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The Relationship between stock market and Bond Market

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Abstract: As we know, stock market and bond market are the important component of financial market. The relationship between them is close. We take the weekly returns of the new composite index and Shanghai Stock Exchange index, From January 1, 2012 to December 31, 2017, established a vector autoregressive model to explore the relationship between them. The empirical results show that the return of stock market just have a little impact on the return of bond market, and the impact has a certain lag. the return of bond market has strong autocorrelation.

Keywords: Stock market; bond market; yield; correlation

1. Introduction

To promote economic development and improve economic efficiency is an important part of the financial market. They plays an important role in national monetary policy and fiscal policy regulation. At the same time, different financial markets can promote each other and develop together, especially the stock market and bond market.(They all have relatively complete price discovery mechanism).They mutual reference pricing, complementary to each other , plays an important role in maintaining the stability of the financial system and optimizing the national capital structure. Therefore, obtain the maximum income on the basis of avoiding the single market risk. It has benefit from the research on the correlation between these two markets. It has attracted the attention of scholars at home and abroad.

As far as China's current situation is concerned,the financial market is restricted by the national political and economic system, it leads to some problems in the process of its development. And the imbalance of the operating mechanism of the enterprise bond market and the decrease of the stock market funds are all reflect the inharmonious between the development of financial markets and China's economic growth. These will affect and restrict the healthy development of the financial market. Especially in recent years, China's economy has shown a high growth. However,stock marketas a barometer of economy, it rise has never been fully reflected in the high growth of Chinese economy.Therefore, in this context, research and analysis the correlation between stock market and bond market yield is one of the prerequisites for investors to diversify risk.

2. Theory Analysis and Literature Review on the relationship between Stock Market and Bond Market

Relevant foreign mature experience shows that there is a correlation between stock market and bond market, but the relationship between them is unstable and time-varying. There are three different situations (positive, negative, and irrelevant) with the change of macroeconomic environment and financial market, and it is not simple "seesaw effect"(2015)(2014). The negative correlation is due to the large fluctuations in the stock market.If the stock market is soaring, investors will take a risk avoiding strategy. When the stock market plunged, investors will make changes in investment capital for profit motive. At this time, a large number of

funds quickly transferred from the stock (bond) market, showing a "seesaw effect" (also known as the escape effect). The impact of exogenous macroeconomic or policy factors will lead to positive correlation between the two markets. For example, the corresponding macroeconomic policies adopted by the government to stabilize the economic cycle changes (such as loose monetary policy), and cyclical fluctuations in domestic or external economies. In addition, when the two markets are relatively stable and the trend changes in a single market are not obvious, or when the product specificity risk within a single market is offset by the substitution effect of other products in the market. The stock market and the bond market may also show a less significant correlation.

The research on the interaction between Chinese stock market and bond market is mainly based on the analysis of the existence of the linkage between them and the factors affecting the interaction. For example, Wang Lu(2013) analyses that the linkage between stock market and bond market has asymmetry of mechanism transformation, and there are alternate escape effects and contagion effects (in which the positive correlation state lasts longer).Wang Binhui(2010) and other people have used GARCH model to study the price and volatility spillover effect of stock market, bond market and exchange rate market in China. There is no price information transmission and there is no yield spillover effect between them. The stock market and bond market only have one-way volatility transmission from stock market to bond market. Wang Yintian, Wen Zhiying(2010) and Wang Lu(2008) analyzed the specific factors affecting the stock market and the bond market, macroeconomic variables such as interest rate level, Inflation and money supply will affect the linkage between the two, and can be divided into direct and indirect ways.

Based on the above research, this paper discusses the relationship between stock market and bond market from the perspective of market yield.

3. An empirical study on the relationship between Stock and Bond Market

3.1 Stock and bond market yield correlation test

(1) Sample selection and data sources

The sample interval selected in this paper is from January 1, 2012 to December 31, 2017 after the completion of the split share structure reform.

