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Financial Cycles and Monetary Policy: An Empirical Analysis based on McCallum Rule

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Abstract. Based on the construction of the comprehensive financial cycle index, this paper uses the McCallum rule to empirically test the interaction mechanism between financial cycle and monetary policy. The results show that the interaction between the financial cycle and monetary policy has certain "asymmetry" characteristics; the impact of the financial cycle on the real economy, causing changes in the money supply, and promoting the adjustment of China's monetary policy; at the same time, due to the financial cycle Considering the impact, China's monetary policy has a strong counter-cyclicality in the short term, and the monetary policy control effect based on the McCallum rule is relatively significant. To this end, China must focus on promoting financial reforms focusing on diversification of market entities, orderly market competition, and legalization of financial supervision, so as to better eliminate external shocks caused by financial cycle fluctuations and continuously enhance monetary policy promotion. The effect of real economic growth.

Keywords: financial cycle; monetary policy; McCallum rule.

1. First, Introduction and Literature Review

Since the outbreak of the global financial crisis in 2008, countries have adopted a large number of fiscal and monetary policies to promote the recovery of the real economy. To a certain extent, the global financial market has been turbulent, and financial asset prices and credit creation have shown obvious cyclical fluctuations. That is, the so-called "financial cycle" has emerged. However, under the impact of the financial cycle, is the impact of the monetary policy adopted by a country on the real economy significant? As a developing country that needs to improve its financial market system, how to design a monetary policy that serves the real economy and effectively cope with the impact of the financial cycle has become a real problem that needs to be solved urgently.

Foreign scholars' research on the financial cycle can be traced back to the "debt-deflation" theory proposed by Fisher (1933) during the big crisis period. Since the 1980s, the real economic cycle theory (RBC) analysis of the rise of macroeconomic mainstream theory, the Keynesian financial economic cycle theory has been violently impacted. Until the end of the 1990s, with the emergence of more mature theories such as the "credit cycle theory" proposed by Kiyotaki and Moore (1997) and the "financial economic cycle theory" proposed by BGG (Bernanke, Gertler and Gilchfist, 1999), this The situation has changed. Since the compatibility with the mainstream macroeconomic model is more compatible, these two models become the basis for modeling many subsequent financial economic cycle models (Chen Yulu, 2016).

After the 2008 crisis, researchers gradually incorporated financial shocks into independent equilibrium models as independent factors affecting economic cycle volatility, such as: Christiano, et al. (2010) by introducing financial friction into the currency equilibrium model. The discovery of financial shocks is an important cause of economic fluctuations in the US and the Eurozone; studies by Jermann and Quadrini (2012) and Chfistiano, et al. (2013) also believe that shocks from the financial sector do have a very strong important influence. In recent years, Chinese scholars' research mainly focused on the relationship between financial cycle and economic cycle. They found that China's financial cycle has the characteristics of "asymmetry", and most of the financial cycle precedes the fluctuation of the real economy (Deng Chuanghe Xu Man, 2014; Ma Yong et al., 2015; 2016). Overall, there is a close relationship between China's financial cycle and the real economic cycle, and China is already in the superposition of the financial cycle contraction and the economic cycle down (Yi Nan and Zhang Bin, 2016; Fan Xiaoyun et al., 2017). However, although the impact

of the financial cycle on the economic cycle is so important, there is still controversy in the academic community as to whether the design of monetary policy rules needs to consider the impact of the financial cycle. The scholars who support monetary policy should consider financial stability believe that the central bank must also pay attention to financial stability factors when the short-term inflation level is effectively controlled (Eichengreen et al., 2011; Teranishi, 2012; Albulescu et al., 2013) Scholars who oppose monetary policy should consider financial stability. It is impossible to maintain financial stability and achieve sustainable economic development. Trying to achieve financial stability through monetary policy is not necessarily effective (Smets, 2013; Ueda and Valencia, 2014)). In this regard, some Chinese scholars have conducted in-depth research on the McCallum rules from the monetary policy rules, and some scholars emphasize that the rules of monetary policy must fully consider the impact of the financial cycle from the perspective of Taylor's rules. He Xianghua, 2008; Wu Jilin and Huang Chen, 2013; Ma Yong et al., 2017).

Throughout the relevant literature, although empirical research on the financial cycle and monetary policy has existed in large numbers, it is obviously insufficient to study the endogenous relationship between the financial cycle and monetary policy under a unified framework. Therefore, the following arrangements are as follows: First, construct China's financial cycle index, use GMM to estimate the interaction mechanism between financial cycle and monetary policy statically. Secondly, use VAR model and impulse response function to dynamically observe financial cycle fluctuations and monetary policy changes. The trend relationship; finally, from the perspective of the linkage between the financial cycle and the real economy, put forward the countermeasures and suggestions for the optimization of China's monetary policy.

