Influence Mechanism of Contagion Effect of Asset Price Bubble between Markets — Take the real estate market and the stock market, for example

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ABSTRACT. With the strengthening of macroeconomic regulation in the real estate market and the stock market being at a historically low valuation, there is an urgent need to study the mechanism of bubble contagion effects between the two markets. This study primarily measures the asset price bubbles in the real estate market and the stock market using two sets of variables. It aims to explore the short-term and long-term interactive relationship of bubbles between the two markets. After preprocessing the data, the Augmented Dickey-Fuller (ADF) unit root test is conducted to ensure the stationarity of the time series. Subsequently, an Error Correction Model (ECM) is established to test for the long-term equilibrium relationship among the variables. Based on the analysis results of the Vector Error Correction Model, it is concluded that there exists a cointegration relationship between the real estate market bubble and the stock market bubble, with a negative long-term equilibrium impact on each other. This conclusion provides valuable investment advice for investors in both markets, suggesting different strategies for long-term and short-term investments, and holds significant practical value.

Keywords: Asset price bubble; Contagion effect; Vector Error Correction Model

1 Introduction

Government's macro-control measures aim to stabilize the real estate market and prevent risks, altering the industry's landscape. Adjustments in real estate prices and market bubbles are attempts to mitigate risks, but the pressure continues to accumulate. The impact of a real estate bubble burst on asset allocation in other markets needs empirical study for informed decision-making. Understanding bubble transmission mechanisms is crucial for predicting market changes and guiding investors in adjusting their asset allocation. It helps provide timely risk warnings and aids in formulating sound investment strategies.

A. Bhunia et al. (eds.), *Proceedings of the 2023 International Conference on Finance, Trade and Business Management (FTBM 2023)*, Advances in Economics, Business and Management Research 264,
https://doi.org/10.2991/978-94-6463-298-9_43

1.1 The reference of bubble measurement of the current real estate market and stock market

The measurement and prediction of bubbles in the academic community still lack consensus. In the article by ([1] Kiselev and Ryzhik, 2010), a simple stochastic differential equation model is used to study the formation and collapse of bubbles in social environments, involving key behaviors such as mean reversion, speculative social response, and random fluctuations. Numerical simulations and rigorous analysis are conducted under different parameter values. ([2] Jarrow, R.A., Protter, P. and Shimbo, K. 2010) The text introduces a method for studying asset price bubbles in continuous-time models based on a local martingale framework. This approach provides a new way for precise measurement of bubbles. ([3] Jiang and Zhou et al., 2009) combines economic theory, behavioral finance, and mathematical/statistical physics to propose the logarithmic periodic power law model as a flexible tool for bubble detection. In ([4] Ji, 2018)'s article, the author analyzes the bubble phenomenon in the Guangzhou real estate market using both single and composite indicators, exploring the reasons behind bubble formation. The results show a clear upward trend, and the author's indicator usage is important for this study.

1.2 Selection of indicators for measuring asset price bubbles in the real estate market and stock market

Selection of real estate market bubble measurement indicators.

[5] Lv Jianglin (2010) found that the price-to-income ratio is the most appropriate indicator for evaluating the level of the real estate bubble in China. [6] Xue Wenyan (2012) pointed out in her study on measurement indicators of the real estate bubble that, after summarizing previous research, indicators such as the net present value of rental cash flows, and price-to-rent ratio can be used to measure the asset price bubble.

After comparing the availability of data and the complexity of data processing, it is determined that the most suitable measurement indicators for the real estate market bubble are the geometric mean of the price-to-income ratio, house price growth rate to GDP growth rate, and mortgage loans to monthly household income. Therefore, this set of data is selected as the measurement indicator for the real estate market bubble.

Selection of stock market bubble measurement indicators.