The bond market in China has been developing for a long time since the 1980s. Both the exchange bond market and the interbank bond market have developed very rapidly. The latest data from the peoples Bank of China show that bond issuance in the interbank bond market jumped sharply in January 2013, with issuance totaling 521.46 billion yuan, up 182.9 percent from a year earlier. All kinds of signs indicate that the development scale of interbank bond market is expanding and the market structure is being optimized step by step. On the other hand, the investment structure of the bond market shows a trend of diversification, and more than95% of the bond market investors rush into the bond market in the interbank bond market. At the same time, the exchange bond market is also relatively rapid development and proportion is rising year by year. Therefore, this paper selects the new composite index of Chinese debt which covers a more comprehensive range, and selects the widely used index of Shanghai stock market as the research object of stock market yield.

The specific data of stock market returns and bond market returns used in this paper are all derived from the WIND database.

(2) Data processing and statistics

The weekly yields of stocks and bonds are respectively SR($SR_t = \frac{S_t - S_{t-1}}{S_{t-1}}$) and BR($BR_t = \frac{B_t - B_{t-1}}{B_{t-1}}$)

indicates (where S_t and S_{t-1}, B_t and B_{t-1} represent stock returns for week t and t-1, and bond yields for t weeks and t-1 weeks, respectively).

3.2 Choice of empirical research methods

(1) Vector autoregressive model

The VAR model is mainly used to study the interaction between different variables. In the early 1980s, the vector autoregressive model proposed by the famous scholar SIMS, its specific meaning is: for the time series variables y_{1t}, y_{2t}, y_{3t}, …,y_{nt}, which can be defined as an n × 1 dimensional vector Y_t

$$Y_t = \begin{bmatrix} y_{1t} \\ y_{2t} \\ y_{3t} \\ \vdots \\ y_{nt} \end{bmatrix}, \quad t=1,2,3\ldots T$$

Therefore, a p-order VAR model VAR(P) can be defined as:

$$Y_1 = C + \Phi_1 Y_{t-1} + \Phi_2 Y_{t-2} + \cdots + \Phi_p Y_{t-p} + \varepsilon_t$$

Where C represents an n × 1 dimensional constant vector, Φ represents an n × n dimensional autoregressive coefficient matrix, and ε_t is n × 1 dimensional vector white noise, which satisfies the following relationship:

$$E_{(\varepsilon_t)} = 0$$
$$E_{(\varepsilon_t \varepsilon_t')} = \Omega$$
$$E_{(\varepsilon_t \varepsilon_{t_s}')} = 0 \quad for\ t \neq s$$

The following VAR models can be built:

$$M_t = n_t m_{t-1} + n_2 m_{t-2} + \cdots + n_p m_{t-p} + qS_t + \varepsilon_t$$

Among them, M_t is K-dimensional endogenous scalar, which indicates the weekly yield of stocks in different periods (i.e. the weekly yield of stocks in t period), and S_t is a D-dimensional exogenous variable, indicating the weekly yield of bonds in different periods, (i.e. bonds in Weekly yield of t period), q represents the coefficient of influence matrix of stock weekly yield on bond yield, and p represents the autocorrelation lag order of the model.

(2) Impulse response function

In the empirical study of VAR model, it is not necessary to a priori constraint on the variables introduced into the VAR model, and it is only possible to analyze the dynamic changes of the system when the VAR model is subjected to a structural impact. This analysis method is called an impulse response function. Consider the following two variable models:

$$x_t = a_1 x_{t-1} + b_1 z_{t-1} + \varepsilon_{1t}$$
$$z_t = c_1 z_{t-1} + c_1 x_{t-1} + \varepsilon_{2t}$$

When ε_{1t} changes (the random disturbance term $\varepsilon_t$in the model is called new interest), the current value of x will also change, and the value of x and t will be affected by the equation path depicted. Impulse response is one way to portray this effect (i.e. how a change in innovation affects other variables and ultimately acts on itself).

