

Research on the phase characteristics and driving mechanism of Chinese business cycle fluctuation

—Empirical analysis based on MS-TVTP model*

Zhang Tongbin, Gao Tiemei**

Based on the Keynesian IS curve and MS-TVTP model, this paper studies the phase operating characteristics and driving mechanism of Chinese business growth cycle fluctuation by specifying output gap series through coincident composite index and estimating expectation variable through state space model. The results are that the influences of output gap expectation on business growth cycle are positive and the effects of real interest rate are negative. Both of them exert asymmetric features in different regimes. The estimation results of smoothed probability and transition probability show that the financial and investment composite indexes are the significant driving factors of business growth cycle switch among different regimes. Compared to promoting economic growth, the monetary policy plays a more effective role in decelerating the growth speed. Although the speed of investment's influence during the economic downturn phase is rapid, the lag of its effects is lengthened due to the investment cycle and capital formation. Releasing reform dividend through stabilizing expectation and reducing the fluctuation of business cycle by employing the macro prudent government are important ways to maintain the steady growth of Chinese economy.

Keywords: growth cycle, output gap, driving effect, MS-TVTP model

1. Issues stressed and literature review

After the international financial crisis in 2008, Chinese government implemented a series of economic stimulus plan to stabilize economic growth. After the fast recovery in 2009, the economy fell sharply again since the beginning of the second quarter of 2010 and the signs of stabilization and recovery did not appear until the second quarter of 2012. Compared with the operating condition of the previous economic cycle,

* This paper is the stage research results of a national nature science fund project: “research on the inner driving mechanism of China high tech industry R&D investment on technology innovation: structure change, two sides and policy effect (71303035)”; Talents support plan in Liaoning Province higher education “research on effect mechanism of high technology industries in R&D investment on technological progress”.

** Zhang Tongbing (email: tongbinzhang@126.com), Lecturer, PH.D. of Economics, School of Mathematics and Quantitative Economics, Center for Econometric Analysis and Forecasting, Dongbei University of Finance and Economics, China; Gao Tiemei (email: gaotiemei@163.com), Professor and PhD supervisor; School of Mathematics and Quantitative Economics, Dongbei University of Finance and Economics, China.

the volatility of Chinese economic cycle between 2008 and 2012 was significantly enhanced with more significant asymmetry. The increasing volatility of economic cycle is mainly due to the structural changes in economic operation mechanism and the increasing uncertainty of economic operation. From the third quarter in 2012 to the fourth quarter in 2013, the growth rate of China's gross domestic product has consecutively fluctuated from 7.4% to 8%. The characteristic of steady slowdown in economic growth is revealing gradually.

China has already entered the crucial period of raising factor costs, structure transformation with decreasing economic growth. "Steady growth, adjusting structure, promoting reform" will become the theme of the next period of economical operation while decreasing the magnitude of economic cycle fluctuation is the reflection of economic stability. Therefore, studies on the typical features of economic cycle fluctuation in China, especially on the differential operation between expansion and contraction phase, can provide the realistic basis to familiarizing with the economic cycle fluctuation as well as stabilizing economic fluctuation. In addition, researches on the driving factor of economic cycle fluctuation can provide important theoretical reference for China's economic progress while maintaining stability and scientific development.

There are three empirical research methods for economic cycle: boom analysis method, time series analysis and investigation method. Among them, the Markov Regime Switching Model proposed by Hamilton, which refers to MS, provides an effective method for identifying the characteristics of economic cycle and has been widely used. Scholars combined the MS-TVTP model with the Bayesian model and state space model, classified the economic cycle in different stages (regime), studied the conversion feature of different district and predicted economic trend (McCulloch, Tsay, 1994; Kim, 1999; Krolzig, 2001; Wang, 2007). Researches on the characteristics of economic cycle stage are focus on the asymmetric (Liu, Fan, 2001; Liu, 2006) and continuity (Durland and McCurdy, 1994; Plessis, 2006). Most scholars' researches are based on the two areas: expansion and contraction, rapid growth and slow growth. It needs to be pointed out that the traditional MS-TVTP model assumes the conversion probability of each state are same, which has a big gap with the realistic situation. Therefore, Filardo (1994) proposed the Markov Regime Switching Model with Time-Varying Transition Probabilities. In the model of MS-TVTP, the different variables (usually leading indicators) are regarded as the factors affecting the probability of conversion, which is used to calculate the transition probability value between different areas in each period and to study the dynamic conversion feature of economic cycle comprehensively (Layton, 1998; Harding and Pagon, 2002; Castillo and Humala, 2012). The influence factor variables of transition probability can be regarded as the driving factor of economic cycle. The driving mechanism of economic cycle fluctuation can be obtained through the further analysis of influence factors of transition probability.