[7]Lin Sihan (2021) pointed out in the study that based on the PSY method to identify the asset price bubble cycle of seven listed industries, and using the TVP-SV-VAR model and the generalized variance decomposition method to construct the analysis method of dynamic connected index, the bubble contagion between various markets in the stock market was studied, and the three industries of industry, medicine and health and information technology were the most bubble contagious, and the main consumption and public utilities were weaker than other industries. Its bubble measurement coefficient for the stock market mainly uses the price-earnings ratio method.

According to previous research and the availability and intuitiveness of data, the average price-earnings ratio (PE) of the Shanghai Composite Index from 2003 to 2022 is directly used as an indicator to measure the stock market bubble.

2 A brief description of research ideas and methods

2.1 Research ideas

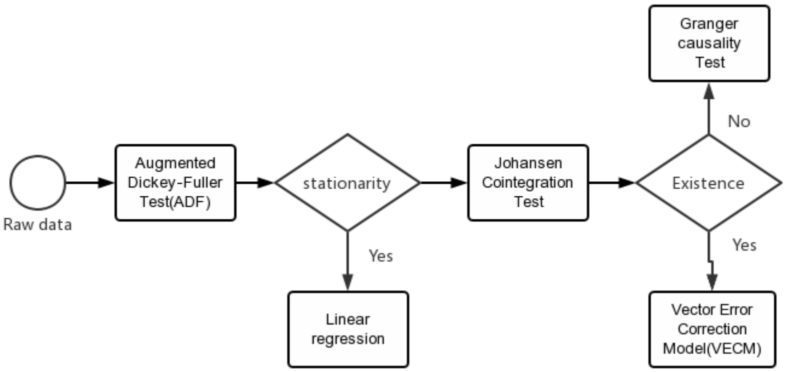

Fig. 1. Research framework

Figure 1 shows the steps we take in the research. Before investigate the short-term and long-term interactive relationship of bubbles between the two markets, data preprocessing is conducted as necessary, including addressing extreme outliers and missing values. The following steps are taken:

(1) Data processing: Appropriate methods are used to address extreme outliers and missing values in the data.

(2) ADF unit root test.

(3) Johansen cointegration tests.

(4) VECM models establishment.

2.2 Possible innovation in research methods

1. This study selects three indicators - price-to-income ratio, house price growth rate to GDP growth rate, and mortgage loans to monthly household income - as measurement coefficients for the real estate market bubble. These indicators reflect market valuation and investor expectations with economic significance and practicality.

2. Cointegration tests based on the VAR model are employed to examine the long-term equilibrium relationship and causal link between the real estate market bubble and the stock market bubble. This approach utilizes dynamic information among variables and mitigates biases that can arise from one-directional tests.

3. An error correction model is established to analyze short-term fluctuations, long-term equilibrium adjustment, and the impact of bubble bursts on the real estate market

bubble and the stock market bubble. This approach uncovers dynamic adjustment mechanisms and market responses to bubble bursts.

3 Research Contents of the Thesis

3.1 Data acquisition and processing

The annual data provided by China's National Statistics from 2003 to 2022 is used. The variables include the annual average price-to-earnings ratio of the Shanghai Composite Index, the average selling price of real estate properties, per capita annual income of Chinese residents, GDP growth rate of China, and personal mortgage loans from Chinese real estate development enterprises. After performing simple data processing using Excel, the data are transformed into the average price-to-earnings ratio of the Shanghai Composite Index and the geometric mean of the real estate indicators. These variables are denoted as Real Estate Market Bubble (REMB), representing the measurement indicator for asset price bubbles in the real estate market, and Stock Market Bubble (SMB), representing the measurement indicator for asset price bubbles in the stock market.

3.2 Augmented Dickey-Fuller unit root test

Before proceeding with the modeling, it is necessary to conduct unit root tests on the two series. The results are as follows:

Table 1. ADF unit root test (REMB)

Null Hypothesis: REMB has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic - based on SIC, max lag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.444110	0.8788
Test critical values:	1% level	-3.920350	
	5% level	-3.065585	
	10% level	-2.673459	

Table 2. ADF unit root test (D(REMB))

Null Hypothesis: D(REMB) has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.813260	0.0018
Test critical values:	1% level	-3.920350	
	5% level	-3.065585	
	10% level	-2.673459	

*MacKinnon (1996) one-sided p-values.