(3) Variance decomposition

The variance decomposition is to evaluate the importance of each structural impact and to analyze the contribution of its influence on the changes of endogenous variables. The results can clearly show the relative contribution of each random disturbance term to the equation in the VAR model. Since only a stable VAR model can be used for variance decomposition, the model needs to be tested for stability before analysis.

(4) Granger causality test

The Granger causality test is to test whether the lag term of one variable X can better predict another variable Y, if the effect is better without the introduction of the X variable, only the lag term of the y variable is used. Variable x can be regarded as the Granger cause of Y variable. Any one of the test results is sensitive to the method of dealing with the nonstationarity of sequence and is related to the selection of the lag length p. Therefore, it is necessary to select the most appropriate delay length to carry out the Granger causality test.

3. 3 Empirical process

(1) Descriptive statistics

Table 3-1 is a descriptive statistic for the weekly yields and JB test for the stock and bond markets in the sample interval. From this we can see that the JB statistic of the stock market yield is 209.27, and the JB statistic of the bond market yield is 178.08. The values are very large and obviously do not obey the normal distribution. At the same time, the kurtosis and skewness of the stock market are 6.929224 and -0.724864 respectively. The kurtosis and skewness of the bond market are 6.922224 and -0.479814 respectively. The kurtosis greater than 0 indicates that both distributions are steeper than the normal distribution and the kurtosis greater than 0 means that both distributions are steep. The skewness is negative, it's obviously left deviation. We can also see that the stock market yield rate fluctuates greatly, the maximum rate of return can reach 9.49%, the minimum rate of return can reach -13.32%, and the volatility exceeds 20%. By comparison, the bond market yields are less volatile, the maximum value is 0.96%, the minimum value is -1.28%, and the fluctuation range is only about 2%. Therefore, during the sample period, the average of the stock market yields is greater than the bond marketyield average.

Table 3-1 Basic statistics on stock and bond market yields

	BR	SR
Mean	0.075293	0.178285
Median	0.076900	0.321400
Maximum	0.956700	9.497900
Minimum	-1.284400	-13.31670
Std. Dev.	0.264911	2.992904
Skewness	-0.479814	-0.724864
Kurtosis	6.929224	6.438034
Jarque-Bera	209.2677	178.0829
Probability	0.000000	0.000000
Sum	23.11500	54.73350
Sum Sq. Dev.	21.47448	2740.986
Observations	307	307

Figure 3-2 is a line chart of sample data. From Figure 3-2, we can see that the stock market and the bond market are significantly different. The yield curve of the bond market fluctuates very little and is almost stable, but the stock market yields fluctuate sharply by a large margin,and the volatility of the stock market yield has agglomeration.

(2) Establish a vector autoregressive model

In order to establish an accurate VAR model to selection the lag order P is required. In general,we should select the maximum p valueto reflect the dynamic characteristics of the constructed model as complete as possible.In addition, we need to consider data freedom and follow the first priority.