2. Second, The Interaction Mechanism between the Financial Cycle and Monetary Policy

2.1 Construction of China's Financial Cycle Index

Based on the existing literature and some characteristics of the real economy and financial system, this paper refers to the research of Ma Yong et al. (2016), and selects the following eight variables as the basic indicators of the financial cycle index, and makes a simple explanation: (1) Real estate prices, representing the growth rate of 70 large and medium-sized cities, represent this variable. (2) Stock price, using the quarterly growth rate of the A-share index as a representative variable for measuring the stock price. (3) Bank spread, the difference between the benchmark interest rate of the loan and the 7-day interest rate of the interbank borrowing is selected as the representative variable. (4) Financial leverage ratio, represented by “borrowed funds/total investment” in fixed asset investment. (5) Long-term risk premium, the difference between the 10-year government bond interest rate and the bank's 7-day interbank offered rate is taken as a representative variable. (6) Capital flows, This paper uses “capital and financial project balances/GDP” to represent capital liquidity. (7) Money supply. The year-on-year growth rate of M2 is selected to represent the money supply. (8) The scale of social financing, this paper uses the quarterly growth rate of social financing scale to express this variable.

Technically, there are significant differences in the above eight representative variables in terms of data types and units of measure. In order to make it technically operable, the related variables are standardized by the Min-Max method with reference to existing research practices:

$$K_{it}^{'} = 100 \times \frac{K_{it} - \min(K_i)}{\max(K_i) - \min(K_i)} \tag{1}$$

Where, Kit is the original value of the variable i in the t-th period; min (Ki) and max (Ki) respectively represent the minimum and maximum values of the variable i in the entire sample time span; K'it represents the variable i in the t-th phase Standardized values after dimensionless conversion. It should be pointed out that after standardization, the range of data values can be

stabilized at [0, 100], which is conducive to further investigation and processing, and the upward and downward fluctuations of the values correspond to the increase and decrease of the prosperity of the financial cycle.

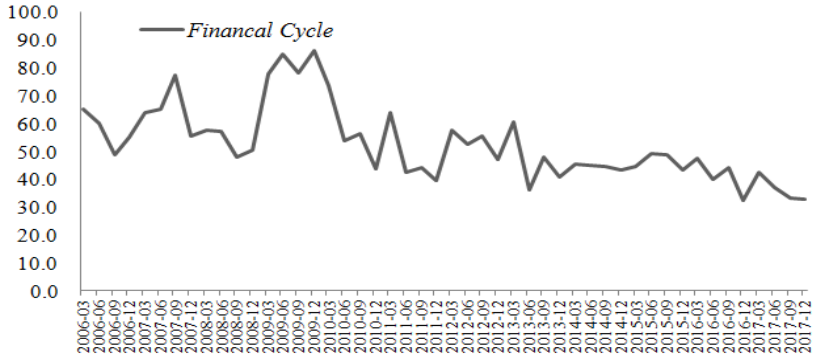

Figure 1. Basic trends of China's financial cycle from 2006 to 2017

After that, we integrate the standardized financial variables into a comprehensive financial cycle indicator by means of simple arithmetic averaging, namely the financial cycle index (denoted as FC). The fluctuations of the financial cycle index are shown in Figure 1, which showed an upward trend from 2006 to 2009. This was mainly due to the extremely prosperous capital market before the global financial crisis, and the short-term after the financial crisis broke out due to the introduction of a stable financial system. The measures were timely, and the impact on China was relatively small. After 2009, the impact of the financial crisis on the financial system has gradually emerged, and the problems of China's economy facing transformation and upgrading have become increasingly prominent. Therefore, the financial cycle will fluctuate downward from 2010 to 2017. In general, the financial cycle index basically conforms to the trend of China's economic development and the fluctuation of the financial cycle, indicating that the financial cycle index is generally effective.

Based on the construction of a comprehensive financial cycle index, we have drawn a trend chart of China's financial cycle and monetary policy changes in 2006-2017 (see Figure 2). It can be seen from Figure 2 that the financial cycle and monetary policy show a clear synchronization trend, and compared with monetary policy, the feedback of financial cycle fluctuations has a certain lag, which is to study the interaction between financial cycle and monetary policy. The mechanism provides a practical basis.