Table 3. ADF unit root test (SMB)

Null Hypothesis: SMB has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.322071	0.1761
Test critical values:	1% level	-3.857386	
	5% level	-3.040391	
	10% level	-2.660551	

Table 4. ADF unit root test (D(SMB))

Null Hypothesis: D(SMB) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.281089	0.0001
Test critical values:	1% level	-3.857386	
	5% level	-3.040391	
	10% level	-2.660551	

*MacKinnon (1996) one-sided p-values.

Table 5. all ADF unit root test

Variable	t-Statistic	Prob.*	Test critical values:			Conclusion
			1% level	5% level	10% level	
REMB	-0.44	0.8788	-3.92	-3.07	-2.67	non-stationarity
D(REMB)	-4.81	0.0018	-3.92	-3.07	-2.67	stationary after differencing
SMB	-2.32	0.1761	-3.86	-3.04	-2.66	non-stationarity
D(SMB)	-6.28	0.0001	-3.86	-3.04	-2.66	stationary after differencing

All the result of ADF unit root test are showed in table 1-4, and the table 5 shows the total result and conclusions. From these charts, It can be observed that the original series REMB and SMB are both non-stationary. This is indicated by their respective ADF test statistics' p-values of 0.8788 and 0.1761, which are greater than 0.05. Hence, the original series is differenced once to obtain D(REMB) and D(SMB). At this point, the corresponding p-values of their ADF test statistics are 0.0018 and 0.0001, both of which are less than 0.05. The null hypothesis is rejected, indicating the absence of a unit root and stationarity of the series. This implies that REMB and SMB are integrated of order one (I(1)), making them suitable for cointegration testing.

3.3 Johansen cointegration test

The results of the Johansen cointegration test are as follows:

Table 6. Cointegration test

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.627098	22.78768	18.39771	0.0114
At most 1 *	0.298134	6.018217	3.841466	0.0142

As what can be seen on the table 6, the results obtained from the Johansen cointegration test suggest that there exists a long-term cointegration relationship between the bubbles in the real estate market and the stock market.

3.4 Establishment of the Error Correction Model (ECM)

The next step involves estimating the Error Correction Model (ECM) as follow:

Table 7. ECM model parameter estimation

Error Correction:	D(REMB)	D(SMB)
CointEq1	0.083356	-31.55958
D(REMB(-1))	-1.0371	24.49967
D(REMB(-2))	-0.929822	12.78910
D(SMB(-1))	-0.003911	0.106273
D(SMB(-2))	0.001179	-0.04884
C	0.132628	-1.612117
R-squared	0.578885	0.577206

Adj. R-squared	0.387469	0.385028
Sum sq. resids	0.779194	1430.812
S.E. equation	0.266150	11.40499
F-statistic	3.024225	3.003485
Log likelihood	2.081070	-61.80062
Akaike AIC	0.461051	7.976543
Schwarz SC	0.755126	8.270619
Mean dependent	0.047504	-0.207059
S.D. dependent	0.340065	14.54344

The estimation results are showed on the table 7, Among the data, for the long-term relationship in the system, the equation is as follows:

$$REMB(-1) = -0.037SMB(-1) + 2.25 \quad (1)$$

Additionally, the estimation equation for the Error Correction Model (ECM) is:

$$D(REMB) = 0.08CointEq1 - 1.04D\big(REMB(-1)\big) - 0.92D\big(REMB(-2)\big) - 0.004D\big(SMB(-1)\big) + 0.001D\big(SMB(-2)\big) + 0.13$$

$$D(SMB) = -31.56CointEq1 + 24.49D\big(REMB(-1)\big) + 12.79D\big(REMB(-2)\big) + 0.11D\big(SMB(-1)\big) - 0.05D\big(SMB(-2)\big) - 1.61 \quad (2)$$

In the ECM model, it can be observed that there exists a long-term equilibrium and short-term adjustments within the system. When a variable deviates from equilibrium, the system will adjust it back to the equilibrium state.