There are other representative researches on the driving factors of economic cycle fluctuation. Liu and Liu (2005) used the component decomposition method and draw a conclusion that economic cycle fluctuation is correlated to China's monetary volatility is closely. They also suppose that the decreasing investment volatility is the

important reason of decreased output volatility. Simone and Clarke (2007) analyzed the continuing features of positive impact and temporary characteristics of negative impact on the basis of revised “traction model” proposed by Friedman (1993). From the perspective of supply and demand, Wang and Wang (2011) based on the new Keynesian model to analyze the function of preference shocks, government spending shocks and interest rate shocks on output variables. They supposed that the supply shocks on China’s economic fluctuations are larger. From the perspective of industry, Ren and Chen (2012) supposed that the economic boom could be conducted along the industrial chain from the needs of downstream to that of upstream, which leads to the phenomenon of “economic moving round”. In terms of types of economic cycle fluctuations, foreign scholars generally study the classical cyclical fluctuations while domestic scholars mainly study the growth rate cycle fluctuations with rare researches on growth cycle. In the present situation with stable economic growth and decreasing growth rate, the style of growth cycle is more in line with the current situation of Chinese economy. Based on the current literature, this paper studies the Chinese economic growth cycle and expands in the following three aspects: (1) Based on the new Keynesian IS curve and MS-TVTP model, economic growth cycle fluctuation model with a regime switching and dynamic conversion is constructed. (2) With the coincident composite index and state space model method, the variable of output gap and expectation are accurately estimated. (3) Based on the econometric analysis method, the conversion probability influence factors and lag order number are accurately selected to study the driving mechanism of economic cycle fluctuation.

2. The state transition of economic cycle fluctuation and construction of driving mechanism model

Based on the traditional Keynes wave theory, when the commodity market is equilibrium, for the total demand, the IS curve can be expressed as the formula (1),

$$y_t = \beta_0 - \beta_2 i_t \quad (1)$$

where y_t is the output gap, i_t is the real interest rate and β_0, β_2 is the parameter. On the basis of considering the cross term utility function and dynamic budget constraints, McCallum and Nelson (1999), Fuhrer (2000) derived the additional expected IS curve, as follows,

$$y_t = \beta_0 + \beta_1 E_t y_{t+1} - \beta_2 (i_t - E_t \pi_{t+1}) \quad (2)$$

where E_t is the expectation operator, $E_t y_{t+1}$, $E_t \pi_{t+1}$ is the expectation of output gap and inflation in the period of $t+1$. The difference between nominal interest rate i and inflation ($E_t \pi_{t+1}$) is the actual Ex-ante interest rate, β_1 is the parameter. Equation 2 means that the representative family achieves the best consumer decision-making with the budget constraints and in the hypothesis of rational expectation, which shows

the forward-looking characteristics. i_t^* represents the real interest of Ex-ante ($i_t - E_t \pi_{t+1}$). Adding the random disturbance term u_t , the IS curve can be described as the econometric model (3),

$$y_t = \beta_0 + \beta_1 E_t y_{t+1} - \beta_2 i_t^* + u_t \quad (3)$$

In different stages of economic expansion and contraction, the effect of output gap expectation and real interest rate Ex-ante on y_t has asymmetric effect. $\beta_0 - \beta_2$ in the model 3 is changed with the state. Therefore, this paper introduces the IS model (4) that includes the transfer process of the system,

$$y_t = \beta_0(S_t) + \beta_1(S_t) E_t y_{t+1} - \beta_2(S_t) i_t^* + u_t \quad (4)$$

Where S_t is the state variable. Assuming that the values of 1, 2 and 3 represent the regime of high economic growth, moderate economic growth and low economic growth respectively. In addition, the variance of u_t (σ^2) is also the state variable in this paper.

The probability density function of y_t is assumed to be normal distribution, and the probability density function in the situation of i shows as follows,

$$f(y_t | S_t = i) = \frac{1}{\sqrt{2\pi\sigma_i^2}} \exp\left(-\frac{(y_t - \mu_i)^2}{2\sigma_i^2}\right) \quad (5)$$

where $i=1,2,3$, $t=1,2,\dots,T$. μ_i , σ_i^2 are the mean of y_t , the variance of u_t respectively in the situation of i . According to the equation (5), the maximum likelihood function is constructed as follows,

$$\ln L = \sum_{t=1}^T \ln \sum_{i=1}^3 f(y_t | S_t = i) \Pr(S_t = i | Y_t) \quad (6)$$

$$p_{S_{it}} = \Pr(S_t = i | Y_T) \quad (7)$$

where Y_t is the sample information set of the period 1, 2...t. $Y_t = \{y_1, y_2, \dots, y_t, E_1 y_2, E_2 y_3, \dots, E_t y_{t+1}, i_1^*, i_2^*, \dots, i_t^*\}$, $\Pr(S_t = i | Y_t)$ is the probability of y_t in the time of t and in the situation of i based on Y_T .

