

Research on Synergy of Sino-US Economic Fluctuation Based on Multivariate Garch-Bekk Model*

Zhang Luan, Yao Mengjie

School of Finance and Economics, Jiangsu University, Zhenjiang Jiangsu 212013

Abstract

With the rapid development of world economic integration, the synergy of the economic cycles of the countries has further improved. Employing a GARCH-BEKK model, this paper measures the synergy of economic fluctuations between China and the United States by stage since 1992 Q1 to 2018 Q4. The results show that the synergy existed in Sino-US economic cycle fluctuation, and with significantly time-varying characteristics. The synergy of Sino-US economic cycle fluctuation in economic expansion phase is higher than in economic contraction phase. Currently with the gradual progress of the "One Belt And One Road" initiative and China's active integration into the world economy, the synergy of Sino-US economic development is gradually declining.

Keywords: Sino-US Economic Fluctuations; Synergy; Multivariate GARCH-BEKK Model

1. INTRODUCTION

Under the background of economic globalization, the economic relations among countries are getting closer and economic dependence is increasing. As the largest developed and developing countries of the world, the United States and China have attracted worldwide attention for their economic development. Since the establishment of diplomatic relations between the United States and China, the two

* This paper is funded by Philosophy and social sciences research fund of Education Department of Jiangsu Province (2018SJA1048) and Innovation project for Graduate students of Education Department of Jiangsu Province (CXLX13_697).

countries have conducted in-depth cooperation and exchanges in the fields of economy, science and technology. The GDP growth and national income of the two countries have both grown rapidly. In 2006, the sub-prime mortgage crisis broke out in the United States and quickly spread to other countries, turning into a global financial crisis. China's economy also showed downward signs from its high-speed growth trend. Since then, although China has adjusted its national strategy into the "new normal" and its comprehensive national strength has been continuously enhanced, trade frictions in foreign economic cooperation and development have continued. In March 2018, the United States announced a tariff increase on about \$60 billion of goods imported from China, which set off a trade war between China and the United States and affected the development of Chinese industries, especially high-tech industries. It has a significant sense for China to reduce the impact of economic fluctuation from US, continue to open up and participate in international competition to analyze the rule of Sino-US economic fluctuation by stage.

The economic cycle synergy is obviously important to the economic development of all countries. In the early 1930s, scholars began to study it and formed a variety of theoretical schools and model methods. Kouparitsas (2003)^[1] found that the economic development of all countries in the world, especially developed countries, showed a very high correlation. Since the end of Bretton Woods System, the G7 has been highly correlated. Kose and Otrok (2012)^[2] analyzed the G7 economy based on monthly data from 1960 to 2003, it was concluded that the synergy among G7 was steadily increasing. Zhang Bing (2006)^[3], accurately measured the economic synergy between China and the United States by analyzing the correlation coefficient of economic growth rate fluctuation between the two countries, and concluded that it had an increasing trend. Shen Ji, Cao Xing (2011)^[4] using HP filter method concluded that the synergy of Sino-US economic cycle varied with different economic phases, and the synergy between the two countries declined gradually. China has a better potential on economic development than US. Zhang Bing (2015)^[5] established Markov regime switching model and found that there was an obvious economic fluctuation synergy between US and China. The economic recovery of US can promote the economic growth in China, but the impact of China's "new normal" economy on US is not significant. Yu Yang (2017)^[6] considered that the pattern of economic fluctuation in China would change, since China now is in the economic transition phase.

These researches mainly focus on the measurement and determinants of the economic synergy, but lack of the deep research on the stage of economic fluctuation synergy. And because the measurement models adopted by scholars are different, the degree of economic synergy is controversial.

2. GENERAL ANALYSIS ON SINO-US ECONOMIC FLUCTUATION

2.1 Division on the phases of Sino-US economic cycle

According to international economic cycle theory, we adopted TR coefficient method of Don Harding and Adrian Pagan (2006) ^[7] to divide the phases of economic synergy in China and US based on GDP growth rate from 1992 Q1 to 2018 Q4. And the wavelength less than 3 years is divided to the next phase. The results are shown in Table 1. All the data are from World Bank Open Data.

