

Since there are so many coefficients in the VAR system which is mainly supported by Grange test, impulse response analysis, and variance decomposition analysis to examine the mathematical relation between research data, it is unimportant to calculate each coefficient, thus, when we establish VAR model, after getting S_t and E_t from database, we just need to select these two time series and open it as VAR with Eviews, then all the coefficient will be calculated automatically by the Eviews system, and it will show us the final expression.

4.2. Data

The sample period runs from March 23, 2018, when the US President Donald Trump signed the memorandum to January 17, 2020, when the first phase of the Sino US trade agreement was successfully signed. Excluding non-trading day, there are totally 446 groups daily data. We get these 446 groups daily data of intermediate rate of RMB against US dollar (direct quotation) from State Administration Foreign Exchange and Shanghai Composite Index from RESSET, then get the natural logarithms of them, and mark with LNUSDCNY and LNSZ to eliminate the possible heteroscedasticity. Figure1 displays the exchange rate and stock prices time series.

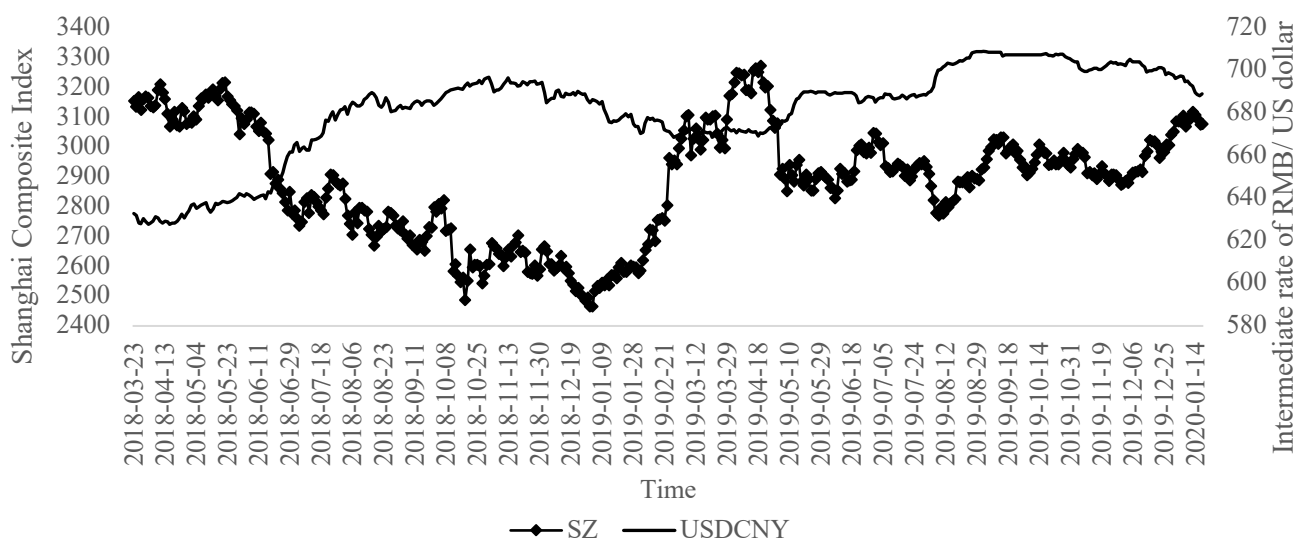


Figure1: Rate of exchange and stock prices chart.

4.3. Empirical Result

4.3.1. Correlation Test

We could visually observe the correlation between the variables through the scatter diagram (Figure 2). The ordinate is USDCNY, and the abscissa is closing prices of SZ. Figure 2 visually reflects that the tracing points of them slope down to right, which shows a negative correlation between them during the Sino-US trade war. We could get the accurate coefficient -0.394681 with the help of Eviews, that is, during the Sino US trade war, there is a slight negative correlation between rate of exchange and stock values. It is worth noting that the correlation test could only reflect the negative relation from the numerical, without any practical implications, so we need some specific test.