3.5 impulse response

Figure 2 represents a schematic diagram of impulse response analysis.

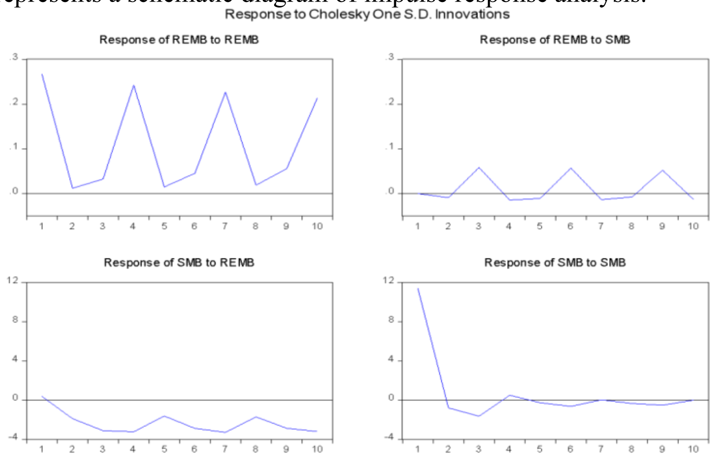

Fig. 2. Impulse Response Function

From figure 2, it can be observed that REMB is primarily influenced by its own changes in a positive direction. Furthermore, when SMB experiences a positive shock of one unit given REMB, REMB exhibits alternating positive and negative changes, with the predominant effect being positive.

Regarding SMB, in the first period, it is mainly influenced by its own changes, but in the third period, it becomes negatively influenced and subsequently approaches zero. In terms of the impact of REMB on SMB, when REMB experiences a positive shock of one unit given SMB, SMB shows a negative impact, and this effect is persistent.

3.6 Variance Decomposition

Further variance decomposition of REMB and SMB is conducted to study the contribution of factor changes to the volatility of both variables. The table below presents the results:

Table 8. Variance Decomposition of REM

Period	S.E.	REMB	SMB
1	0.27	100.00	0.00
2	0.27	99.88	0.12
3	0.27	95.40	4.60
4	0.37	97.26	2.74
5	0.37	97.18	2.82
6	0.37	94.99	5.01
7	0.44	96.25	3.75
8	0.44	96.23	3.77
9	0.45	94.96	5.04
10	0.49	95.84	4.16

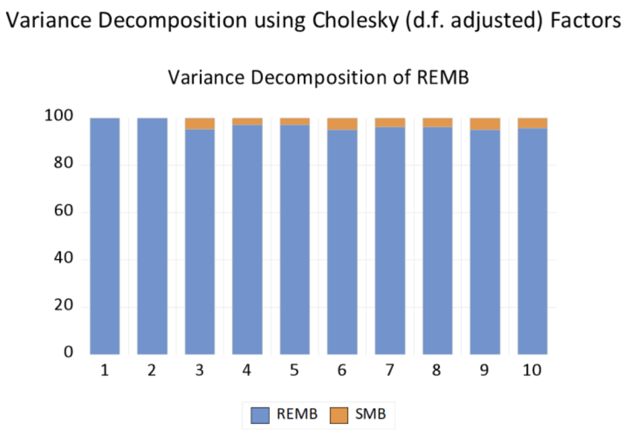

Fig. 3. Cumulative contribution of variance decomposition in REMB

From table 8 and figure 3, we can determine that with the increase in time periods, the proportion of REMB explained by its own changes gradually decreases. However, in the 10th period, the explanatory ratio is still 95.84%, indicating a significant contribution.

In terms of SMB, its explanatory power for REMB variations is 4.16% in the tenth period, suggesting a relatively small impact of SMB on REMB.