Table 1. Division of Economic Cycles in US and China

Waves	US					China				
	Year	Peak	Trough	Expansion Length	Contraction Length	Year	Peak	Trough	Expansion Length	Contraction Length
1	1992-1995	1993	1993	2	2	1992-1999	1992	1999	1	6
2	1996-2002	2000	2012	4	3	2000-2009	2007	2009	7	2
3	2003-2009	2005	2009	3	4	2010-2018	2010	2018	1	7
4	2010-2018	2014	2018	4	4	2019-	2019		1	

2.2 Comparative analysis of GDP in US and China

GDP is a representative index to measure the economic development of a country. We use nominal GDP growth rate and real GDP growth rate to examine the economic fluctuation in US and China.

As shown in chart 1, the nominal GDP of US and China are rising steadily from 1978 to 2018, but there are some recessions. And the economic relationship of the two countries can be divided into 3 phases. From 1978 to 2008, with the recovery of diplomatic relations of US and China, both the two countries had the economic expansion. From 2008 to 2010, subprime crisis in the US led to the economic depression and China's GDP also declined suddenly, and the economic depression lasted two years. The economies of the two countries recovered from the crisis and started to develop together from 2010. China adjusted its economic strategy in time and developed rapidly.

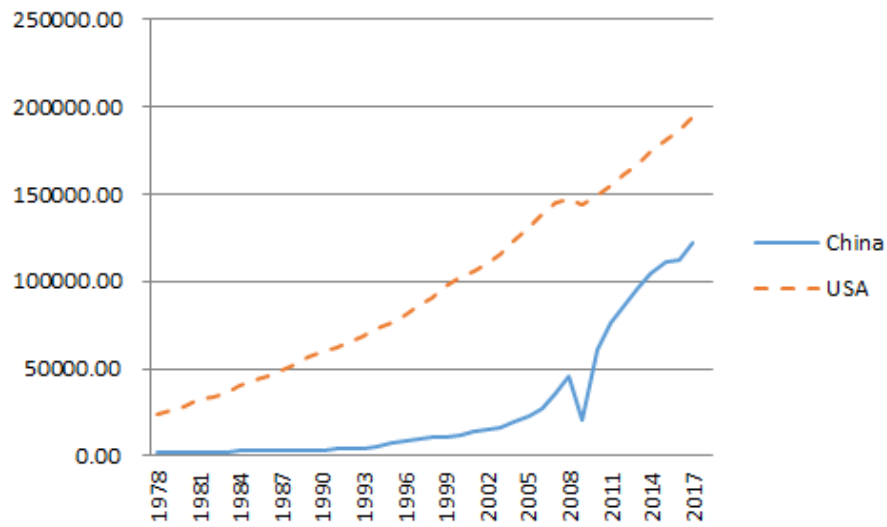
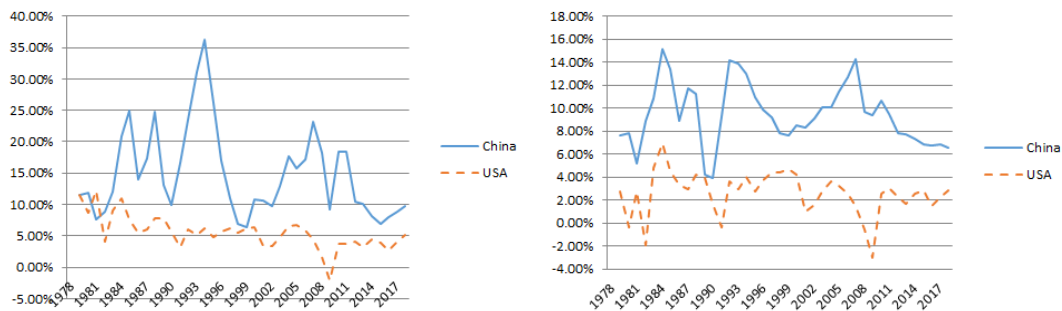


Chart 1 Annual Nominal GDP of US and China

Source: World Bank



a. Nominal GDP Growth Rate

b. Real GDP Growth Rate

Chart2 Annual GDP Growth Rate of US and China

Source: World Bank

As shown in chart 2, when we analyze the GDP growth rate of US and China, it is found that the economic fluctuation of US and China was not synchronous even opposite before 1982, and two economies were less closely related then. After 1982 the economic correlation between the two countries has become increasingly stronger due to the strengthening of bilateral trade, the increasing OFDI, the gradual opening of financial markets, and investors' positive expectations of both US and China. In 2008, the two economies declined synchronously due to the subprime crisis, and then recovered slowly from 2012.