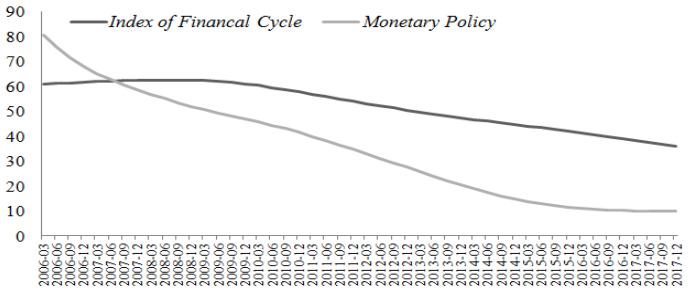

Figure 2. Trends in China's Financial Cycle and Monetary Policy In 2006-2017

Note: Both curves in the graph are periodic trends after seasonal adjustment and HP filtering.

2.2 Analysis of the Impact of the Financial Cycle on Monetary Policy

Based on the actual situation in China, this section will rebuild the general McCallum rule. The McCallum rule (McCallum, 1993) is:

$$\Delta b_t = (\Delta y_t^f + \Delta p_t^*) - \Delta \bar{v}_t + \lambda (X_{t-1}^* - X_{t-1}) \quad (2)$$

Among them: the central bank's base money supply growth rate; the potential growth rate of the economy under full employment conditions; the inflation target value set by the central bank; the average growth rate of the base currency circulation rate in the first 16 quarters; The logarithm of the target nominal GDP; Xt-1 represents the logarithm of the actual nominal GDP of the previous period; λ represents the response coefficient of the base currency change to the nominal GDP gap, which satisfies the following two conditions: First, the value of λ should be greater than 0 and its size is sufficient to provide feedback on the nominal GDP gap; second, the value of λ should be less than 1, eliminating the dynamic instability problem that may occur in the growth rate of the base currency. Therefore, combining the Chinese real and the proxy symbols of the variables in this paper, we construct the McCallum rule formula as follows:

$$M_t = \beta_1 Y_t + \beta_2 V_t + \beta_3 gap_{t-1} + \beta_4 FC_t + \varepsilon_t^M \tag{3}$$

Among them, suppose the Chinese monetary authority's expected inflation target value is 0; and replace it with the Mt symbol; replace it with the symbol Yt; replace it with Vt; replace it with gapt-1. B1, β2, β3, and β4 respectively represent the reaction coefficients of the corresponding variables; indicating the monetary policy shock.

This paper selects China's 2006-2017 quarterly data for regression, all data from the China Economic Database and Wind Database. In the selection of estimation methods, this paper uses the generalized estimate (GMM) method to regress the following equations, and effectively solves the endogenous correlation between explanatory variables by using instrumental variables to ensure the authenticity and reliability of the estimation results. . In the data processing, before the data is brought into the model, the sum and the parts are smoothed by the HP filtering method to obtain the respective periodic curves.

Table 1. GMM estimates for the McCallum rule

coefficient	Coefficient estimation (t value)	Adjusted R2	J statistic (p value)
β1	1.611***(58.809)	0.997	10.179 (0.808)
β2	-0.006***(-3.500)		
β3	0.003***(3.890)		
β4	0.051***(17.220)		

It can be seen from Table 1 that the regression coefficients of each variable show significant characteristics, and the adjusted R2 reaches 0.997, indicating that the estimated model is generally effective. It is worth noting that the formulation of the central bank's monetary policy is mainly influenced by the economic cycle, and the monetary policy reacts weakly to the average growth rate of the base currency circulation. This is mainly because in a country with stable economic development and financial system, the speed of the base currency circulation is difficult to fluctuate sharply in the short term. In addition, unlike McCallum's estimated value of λ, China's monetary policy does not respond strongly to the GDP gap, mainly because China's actual employment rate is similar to the full employment rate and the GDP gap is small.

2.3 The Role of Monetary Policy in the Financial Cycle

Combined with the aforementioned construction of China's financial cycle index, this paper constructs the following financial cycle equation:

$$FC_t = \alpha_1 FC_{t-1} + \alpha_2 M_t + \alpha_3 Y_t + \varepsilon_t^{FC} \tag{4}$$

Among them: the financial cycle index; the growth rate of the base currency; and the potential GDP growth rate to represent the economic cycle. In terms of coefficients, 1, 2, and 3 are the reaction coefficients of the corresponding variables, respectively, and the random error term indicates the

impact of other factors on the financial cycle. According to Borio's (2014) argument, the financial cycle is highly persistent, and there is a trend of cyclical fluctuations with the economic cycle, so the estimates for 1 and 3 are expected to be positive. At the same time, in general, the corresponding increase in demand for the base currency makes the financial cycle enter the upward phase, so the expected value of estimate 3 is also positive.