Compared with the filtering probability, the smoothing probability is smoother. In addition, in the traditional MS model, the transition probability of P_{ij} will not change with state, which is fixed, as shown in model (8).

$$p_{ij} = \Pr(S_t = i | S_{t-1} = j) \quad (8)$$

In the model of MS-TVTP, p_{ij} varies with time t . It is a function of x_{ijt} .

$$p_{ij,t} = \Pr(S_t = i | S_{t-1} = j, x_{ij,t}), \quad t = 1, 2, \dots, T \quad (9)$$

In which x_{ijt} is the variable affecting the factor of transition probability $p_{ij,t}$. In this paper, we assume the generating function of transition probability is:

$$p_{ij,t} = \Phi(x_{ij,t}, b_{ij}) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{bx_{ij,t}} \exp\left(-\frac{z^2}{2}\right) dz, \quad t = 1, 2, \dots, T \quad (10)$$

Where $\Phi(\cdot)$ is the standard normal distribution function and b_{ij} is the parameter to be estimated. By analyzing the effect of $x_{ij,t}$ on $p_{ij,t}$, we can study the driving mechanism of economic cycle fluctuation in each state.

3. The estimation of output gap, output expectation and the influence factor on transition probability

3.1. The measurement of output gap

At present, scholars mainly use the trend decomposition method, production function method, structural vector autoregressive model and unobservable component method to estimate the output gap. Output is only one aspect of economic activities. Other economic activities that form and reflect the macroeconomic cycle and fluctuation include related finance, import and export, investment. Therefore, this paper selects the indicators of various fields consistent with macro economic fluctuation and calculates the comprehensive output gap in the macro economic sense.

In this paper, more than 200 monthly macroeconomic indicators related to Chinese economic cycle fluctuations are collected totally. We define them as $Y_{i,t}$, $i=1, 2, \dots, N$; $t=1, 2, \dots, T$, where N is the number of indicators and T is the length of the period. We calculate the consumer price index, retail price index, into (out) export commodity price index, price indices of investment in fixed assets, industrial product factory price index etc¹ basing on the price in 2005. The collected named indexes are deflated and seasonal adjusted. The actual variable without the price factor are recorded as $Y_{i,t}^{SA}$. Then H-P filtering method is used to decompose each index $Y_{i,t}^{SA}$ into the trend factor ($Y_{i,t}^T$) and the loop element ($Y_{i,t}^C$). The ratio of the cyclic elements and trend elements is the “notch” sequence of each index, as shown in the formula (11).

$$y_{i,t} = \frac{Y_{i,t}^{SA} - Y_{i,t}^T}{Y_{i,t}^T} = \frac{Y_{i,t}^C}{Y_{i,t}^T}, t = 1, 2, \dots, T \quad (11)$$

Based on the calculated gap sequences and with the industrial added value gap sequence as a benchmark, this paper screens out the indexes that are consistent or synchronous with benchmark index by the time difference correlation analysis method, peak and valley corresponding method. These selected indexes constitute

¹ If there is no special instruction, the data in this paper are from the macro monthly database of China economic information network statistics database, <http://db.cei.gov.cn>. The price index is based on the annual average value of 100. The calculated method can be obtained from the authors.

a group of consistent indicators of Chinese economic growth cycle, as shown in table1.¹

Table 1

The coincidence index group of macro economic growth fluctuation

Index style	Index	Lag of month	Correlation
Coincidence index	Added value of industrial enterprises	0	1.00
	Output of power generation	0	0.79
	Government revenue	-1	0.63
	Import	-1	0.53

Finally, the synthetic index method from the Commerce Department of the United States is used to synthesis the index and a coincident synthesis index is obtained, denoted by y_t . The coincident synthesis index is calculated with the time interval from January 1996 to November 2013 with the value of 100 as the average in 2005. From table1, the coincident synthesis index of growth cycle contains industrial production, national finance, import and other related index gap, which is similar with the output gap index that is calculated with GDP. It covers many aspects of economic activity, which is a comprehensive output gap in the macro economic sense and reflects the situation of economic growth cycle fluctuation. In addition, the consistent synthesis index is calculated with the monthly data, which can be more accurate to analyze and determine the fluctuation characteristics of economic growth cycle than with the quarterly GDP sequence. For the sake of convenience and simplicity, the integrated output gap y_t calculated in the following parts of the paper is called the consistent synthesis index.