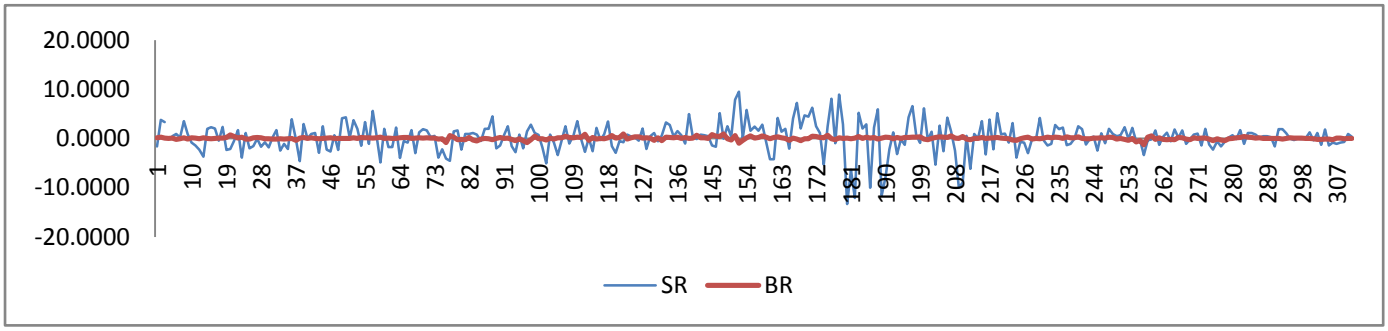

Figure3-2 Stock and bond market yields

Table 3-3 is the result of judging the lag order of VAR(2) for SRand BR.It can be seen that the lag order is 1 and the lag order is 2 with the "*" mark. When the lag order is 1, there are two numbers of * marks included, and when the order of lag is 2, there are three "*" marks. In order to ensure the accuracy of the model, we choose the second order lag order.

Table 3-3 Model VAR (2) lag order judgment result

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-728.5847	NA	0.738003	5.371946	5.398459	5.382590
1	-716.7157	23.47616	0.696515	5.314086	5.393626*	5.346018*
2	-710.2223	12.74795*	0.683866*	5.295752*	5.428319	5.348973
3	-708.3666	3.615927	0.694744	5.311519	5.497112	5.386028
4	-705.2839	5.961498	0.699463	5.318264	5.556883	5.414061
5	-704.0663	2.336613	0.713950	5.338723	5.630369	5.455809
6	-702.7343	2.536723	0.728136	5.358340	5.703013	5.496714
7	-700.9544	3.363511	0.740177	5.374665	5.772363	5.534327
8	-699.6432	2.458414	0.755034	5.394435	5.845161	5.575386

The output of the VAR estimate is obtained by checking the data stationarity test and the model order(Table 3-4).

Table 3-4 Output of VAR Estimation

Standard errors in ( ) & t-statistics in [ ]	SR	BR
SR(-1)	0.131532	-0.009861
	(0.05757)	(0.00506)
	[2.28490]	[-1.94880]
SR(-2)	0.056606	0.006312
	(0.05816)	(0.00511)
	[0.97335]	[1.23477]
BR(-1)	1.638071	0.205707
	(0.65840)	(0.05787)
	[2.48796]	[3.55443]
BR(-2)	-1.837251	0.107292
	(0.66009)	(0.05802)
	[-2.78334]	[1.84917]
C	0.150469	0.052194
	(0.18261)	(0.01605)
	[0.82399]	[3.25167]

Before the impulse response analysis,we should analysis the estimated VAR equation stability, otherwise the result of the impulse response function will be in error. By using the reciprocal method of the AR feature polynomial root, if the reciprocal of all roots of the estimated VAR model is less than 1, and the data pointsof all eigenvalues are within the circle, the VAR model is stable. Otherwise, the standard error of the impulse response function will not be valid.

Based on this, there are four eigenvalues in our estimated model. Figure 3-5 shows the AR root graph. We can see that the four feature roots are all inside the circle and the model is stable.

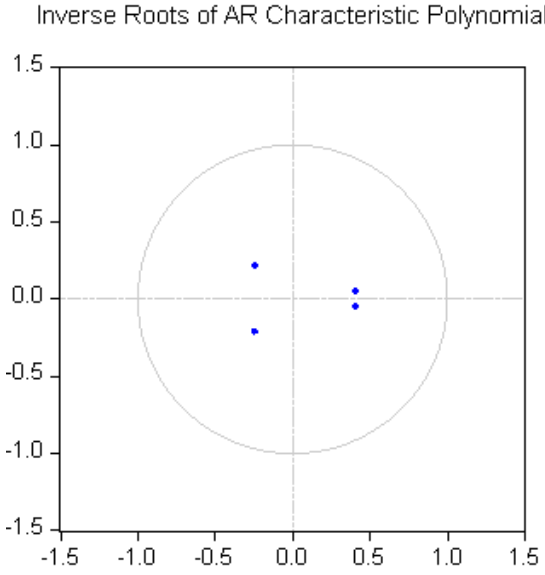

Figure 3-5 AR Root Chart

Table 3-6 is the reciprocal value of the eigenvalue. We can see that the absolute value of the eigenvalue is less than 1 and the model is stable.