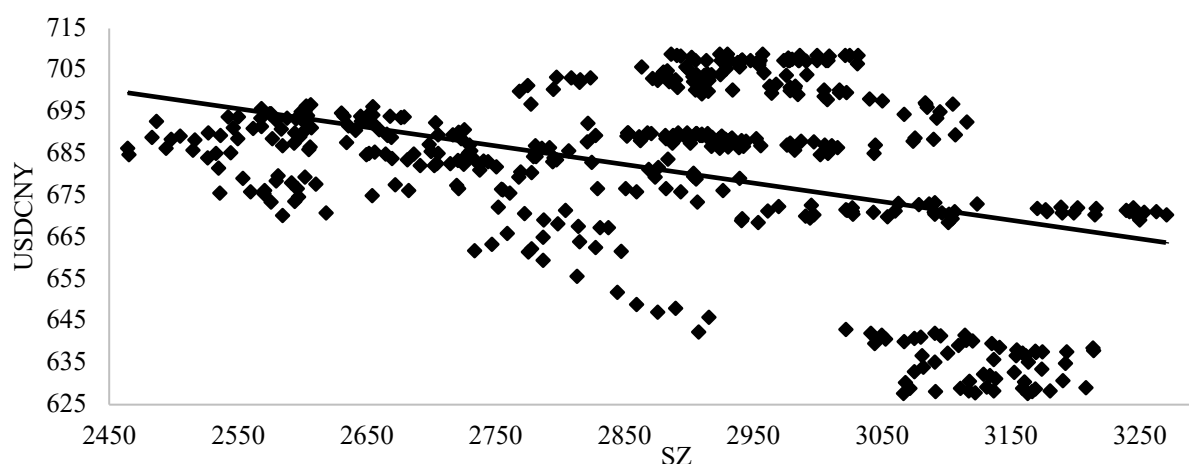


Figure 2: Scatter diagram of rate of exchange and stock value.

4.3.2. Unit Root Test

Table 1: Determination table of intercept term coefficient and trend term coefficient.

	Intercept	Intercept and trend	None
AIC	9.894478	9.894789	9.898935
SC	9.912896	9.922416	9.908144
HQ	9.901741	9.905683	9.902566

Economic models about time series generally establish based on stationary time series, but in reality, most time series are not stationary which cannot reflect the accurate equilibrium relation between the variant, leading to spurious regression only with digital coincident. Thus, we should verify the stationary first. ADF unit root test is taken to examine whether a unit root exists in the original and logarithmic time series. Whether include “Intercept”, “Intercept and trend” or “None” is decided by comparing the AIC, SC and HQ of the model, and choose the smallest one. SZ, for example, in Table 1, AIC and HQ of “Intercept” are smallest. Thus, we choose “Intercept”. Other time series are all “Intercept” by comparing. The lag orders are set by the SC criterion with Eviews. Table 2 indicates that the absolute values of ADF statistics of variables are less than the critical value at the significant level of 1%, 5% and 10%, accepting the null assumption that there is a unit root. In order to continue

the empirical, we test for DUSDCNY and DSZ. The absolute values of ADF statistics of the first order logarithm time series are larger than the critical value at each significant level, rejecting the null assumption, which verify that these time series are stationary. We could also know the logarithmic time series are not stationary but the first-order difference logarithmic time series are stationary.

Table 2: ADF unit root test result.

Variables	C,T,N*	ADF	1%	5%	10%	Stationary
SZ	C,0,0	-2.00736	-3.44482	-2.86781	-2.57017	NO
DSZ	C,0,0	-22.0265	-3.44485	-2.86783	-2.57018	YES
LNSZ	C,0,0	-1.98687	-3.44482	-2.86781	-2.57017	NO
DLNSZ	C,0,0	-22.1940	-3.44485	-2.86783	-2.57018	YES
USDCNY	C,0,1	-2.38314	-3.44485	-2.86783	-2.57018	NO
DUSDCNY	C,0,0	-18.1948	-3.44485	-2.86783	-2.57018	YES
LNUSDCNY	C,0,1	-2.43283	-3.44485	-2.86783	-2.57018	NO
DLNUSDCNY	C,0,0	-18.2355	-3.44485	-2.86783	-2.57018	YES

* Where C represents the intercept, T represents the time trends, and N represents the lag orders

4.3.3. Co-integration Test

Although the first-order difference time series are stationary, difference leads to the loss of long term information of variables, and co-integration test could research long term relationships between several variables. We examine the co-integration with E-G test. In order to eliminate the possible heteroscedasticity, the linear regression equation is established for both original and the first-order difference logarithm time series of them, and we get the residual series E_t and E_{td} , then take the ADF unit root test for the residual series. Table 3 indicates that the absolute values of ADF statistics of E_t series are less than the critical value, accepting the assumption and verifying that there is not co-integration relationship between LNSZ and LNUSDCNY. Meanwhile, the absolute values of ADF statistics of E_{td} series are larger than the critical value, rejecting the assumption and verifying a long term co-integration relationship between DLNSZ and DLNUSDCNY.