Table 9. Variance Decomposition of SMB

Period	S.E.	REMB	SMB
1	11.40	0.11	99.89
2	11.59	2.81	97.19
3	12.12	9.22	90.78
4	12.55	15.25	84.75
5	12.66	16.65	83.35
6	13.00	20.75	79.25
7	13.42	25.54	74.46
8	13.53	26.73	73.27
9	13.84	29.87	70.13
10	14.21	33.45	66.55

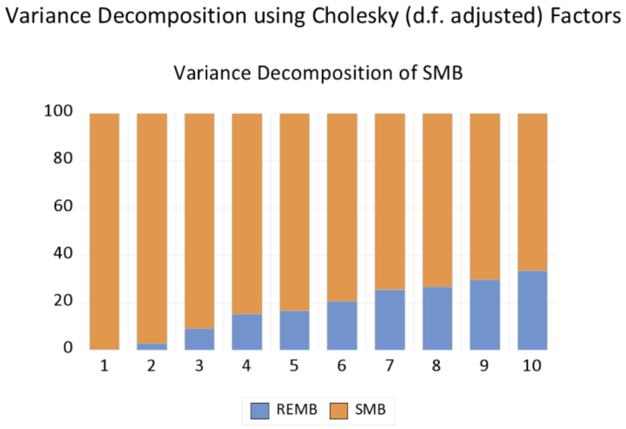

Fig. 4. Cumulative contribution of variance decomposition in SMB

The data in table 9 and figure 4 shows that with the increase in time periods, the proportion of SMB explained by its own changes gradually decreases. However, in the 10th period, the explanatory ratio is 66.55%.

In terms of REMB, its explanatory power for SMB variations is 33.45% in the tenth period. This indicates that REMB's contribution to SMB volatility increases over time, and the explanatory ratio is relatively high, suggesting that SMB has a significant impact on REMB.

4 Research Findings and Recommendations

4.1 Research Conclusion

There is a cointegration relationship between the bubbles in the real estate market and the stock market, with a long-term equilibrium negatively affecting each other. Specifically, the volatility of the stock market's bubble has alternating positive and negative effects on the real estate market's bubble in the short term, while the changes in the real estate market's bubble have a negative impact on the stock market.

Short-term changes in the real estate market's bubble do not immediately impact the stock market, but short-term fluctuations in the stock market's bubble can affect the real estate market. Investors in the stock market can moderately adjust asset allocation in response to real estate market bubbles, while real estate market investors need to be cautious of short-term stock market fluctuations. Long-term investment requires considering the trends in both markets and using them as a reference for asset allocation decisions. This comprehensive approach helps adapt to market changes and achieve better investment returns and risk management.

4.2 Explanation of the Mechanism of Bubble Contagion Effect between Markets

According to current academic research, there is a lack of consensus among scholars regarding the mechanisms of bubble contagion between markets. However, by synthesizing various scholarly perspectives, this paper identifies key factors that can serve as reference points for understanding the bubble contagion effect.

The contagion effects between the real estate market and the stock market encompass both negative and positive influences. Negative effects include the substitution effect, where investors' allocation of resources towards one market displaces funds from the other market, potentially impacting the formation of bubbles. Additionally, government monetary policies and industry-specific economic policies can have negative repercussions on both markets. Market panic, triggered by sharp declines in asset prices, can also negatively impact both markets.

On the other hand, positive contagion effects arise through the wealth effect. When real estate investors generate profits and accumulate wealth, their positive wealth effect spills over into other markets, fueling positive expectations and contributing to the formation of bubbles. The stock market plays a significant role in this contagion, as investors can participate in corporate investments through publicly listed stocks, allowing the performance and behavior of real estate companies to transmit to other markets.

Understanding these interplay and transmission mechanisms between different markets is crucial for investors to formulate effective investment strategies and manage risks. Furthermore, future research should delve deeper into the bubble contagion effect between markets to provide better guidance for investor decision-making and market regulation. The aim of this paper is to provide accurate guidance that enables a comprehensive understanding of the interrelationships between markets, ultimately leading to optimal asset allocation outcomes.

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