3.2. The inflation expectation ($E_t \pi_{t+1}$) and the output gap expectation ($E_t y_{t+1}$)

The expectation can be mainly classified into adaptive expectation and rational expectation. In the estimation of rational expectation, with the inflation as the example, three methods are mainly used. First, inflation in the next phase is instead of the inflation expectation, which means $E_t \pi_{t+1} = \pi_{t+1}$. Second, estimation is based on the survey data, such as the consumer survey, survey of economists expectation. Third is based on the econometric methods, such as regression method, vector auto regression model and state space model. Among them, the state space model is the effective method to estimate the unobservable variable. This paper estimates the inflation expectation and output gap by the state space model.

Based on the relative economic theory about inflation, this paper introduces the new Keynes Phillips curve as the measurement equation and regards the $E_t \pi_{t+1}$ as the state variable. We assume that it satisfy the first-order autoregressive form and we set the state space model:

¹ In table 1, the sign of minus refers to advanced time. The index the are leading for 2 periods or lagging for 2 periods can be the coincidence index.

Measurement equation:

$$\pi_t = \gamma_0 + \gamma_1 \pi_{t-1} + \gamma_2 E_t \pi_{t+1} + \gamma_3 y_t + \xi_t \quad (12)$$

State equation:

$$E_t \pi_{t+1} = \theta_0 + \theta_1 E_{t-1} \pi_t + \varepsilon_t \quad (13)$$

π_t is the inflation rate calculated with the consumer price index (the value of the same month in last year is 100). y_t is the integrated output gap, which also refers to the coincident synthesis index of growth cycle fluctuation. Setting the initial value of estimated parameters, state variables, random perturbation variance as well as covariance, the model (12) and (13) is estimated with the method of Kalman filter. The sequence of state variable and the value of $E_t \pi_{t+1}$ can be obtained.

After estimating the inflation expectation, this paper replaces the weighted average interest rate of interbank lending with the nominal interest rate. The real i^* can be obtained through i minus $E_t \pi_{t+1}$. Only the variable of output gap expectation in the model (3) is unknown. Therefore, the modified model (3) can be set as the measurement equation. The $E_t y_{t+1}$ is the state variable and the state equation can be set as follows,

Measurement equation:

$$y_t = \beta_0 + \alpha_1 y_{t-1} + \alpha_2 y_{t-2} + \beta_1 E_t y_{t+1} - \beta_2 i_t^* + u_t \quad (14)$$

State equation:

$$E_t y_{t+1} = \lambda_0 + \lambda_1 E_{t-1} y_t + v_t \quad (15)$$

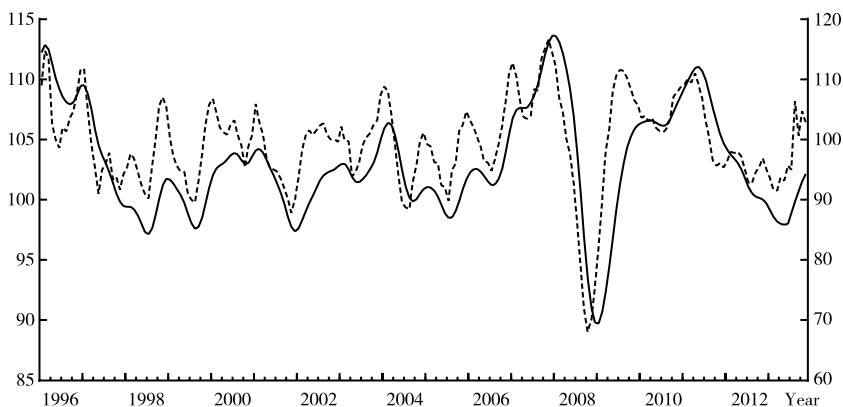


Figure 1. Output gap (solid line, left axis) and the output gap expectation (dashed line, right axis)

Similar with the estimation of the model (12) and (13), the state sequence $E_t y_{t+1}$ can be estimated with the method of Kalman filtering to estimate the model (14) and (15).

The comprehensive output gap series y_t and the expectation series $E_t y_{t+1}$ calculated in this paper is shown in figure 1.

3.3. The selection of the transition probability influence factors

Simpson et al (2001) and other scholars use the federal funds rate, broad money supply M2, the new building permits as the influence factor of transition probability. The above indicators are basically leading indicators. Layton and Smith (2007) considered that the leading synthesized index obtained through the leading synthesized indicator has better leading features and economic significance. Therefore, based on the above research, this paper selects 8 groups of leading index from more than 300 macroeconomic indicators¹ with the industrial added-value gap series as the benchmark, which is similar to the selection and synthesis of output gap.