Table 3-6 VAR model feature root countdown

Root	Modulus
0.409604 - 0.052429i	0.412946
0.409604 + 0.052429i	0.412946
-0.240985 - 0.213420i	0.321903
-0.240985 + 0.213420i	0.321903
No root lies outside the unit circle.	
VAR satisfies the stability condition.	

(3) Granger causality test

Table 3-7 shows the results of the Granger causality test for the variables SR and BR. The results show that at the 5% significance level, the results reject the null hypothesis, the bond market yield is the Granger cause of the stock market return rate in the case of the second-order lag, and the stock market yield is in the second order of the lag. It is also the Granger reason for the bond market's rate of return. The two yields are mutually causal, and the two-way causal relationship is established. In reality, stock market yields and bond market yields can indeed influence the flow of funds between investors through investor sentiment, and the correlation between these two markets is also affected by macro fundamentals and micro liquidity factors. From the perspective of micro-liquidity factors, the correlation between the two markets is positively related to stock liquidity and negatively related to bond liquidity. From the macro fundamental point of view, the correlation between the two markets is positively correlated with inflation rate, industrial growth rate, and interest rate, and negatively correlated with the degree of easing of monetary policy.

Table 3-7 Granger causality test results of stock and bond market yield

Dependent variable: SR			
Excluded	Chi-sq	df	Prob.
BR	11.43548	2	0.0033
All	11.43548	2	0.0033
Dependent variable: BR			
Excluded	Chi-sq	df	Prob.
SR	4.815117	2	0.0900
All	4.815117	2	0.0900

(4) Impulse response function method

Figure 3-8 describes the response of stock and bond market yields to a standard deviation shock.It can be seen that the response of SR to a standard deviation of SR is positive in the first 10 periods, and tends to be stable in the 10th lag, and the impact effect is almost zero. The specific response trajectory: First, the rise of SR did not immediately cause the impact effect on SR at the beginning stage. The impact effect of the first period was 0, but the maximum positive impact effect was achieved in the second period. Then the impact began to decline, and phase 4 rebounded slightly, but not much. With the increase in the number of periods, the fifth period began to slowly fall back until the final impact disappeared. The response of BR to a standard deviation

of SR was started from the second period, showing a downward trend, and the third period rebounded slightly. After the fifth period, it gradually stabilized until the influence disappeared. The response of SR to the standard deviation of BR is from the second period, and it begins to decline in the third period. The fourth period has a small rebound and finally stabilizes. The response of BR to the BR standard deviation innovation was the strongest in the second phase, and the impact effect gradually decreased and disappeared in the third phase.