It can be seen from Table 5 that all regression coefficients are statistically significant, and the adjusted R2 is infinitely close to 1, and the estimated model is generally effective. On the symbol, 1 and 3 are consistent with the theoretical expectation, but the actual sign of 2 is opposite to the expected sign. This shows that China's monetary policy has a strong counter-cyclicality in the short term. From the reality of China, the central bank's currency regulation is also consistent with the changes reflected in the model, which also proves the characteristics of China's monetary policy countercyclical. And the estimated value of 1 reaches 1.021, indicating that the financial cycle has short-term continuity.

Table 2. GMM estimation results of financial cycle equation

coefficient	Coefficient estimation (t value)	Adjusted R2	J statistic (p value)
α1	1.021***(9.565)	1.000	29.000(0.518)
α2	-0.557***(-4.051)		
α3	0.923***(2.929)		

Note: *, **, and *** indicate significant levels of confidence at 10%, 5%, and 1%, respectively.

It is not difficult to see from the above static analysis that there is a certain degree of asymmetry in the interaction between the financial cycle and monetary policy, that is, the effect of monetary policy on the financial cycle is different from the reaction of the financial cycle to monetary policy. Therefore, the VAR model will be constructed below to test the above conclusions through dynamic analysis of the interaction between financial cycles and monetary policy.

3. Analysis of the interaction between the financial cycle and the "asymmetry" of monetary policy

Considering that the monetary policy does not respond strongly to the average growth rate of the base currency circulation rate and the GDP gap, we will eliminate these two variables in the extended McCallum rule model, considering only the economic cycle, the financial cycle may be related to monetary policy. The impact. Establish the following equation:

$$M_t = \delta_1 Y_t + \delta_2 FC_t + \varepsilon_t^M \tag{5}$$

Among them, δ2 is the reaction coefficient of the monetary policy base currency growth rate to the financial cycle fluctuation, which indicates the degree to which the central bank attaches importance to the financial cycle fluctuation when formulating the monetary policy. The other variables in the formula are consistent with the previous meanings. This section will establish an unconstrained vector autoregressive (VAR) model. In the lag period selection, according to the AIC and SC information criteria, the four phases of lag are the optimal lag period of the model. It can be seen from Table 3 that all variables are stable in the unit root test, and the results show that there is no unit root. In the cointegration test, all variables fall within the unit circle, indicating that the VAR model has stability. Figure 3 shows the impulse response results for each variable in the VAR model.

Table 3 .Unit Root Test

variable	Difference number	(C,T,K)	DW value	ADF value	5% threshold	1% threshold	conclusion
M_t	0	(n,n,3)	2.26	-2.48	-1.95	-2.62	I(0)***
Y_t	0	(n,n,4)	1.82	-2.91	-1.95	-2.62	I(0)***
FC_t	0	(n,n,4)	2.12	-2.59	-1.95	-2.62	I(0)***

Note: (C, T, K) indicates whether the ADF test contains a constant term, a time trend term, and a lag period;

*** indicates that the ADF stationarity test passes at a significant level of 1% when the variables are not differential.

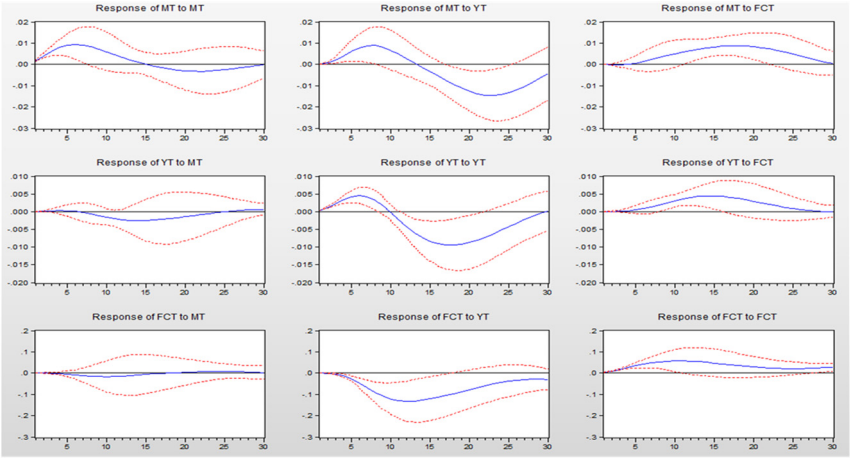

Figure 3. Impulse Response Function of Var Model

Based on the impulse response function, we use Granger causality test to further explore the interaction and conduction mechanism between variables, as shown in Table 4. The Granger causality test of each variable is significant in 1% confidence, indicating that there is a two-way positive causal relationship between monetary policy, economic cycle and financial cycle. In general, the financial cycle plays a crucial role in the VAR model system consisting of three variables: monetary policy, economic cycle and financial cycle.