3. MEASUREMENT ON ECONOMIC FLUCTUATION SYNERGY OF US AND CHINA

3.1 Methodology and data source

Using the GDP of US and China from 1992 Q1 to 2018 Q4, we establish multiple GARCH Scalar-BEKK models to measure the economic fluctuation synergy of the two countries. ^[8] All data are from World Bank and China Statistical Yearbook.

Multiple GARCH model originated from ARCH model. The research on economics and finance always covers many variables, and the traditional ARCH model can only analyze univariate fluctuation. Scholars started to develop multiple GARCH model for multivariate conjoint analysis, which is multivariate generalized autoregressive conditional heteroscedasticity model. But the multiple GARCH model will be in "dimensionality disaster" with the increasing dimension of variables, so the BEKK model is widely adopted. ^[9] Scalar-BEKK model can not only satisfy definite matrix of GARCH model, but also reduce the number of estimated parameters by imposing constraints on parameters, so as to analyze the multivariate fluctuation.

3.2 Model estimation

Based on the real quarterly GDP of US and China in 1992, we adopt the HP filter method to reject the trend sequence and establish the sequence model of GDP fluctuation, ^[10] and the result is shown as chart 3. We find that the economic cycles of US and China are different in the entire sample period. The economic fluctuations of US and China are opposite before 1994. From 1994 to 2008 the difference in the economic cycle between US and China is not significant, and the economic fluctuations of two countries show some convergence. From 2002 to 2009, economic fluctuation started to show significant difference again. Until the subprime crisis, both the two economies declined and showed convergence again, and it is found that the economic fluctuation of China is affected by US and has certain lag.

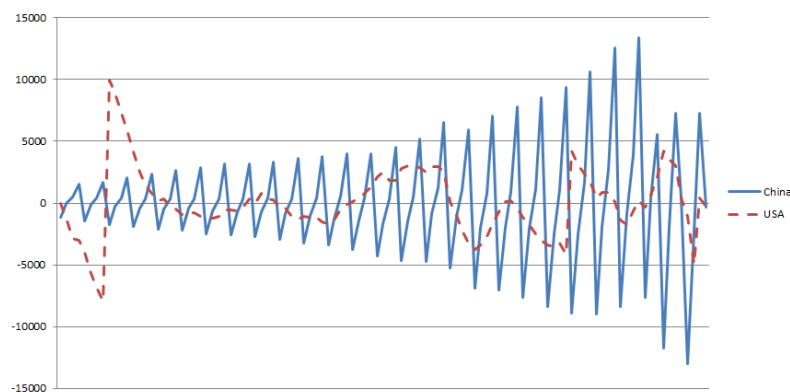


Chart 3 Trend rejection sequence of economic fluctuation in US and China

In order to avoid spurious regression, the ADF method is used for the stationary test on the economic cycle sequence of the two countries. The test results show that the significance level of all variables is less than 0.05, which indicates that the economic fluctuation of two countries reject the nonstationary hypothesis in the sample period. The economic cycle sequence is stationary and satisfies the modeling conditions.

Through descriptive statistics on economic fluctuation sequence of US and China, we can see the mean of the economic cycle is zero, which indicates that the economies of the two countries fluctuated with the trend values. By comparing the standard deviation, we find that China has a bigger economic fluctuation and developed rapidly in “new normal” economy. The P value of Jarque-Bera statistic of all the variables is less than 10% which shows that the sequence rejects the normal distribution. Both the economic fluctuation sequence of US and China has an obvious peak and fat tail.