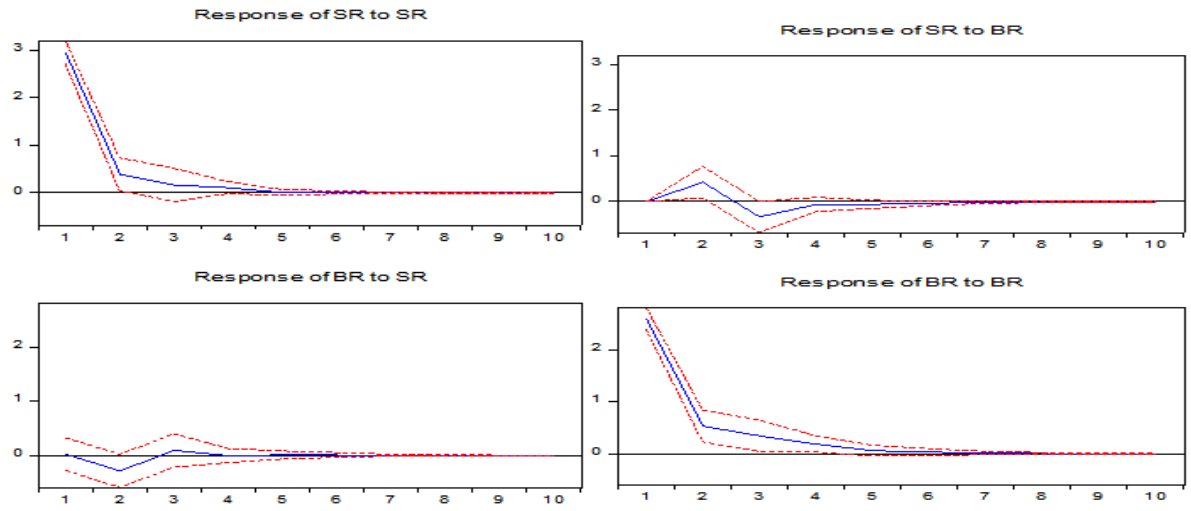

Figure 3-8 Response of stock market and bond market yields to a standard deviation of interest

(5) Variance decomposition

For the above VAR equation, Eviews is used for variance decomposition. Tables 3-9 show the variance decomposition results of stock market yield changes and bond market yield changes, respectively.

From Table 3-9, we can see that the variance decomposition of the stock market return rate has played a role since the second period, and then the force has been increasing. After the sixth period, the force begins to remain stable, and the stock market comes from itself. The impact of the new interest rate contributed about 96.74% of the stock market's yield change, and the impact of the new interest rate from the bond market contributed about 3.26% to the change in the stock market's yield. It can be seen that the change in the stock market's rate of return is mainly affected by changes in its own factors, but the bond market's rate of return will also have a certain impact on its changes.

Table 3-9 Equation decomposition of stock market yield

Variance Decomposition of SR:			
Period	S.E.	SR	BR
1	2.956785	100.0000	0.000000
2	3.013001	98.00360	1.996397
3	3.036079	96.82423	3.175771
4	3.038759	96.78923	3.210773
5	3.039355	96.75178	3.248224
6	3.039582	96.73825	3.261751
7	3.039613	96.73631	3.263691

8	3.039624	96.73564	3.264364
9	3.039625	96.73552	3.264484
10	3.039626	96.73549	3.264508

From Table 3-10, the variance of the bond market's rate of return has played a role since the first period, and then the force has been reduced. It has been basically stable since the sixth period, and the bond market has its own impact on the bonds. The change in market yields contributed about 98.75%, and the impact of new interest rates from the stock market contributed about 1.25% to the change in the yield of the entire bond market. This shows that although the changes in the bond market's rate of return are mainly affected by changes in its own factors, it is also affected by changes in the stock market's rate of return.

Table 3-10 Equation decomposition of bond market yield

Variance Decomposition of BR:			
Period	S.E.	SR	BR
1	0.259902	0.008737	99.99126
2	0.266886	1.161242	98.83876
3	0.269286	1.256208	98.74379
4	0.269945	1.250263	98.74974
5	0.270015	1.250631	98.74937
6	0.270039	1.251242	98.74876
7	0.270042	1.251267	98.74873
8	0.270043	1.251302	98.74870
9	0.270043	1.251307	98.74869
10	0.270043	1.251308	98.74869

4. Conclusions

The empirical results show that the return of stock market just have a little impact on the return of bond market, and the impact has 2 weeks to 6 weeks lag, time. the return of bond market has strong autocorrelation. Which is not consist with theory, the relationship between them is great. The reasons maybe including two aspects. The first is that there is not good mutual complementary relationship between stock market and bond market. The second is the time is not long enough, so the relationship is not so great. But from the empirical analysis we can know the return of bond market is strong autocorrelation, the trend come into being, it will last for a long time.

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