Table 2

The leading index group of macro economic growth cycle fluctuation

Index style	Group	Index	Lag of month	Correlation
Leading index	Financial	Saving deposits of financial institutions	-12	0.65
		Financial institutions lending	-8	0.30
		Narrow money supply (M1)	-5	0.62
	Investment	Fixed assets investment and construction projects	-12	0.40
		Investment in fixed assets of local projects	-11	0.33
		Source of investment in fixed assets loans from China	-8	0.57
		Production of cement	-3	0.64
	Other	Production of cars	-3	0.56

Investment and finance are the two important aspects that are leading to the economic fluctuation. Taking the money supply and the new investment in fixed assets as given, this paper describes the driving mechanism and state transition of the economic cycle fluctuation. If an increase in the money supply, the money supply curve would shift to the right, interest rates would decline, the cost of investment would decrease and the amount of investment would increase, which would lead to the output increase through the investment multiplier and to the economic cycle fluctuation transition from the lower growth to the higher growth. Investment growth, which refers to the driving effect of the new fixed asset investment on the economic cycle fluctuation, is directly implemented through the investment demand to output decision. Compared to the money supply, the transmission of investment on economic cycle fluctuation is more direct and quicker.

¹ The screening indicators are all treated the same with formula (11). Gap sequence is calculated by the price adjustment, seasonal adjustment.

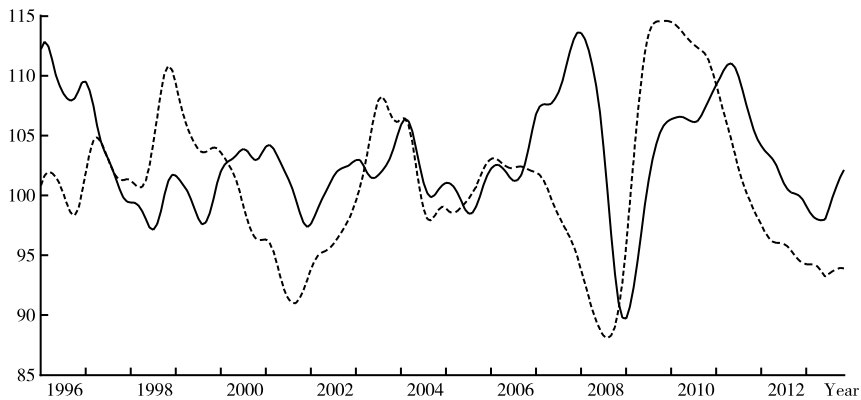


Figure 2. Coincidence composite index y_t (solid line) and x_t^L (dashed line)

Similar with the synthesis method of the indexes in table 1, all the indexes in table 2 are synthesized in the leading synthetic index in the growth cycle fluctuation, which is denoted as x_t^L . Regarding x_t^L as the influence factor of conversion probability in equation (9), the model of MS-TVTP could be estimated. In addition, in comparing the peak and valley of coincident composite index with that of leading synthetic index, of the latter has a better leading characteristic with about 7 leading months.

4. Analysis of the operation characteristics in the economic cycle stages by MS-TVTP model

4.1. Estimation of MS-TVTP model and characteristic description of economic cycle fluctuation

On the basis of the coincident composite index of growth cycle fluctuation (y_t), expectation estimation of output gap ($E_t y_{t+1}$) and the real interest rates (i^*) in the third part, this paper first uses the 12 lagged variables of the leading synthetic index (x_t^L) as the transition variables for the maximum likelihood estimate. The regression model of the equation (4), the smooth probability (7) and the estimation model of transition probability (9) are as follows.

$$y_t = \hat{\beta}_0(S_t) + \hat{\beta}_1(S_t)E_t y_{t+1} + \hat{\beta}_2(S_t)i_t^* + \hat{u}_t \quad (16)$$

$$\hat{p}_{s_{it}} = \Pr(S_t = i \mid Y_T) \quad (17)$$

$$\hat{p}_{ij,t} = \Pr(S_t = i \mid S_{t-1} = j, x_{t-k}^L), k = 1, 2, \dots, 12 \quad (18)$$

In addition to the estimation of the parameters, the estimated results also include the average duration, conditional variance, etc., as shown in table 3.