Since the precondition of Granger test is co-integration, we consider taking the Granger test between DLNSZ and DLNUSDCNY, and we should test the stability of the VAR system firstly. According to the majority principle, we could verify that the lag order is 3, and all roots of the characteristic equations are in the unit circle, meaning that it is a stable system. We establish the VAR(3) system with Eviews.

Table 3: Unit root test for residual series.

Variables	C, T, N*	ADF Statistic	1%	5%	10%	P Statistic	Stationary
E_t	C, 0, 0	-1.88624	-3.44482	-2.86781	-2.57017	0.3388	NO
E_{td}	C, 0, 0	-22.4411	-3.44485	-2.86783	-2.57018	0.0000	YES

* Where C represents the intercept, T represents the time trends, and N represents the lag orders

4.3.4. Granger Test

From the above test, we have already known that the DLNSZ and DLNUSDCNY are stationary and long term co-integration, but we still cannot distinguish the direction of causal relation between the two series. Thus, we need to take the grange test between DLNSZ and DLNUSDCNY. Table 4 indicates that in the original hypothesis of “DLNUSDCNY does not granger cause DLNSZ”, P statistic is 0.2429, larger than 0.05, meaning that at the significance level of 5%, it accepts the null hypothesis; and in the original hypothesis of “DLNSZ does not granger cause DLNUSDCNY”, P statistic is 2.E-08, smaller than 0.05, meaning that it rejects the null hypothesis. In short, during the Sino US trade war, there is not a bidirectional causal relation between variables, but a unidirectional causal relation from Shanghai composite index yield to return rate of intermediate rate of RMB against US dollar.

Table 4: Granger test result.

Original hypothesis	F Statistic	P Statistic	Conclusion
DLNUSDCNY does not granger cause DLNSZ	1.39762	0.2429	Accept
DLNSZ does not granger cause DLNUSDCNY	13.3784	2.E-08	Reject

4.3.5. Impulse Response and Variance Decomposition Analysis

Impulse response analysis could examine the oriented relation between the return rate of exchange rate series and stock yield series when the external economic environment change[33]. It could analyse the response of the time series when other series impose a positive unit shock. Figure 3 and Figure 4 show the result of impulse response, where the tracing period is 10days, the horizontal axis represents the tracking period, and the vertical axis represents response degree to a unit shock from other series. The return rate of exchange rate shows a negative response to a positive unit shock in stock yield, and the negative response peak at -0.0006 in period 2, and then the response fade away. Stock yield shows a negative response of -0.0054 firstly, then it turns positive. After peaking at 0.00056 in period 3, it down to the bottom of -0.001031, and then goes up and down at 0 and fades away. From the dynamic path, the response direction of stock yield from the unit shock of return rate of exchange rate could not be defined, but return rate of exchange rate shows a slightly negative response to the unit shock of stock yield, meaning that an increase in stock yield will appreciate RMB.

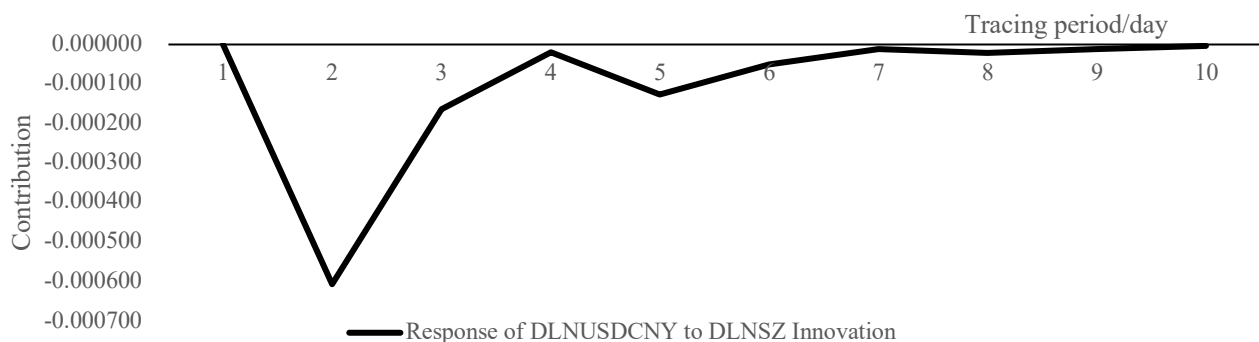


Figure 3: Response of DLNUSDCNY to DLNSZ Innovation.