Table 4. Results of the Granger causality test

	Monetary Policy	**economic cycle**	**Financial cycle**
Monetary policy (lag)	—	5.741*** (0.001)	4.739*** (0.004)
Economic cycle (lag)	6.513*** (0.001)	—	16.627*** (0.000)
Financial cycle (lag)	4.144*** (0.008)	12.974*** (0.000)	—

Note: The value in parentheses is the p value; *** indicates that the 1% confidence level is significant.

Furthermore, based on the determination of the relationship between financial cycle, economic cycle and monetary policy, we analyze the degree of impact contribution between different variables by variance decomposition. The specific results are shown in Table 5. For the sake of analysis, we divide each variable into short-term (1-4 periods), medium-term (4-16 periods), and long-term (16-32 periods), and based on this analysis. As shown in Figure 5, in the short term, the financial cycle, monetary policy and economic cycle are largely affected by their own, and the contribution of variance decomposition is above 75%; in the medium term, the financial cycle and monetary policy The interaction has a certain "asymmetry". In the eighth period, the impact of the financial cycle on monetary policy is only 1.16%, while the impact of monetary policy on the financial cycle reaches 23.51%, but when it continues to the 16th, the financial cycle The interaction with monetary policy is maintained at 20%-25%; in the long run, the impact of the economic cycle on the financial cycle, monetary policy and itself is more than 40%, which is the most important factor. The contribution rate of the interaction between the financial cycle and monetary policy is maintained at around 20%.

Table 5. Variance decomposition of VAR model

	period	Shock		
		Financial cycle	**Monetary policy**	**Economic cycle**
Financial cycle	1	98.979	0.812	0.208
	2	95.826	2.162	2.012
	4	76.225	9.121	14.654
	8	30.453	23.551	45.995
	16	15.916	24.042	60.042
	32	16.195	21.741	62.064
Monetary policy	1	0.000	100.000	0.000
	2	0.073	98.360	1.567
	4	0.030	90.814	9.156
	8	1.759	76.614	21.627
	16	21.488	57.946	20.567
	32	19.526	40.087	40.387
Economic cycle	1	0.000	19.182	80.818
	2	0.055	22.829	77.106
	4	0.398	24.206	75.396
	8	6.779	17.436	75.785
	16	20.016	32.908	47.076
	32	13.804	31.015	55.180

3. Conclusions and Policy Implications

Since the global financial crisis in 2008, the neglect of financial factors by traditional macroeconomics and the serious consequences brought about by it have been deeply examined, and the idea of financial services in the real economy has gradually reached a consensus. In this context, this paper has carried out preliminary theoretical and empirical research on the relationship between financial cycle and monetary policy by constructing China's financial cycle index and expanding the McCallum rule, and has drawn the following three conclusions: First, the use of the base currency growth rate as a representative variable of monetary policy, the construction of the financial cycle equation is established, and monetary policy has a strong counter-cyclical in the short term, and the financial cycle changes in the long run; the second is based on the McCallum rule. China's monetary policy is affected by the financial cycle and economic cycle fluctuations. Third, the monetary policy and the financial cycle constructed by McCallum's rules have an interactive influence mechanism, and their interaction effects are more obvious in a certain period of time. Asymmetry feature.

Starting from the elimination of the external impact of the financial cycle, the analysis conclusions of this paper provide the following three aspects. First, in the reform of financial institutions, the central bank should appropriately transform its functions, appropriately implement policy interventions in financial markets, grasp the best timing of policy regulation, and keep a close eye on the lagging effects of the financial cycle, thereby maintaining the overall stability of the financial system; Second, in the construction of financial markets, cultivate and strengthen a variety of market players, reduce the impact of the financial cycle on the market, continuously improve the financial product innovation mechanism, and resolve the impact from the root causes of the financial market incentive mechanism; third, in the formulation of monetary policy, the central Banks should no longer consider the stability of a single real economy, but also incorporate factors that cause financial volatility into the formulation of monetary policy, and cooperate with other financial regulatory agencies to achieve bistable stability of the real economy and financial system.

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