Table 2 Descriptive statistics on economic fluctuation sequence of US and China

	CGDPBO	UGDPBO
Mean	0.0000	0.0000
Median	-30.44744	-232.0245
Maximum	13365.61	9950.262
Minimum	-12974.56	-7945.112
Std. Dev.	4542.93	2773.075
Skewness	0.127499	0.536469
Kurtosis	4.155571	5.12094
Jarque-Bera	6.243313	25.18772
Probability	0.044084	0.000003
Sum	0.0000	0.0000
Sum Sq. Dev.	2.19E+09	8.15E+08
Observations	107	107

Then the autocorrelation test and partial autocorrelation test are used in the economic cycle sequence of US and China. The P value corresponding to Q statistics is less 0.05 which indicates that the economic cycle has a significant autocorrelation under the

significance level of 5% and passes ARCH test. The volatility cluster of economic cycle in US and China is very significant. So the ARMA-Scalar-BEEK is introduced to measure the economic fluctuation since the traditional regression model cannot fit it well.

Because both the autocorrelation function and partial autocorrelation function show trailing, we use LS command for parameter significance test in ARMA model. The test result shows that ARMA (2, 1) model is most significant. Numerous theoretical and empirical researches indicate that using first order lag can describe the characteristics of time-varying conditional variances well. And considering the estimation cost and interpretation, there is no obvious improvement to increase the order (Chen Lei, Zhang Jun)^[9]. So we set lag order of ARCH and GARCH as 1. After setting the lagged differences of GARCH-BEKK model we use Information criteria for overall model estimation to test the model. The test result shows that both the AIC value and SBC value are minimum, and the normalized residual sequence filtered by the model has no autocorrelation and ARCH effect.

3.3 Results of model estimation

The model estimation results of ARMA-Scalar-BEKK model are shown as table 3. According to the time-varying conditions covariance matrix from the model, we can calculate the time-varying correlation coefficient of the Sino-US economic cycle. And Chart 4 shows the dynamic evolutionary path of Sino-US economic cycle synergy.

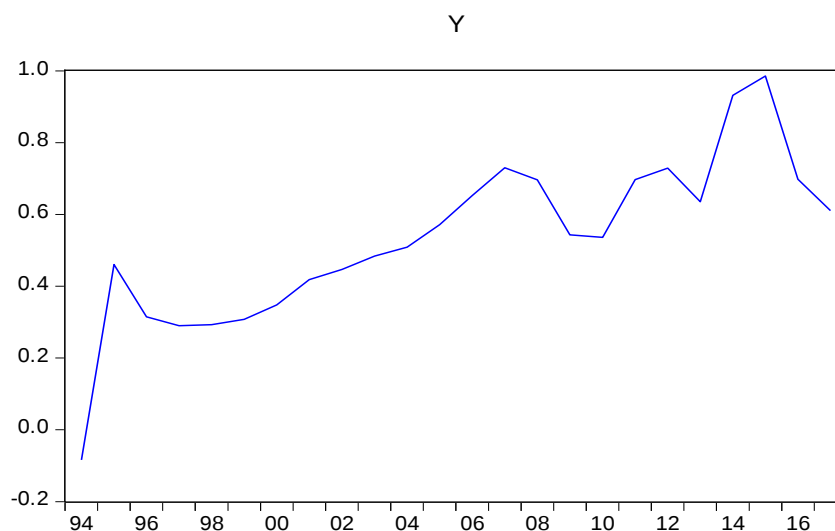


Chart 4 Dynamic evolutionary path of Sino-US economic cycle synergy

Table 3 Results of ARMA-Scalar-BEKK model

First column: mean equation		
	China	US
AR (1)	-0.150661 (0.2293)	1.651698 (0.0000)
AR (2)	-0.537526 (0.0000)	-0.721769 (0.0000)
MA (1)	-0.410044 (0.0047)	-0.988896 (0.0000)
Second column: Scalar-BEKK Model		
Coefficient Matrix C	C11	C21
	20.2332 (0.0110)	-0.5395 (0.5973)
	C22	
	4.2968 (0.0000)	
Coefficient Matrix A	a11	a12
	-0.0000 (1.0000)	-0.0000 (1.0000)
	a21	a22
	-0.0000 (1.0000)	0.0000 (1.0000)
Coefficient Matrix B	b11	b12
	-0.0330 (0.9947)	0.0050 (0.9915)
	b21	b22
	-0.9918 (0.9114)	0.1466 (0.4308)

We conclude the following characteristics of Sino-US economic cycle synergy from table 3 and chart 4.