Table 3

The estimation of MS-TVTP and the description of economic cycle fluctuation

	Regime 1 ($S_t=1$) (high growth)	Regime 2 ($S_t=2$) (moderate growth)	Regime 3 ($S_t=3$) (low growth)
$\hat{\beta}_0(S_t)$	106.336*** (0.00)	101.315*** (0.00)	97.075*** (0.00)
Coefficient estimation $\hat{\beta}_1(S_t)$	0.617*** (0.00)	0.509*** (0.00)	0.498*** (0.00)
$\hat{\beta}_2(S_t)$	-0.015*** (0.00)	-0.083*** (0.00)	0.792*** (0.00)
Average duration	11.93	18.56	1.11
Conditional variance	2.929	2.065	3.501
Frequency	78	117	16

Note: the value in the bracket is p. “***” represents a significant level at 1%.

The estimated coefficients of output expectation variables show that expectation has positive effect on the economic growth and also has different significant asymmetry in different regions. Among them, region 1 with the high economic growth has the greatest role while region 3 with the low economic growth has the minimum effect. That stabilizing the expectation and releasing reform dividends have no longer relied on the short-term stimulus policies has become an important part of Chinese economic growth. In addition, from table 3, the estimation coefficients of the real interest rate show that the interest rate in region 1 and region 2 has significant negative effect on coincident composite index, which is consistent with the economic theory of the monetary policy transmission mechanism.

4.2. The characteristic analysis of economic cycle fluctuation stages

From the estimation results of table 3, the estimation of output gap expectation in region 1 with the high economic growth is 0.617. During this period, the expectation of economic growth will form a false demand in a certain extent, which leads to the blind expansion of investment and excessive consumption. Then it would have a significant effect on economy through the investment multiplier and the consumption multiplier, which will trigger a new round of investment and consumption boom. In addition, expectation in the hot economy will trigger a series problem such as real estate speculation, rising inflation. Therefore, the expectation in period with high economic growth has significant effect. At the same time, table 3 shows the interest rate in period with high economic growth has less effect with the coefficient of -0.015, which is due to the inertia of rapid economic growth making the effect of monetary policy weakened.

The estimated coefficient of expectation $\hat{\beta}_1(S_t=2)$ in the region 2 with the moderate economic growth is 0.509, which indicates that expectation in period with moderate and stable economic development can make investment and consumption in a

reasonable interval, investment has a stable returns, consumer can sustainable, economic growth continue to stable. In addition, the coefficient of real interest rate is significantly negative with the value of -0.083, which indicates that in the period with the rising real interest rate, the increasing investment cost leads to a decreasing revenue and investment level. Moreover, interest rate has a negative effect on consumption and export. Therefore, the regulation of interest rate in the period with the moderate economic growth plays a full role.

In the period with the low economic growth, the coefficient of expectation on the coincident composite index is $\hat{\beta}_1(S_t=3)=0.498$. When the economy is downturn, total demand would decrease and the management risk of enterprise would increase, which leads the expectation to contract the investment. The uncertainty of revenue expectation contributes to the decreasing consumption spending. Therefore, each decreasing component of demand leads to the economic decline through the multiplier effect. It needs to point out that since the rigid of economic growth, such as fixed capital continues to be formed, basic consumer spending continues to be increasing, could weaken the effect of expectation, then the effect of the expectation in the period with low economic growth on coincident composite index is relatively small. In addition, table 3 shows that the changing direction of interest rate is coincident with the coincident composite index, which is due to that although People's bank of China has cut interest rates repeatedly during the financial crisis in 2008, the external factors contributes to the economic downturn. The unreasonable sign of coefficient of the interest rate is not a true reflection of the relationship between interest rate and coincident composite index.

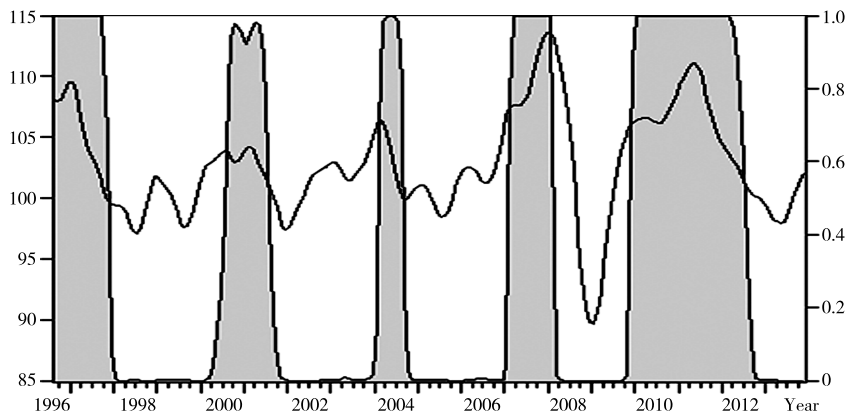


Figure 3. The smooth probability in regime 1(shadow, right coordinates) and coincidence index (solid line, left coordinates)