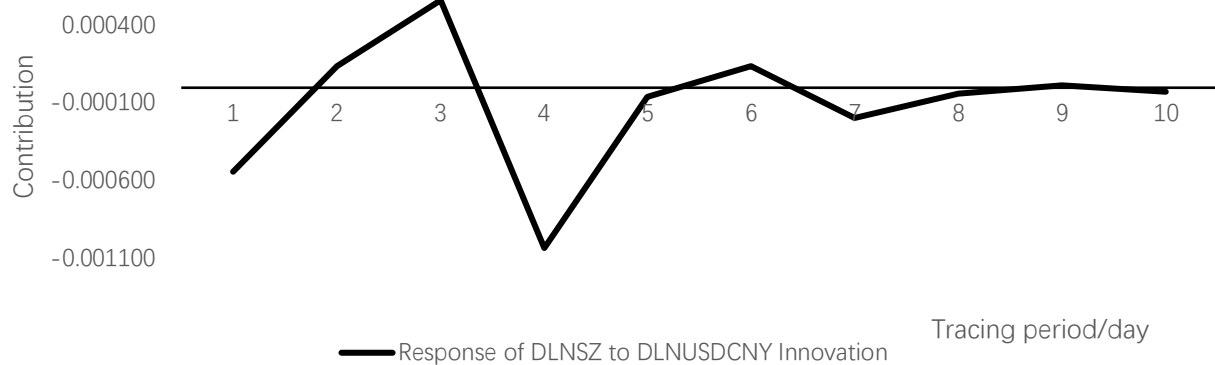


Figure 4: Response of DLNSZ to DLNUSDCNY Innovation.

Variance decomposition could show the contribution degree of each structure. Table 5 records a 10-day tracing period of the variance decomposition statistic of stock yield and return rate of exchange rate. In general, stock yield is almost 100% affected by itself, with a 0-contribution degree of return rate of RMB exchange rate; and the return rate of exchange rate is affected by itself in period 1, but then the contribution degree of stock yield increase to 9% and keep it.

Table 5: statistic of variance decomposition analysis.

Period	DLNSZ Variance Decomposition		DLNUSDCNY Variance Decomposition	
	DLNSZ	DLNUSDCNY	DLNSZ	DLNUSDCNY
1	100.0000	0.000000	0.208858	99.79114
2	99.99127	0.008726	8.508746	91.49125
3	99.76421	0.235789	9.021888	90.97811
4	99.10938	0.890616	8.975082	91.02492
5	99.10752	0.892482	9.290960	90.70904
6	99.09365	0.906346	9.342742	90.65726
7	99.06957	0.930429	9.345367	90.65463
8	99.06861	0.931389	9.353554	90.64645
9	99.06842	0.931579	9.356370	90.64363
10	99.06801	0.931986	9.356731	90.64327

5. Conclusion

In this study, we examine the dynamic linkage between the rate of exchange and stock prices during the Sino US trade war. The sample period runs from March 23, 2018, to January 17, 2020, contains 446 groups of valid data. The scatter shows the negative correlation visually and Eviews shows us that the correlation coefficient is -0.394681. ADF unit root tests suggest the original time series and logarithmic time series are all one-order integration, and the corresponding first-order difference time series are all stable, meeting the premise of co-integration test. Then, we examine the co-integration with E-G test verify that there is not a co-integration relation between LNSZ and LNUSDCNY, but a co-integration relation between DLNSZ and DLNUSDCNY. The Granger test suggests that during the Sino US trade war, there is not bidirectional causal relation between the return rate of the

intermediate rate of RMB against US dollar and Shanghai composite index yield, but a causal relation from the stock yield to return rate of exchange rate. After setting the lag order with 3, we establish a stable VAR(3) system. Impulse response analysis shows that the response direction of stock yield from the unit shock of return rate of exchange rate could not be defined, but the return rate of exchange rate shows a slightly negative response to unit shock of stock yield. What is more, Variance decomposition analysis indicates that stock yield is almost 100% affected by itself and contributes a 9% degree to stock yield.

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