(1) The coefficient of Sino-US economic fluctuation is not stable. It has a significant dynamic change in different period. The Sino-US economic fluctuation has a negative correlation before 1994. Since then the economic fluctuation in two countries is positive correlation, and shows a significant synergy.

(2) From 2002 to 2009, both the US and China were in economic contraction, and the Sino-US economic fluctuation synergy showed a lower level. The coefficient is less than 0.5. Furthermore, during this phase the economic fluctuation synergy of the two countries strengthened firstly and weakened later. Affected by the subprime crisis in US China's economy declined, and the impact is hysteretic.

(3) From 2009 to 2018 is the phase of economic expansion. In order to reduce the economic influence of US, China formulated the "New Normal" strategy, and made deep economic reform and adjustment. China's economy reached a small peak in 2012. At the same time the economy of US recovered from the crisis, which has an obvious promoting effect on China's economy as a close trade partner.

4. CONCLUSIONS AND RECOMMENDATIONS

We choose the largest developed country and developing country in the world as the object and adopt multiple GARCH-BEKK model to research the economic fluctuation synergy of US and China. The results show that Sino-US economic cycles have a certain synergy, and the degree of synergy in economic expansion phase is higher than economic contraction phase. The economic fluctuation of US and China is basically synchronous, which indicates that the US and China have an increasingly economic dependence on each other. But recently with the resurgence of trade protectionism in US, there are many economic frictions especially on trade between US and China, which casts a shadow over Sino-US economic relationship. China has actively integrated itself into the world economy and continued to carry out reform and opening up. Especially with promotion of the One Belt and One Road Initiative, China has strengthened the economic communication with other countries. The economic fluctuation synergy of US and China is unstable, and shows downward trends.

In order to reduce the negative impact of Sino-US economic fluctuation synergy on China's economy, the following recommendations are proposed. Firstly, China should strengthen the capability of independent innovation and reduce the dependence on import of key technology. Secondly, China should continue to promote economic cooperation with countries along the belt and road, increase the investment in foreign country, and diversify the export markets to reduce the dependence on US economy. Thirdly, China's government should establish an effective trade friction early warning and rapid response mechanism to reduce the impact of external economic fluctuations on the domestic economy.

REFERENCE

- [1] Baxter M, Kouparitsas, Michael A. Trade Structure, Industrial Structure, and International Economic Cycles[J]. American Economic Review, 2003, 93(2):51-56.
- [2] Kose M A , Otrok C , Prasad E . GLOBAL BUSINESS CYCLES: CONVERGENCE OR DECOUPLING?[J]. International Economic Review, 2012, 53(2):511–538.
- [3] Zhang Bing. Analysis on Synchronization and Transmission Mechanisms of Sino-US Economic Cycles [J]. World Economy Study,2006(10):31-38.
- [4] Shen Ji, Cao Xing. Analysis on Economic Cycle Correlation of China and the U.S.A [J]. Economy and Management, 2011, 25(12):9-15.
- [5] Zhang Bing. The Economic Cycle Co-movements of China and the USA: Based on Markov Regime-switching Models [J]. Nankai Economic Studies,2015(03):3-18.
- [6] Yu Yang. A Study on the Character of Economic Cycle Fluctuation and Its Driving Factors during Economic Transition Period in China[D]. Jilin University,2017.
- [7] Don Harding, Adrian Pagan. Synchronization of cycles [J]. 132(1):59-79.
- [8] Rasmus S. Pedersen, Anders Rahbek. Multivariate variance targeting in the BEKK–GARCH model[J]. The Econometrics Journal, 2014,17(1).
- [9] Chen Lei, Zhang Jun. Economic Cycle Synchronization and its Transmission Mechanism in BRICS [J]. The Journal of Quantitative & Technical Economics,2017,34(03):95-111.
- [10] Wang Xin, Chen Lizhen. The Study on the Impact of U.S Recession upon China's Real Economy and Its Transmission Mechansim [J]. China Soft Science,2012(11):29-40.