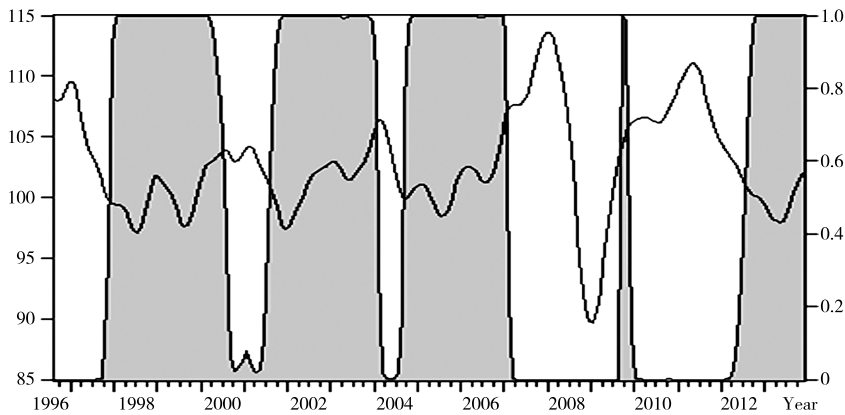


Figure 4. The smooth probability in regime 2(shadow, right coordinates) and coincidence index (solid line, left coordinates)

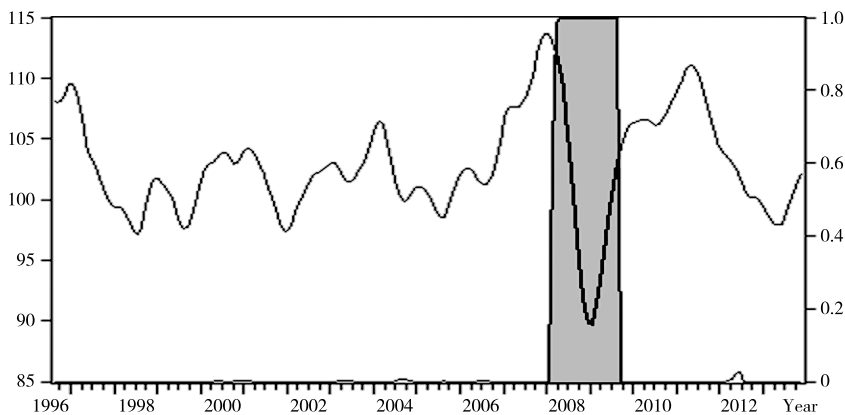


Figure 5. The smooth probability in regime 3(shadow, right coordinates) and coincidence index (solid line, left coordinates)

4.3. The division of the economic cycle stage based on the MS-TVTP model

Results in table 3 show that among the series of coincident composite index from January 1996 to November 2013, 78 phases are in the high economic growth, 117 phases in moderate economic growth, and only 16 phases in the low economic growth. That is to say, period of moderate growth is longest with about 55.45% of the whole range while period of low growth is shortest with about 7.58% of the whole range. In addition, the mean of coincident composite index in the period of high growth, moderate growth and low growth is 106.336, 101.315 and 97.075 respectively, which is consistent with $\beta_0(1) > \beta_0(2) > \beta_0(3)$. The conditional variance of the region 1, region 2 and region 3 is 2.929, 2.065 and 3.501 respectively. The fluctuation degree of the region

3 is highest while that of the region 2 is lowest.

After the estimation of smooth probability in model (17), various stages of economic cycle fluctuation can be effectively recognized. The estimates of smoothed probability are shown in the dashed area from Figure 3 to Figure 5. Among them, Figure 3 shows the probability of China's high economic growth in the whole range while Figure 4 and Figure 5 show the probability of China's moderate and low economic growth in the whole range respectively.

Comparing with the coincident composite index series of three figures from Figure 3 to Figure 5, we find that Chinese coincident composite index is transiting from high growth interval to moderate growth interval, which is influenced by the Asian financial crisis in 1997. With the increasing intensity of regulation, China was freed from the financial crisis and had a steady development. In the period that from August 2000 when the economy was back to the high growth phase to January 2008, it has a stable growth in Chinese economy and the coincident composite index is operated in the interval from the high growth to the moderate growth. With the influence of international and domestic factors, such as international financial crisis and Chinese tightening macro-control policy, the coincident composite index in February 2008 fell quickly to the stage of low growth and Chinese economy fell to the floor of the valley. With the strong regulatory policy that aims to stabilize growth, the coincident composite index in December 2008 bottomed rebound into a new round of expansion. Then in September 2009, it stepped into the regime of moderate growth and quickly rebounded in the high growth regime. It is due to the downturn of external demand caused by the global economy, as well as the domestic structural contradiction and energy resource costs, the coincident composite index continued to decline in April 2010 and was adjusted to the regime of moderate growth in July 2012. Since the third Plenary Session of the 18th CPC Central Committee, Chinese government no longer pursuit the growth rate but focus on structural adjustment. The moderate growth will be the main theme of economic growth in the future period.

5. Researches on the driven factors of economic cycle fluctuation based on the classification of the leading synthetic index

For further analysis of the conversion characteristics of different regimes and the driven factors of phase transformation, this paper classifies the leading indexes in accordance with the economic significance on Table 2. The financial leading synthetic index is calculated with the saving deposits of financial institutions, loans of financial institutions, narrow money supply amount (M1), which is demoted as x_t^{LF} . The leading investment synthetic index is calculated with the fixed assets investment projects, fixed assets in local projects, domestic loans in the fixed assets investment, which is denoted as x_t^{LI} . x_t^{LI} and x_t^{LF} are regarded as the influence factors $x_{ij,t}$ of the conversion probability $p_{ij,t}$ in equation (9). Based on these, this paper studies the influence of the financial and investment factors on the state transition of the economic growth cycle fluctuation.

In this paper, 24 transition variables from the first-order lag to twelfth-order lag of x_t^{LF} and x_t^{LI} are used, three models are estimated for 24 times and the conversion variable and the lag order are selected with the principle that maximum likelihood value is maximum and the AIC value is minimum. The conversion probability and estimation are shown in the following Table 4¹.

Table 4

State transition probability of economic cycle fluctuation and the estimation of driving factors

Conversion time (t)	State conversion (regime $j \rightarrow$ regime i)	Transition probability	Financial leading index (x_t^{LF})		Investment leading index (x_t^{LI})	
			Lags	Conversion probability	Lags	Conversion probability
1997.12	high $\rightarrow$ moderate (1 $\rightarrow$ 2)	$p_{21,t}$	8	0.0013	3	0.0689
2000.8	moderate $\rightarrow$ high (2 $\rightarrow$ 1)	$p_{12,t}$	5	0.2240	5	0.0361
2001.8	high $\rightarrow$ moderate (1 $\rightarrow$ 2)	$p_{21,t}$	8	0.1563	2	0.5826
2004.2	moderate $\rightarrow$ high (2 $\rightarrow$ 1)	$p_{12,t}$	5	0.4857	5	0.0661
2004.9	high $\rightarrow$ moderate (1 $\rightarrow$ 2)	$p_{21,t}$	8	0.0001	2	0.0969
2007.2	moderate $\rightarrow$ high (2 $\rightarrow$ 1)	$p_{12,t}$	5	0.1144	5	0.0325
2008.2	high $\rightarrow$ low (1 $\rightarrow$ 3)	$p_{31,t}$	5	0.7682	3	0.0492
2009.9	low $\rightarrow$ moderate (3 $\rightarrow$ 2)	$p_{23,t}$	5	0.6256	5	0.7043
2009.12	moderate $\rightarrow$ high (2 $\rightarrow$ 1)	$p_{12,t}$	5	0.6431	5	0.1894
2012.7	high $\rightarrow$ moderate (1 $\rightarrow$ 2)	$p_{21,t}$	8	0.0126	3	0.2660

Note: the conversion probability $p_{ij,t}$ is time series. However, since the analysis of conversion point is more meaningful, only the conversion probabilities of 10 conversion points are listed.

The financial leading synthetic index and the investment leading synthetic index, to a certain extent, are the reflection of the macroeconomic regulation. The lagging period reflects the delay of economic regulation, which means the process from the policy formulation to policy implementation is that condition path eventually playing the role. Based on the estimation of table 4, this paper deeply studies the characteristic of financial and investment factors' driving on the station conversion of economic growth cycle.

5.1. The research on financial factor's asymmetric effect on state transition of economic cycle

For the lagging effect of financial factor on economic growth cycle, table 4 shows the driving effect of the 8th lag of financial leading synthetic index is most significant on the downturn of coincident composite index from high regime to moderate regime

¹ This paper only selects the corresponding transition variable and lags when the transition probability is maximum, which means only the main influence factor is analyzed. Other lags of conversion variable can be obtained from author if necessary.

while the effect of the 5th lag of financial leading synthetic index is most significant on the transition of economic growth cycle from the moderate to high regime. Overall, compared to the promotion of economic recovery, the financial factor or monetary policy's lagging of cooling economy is longer.

For the impact of monetary expansion on economic cycle, China has issued the treasury bonds for long-term infrastructure projects after 1998. For matching with the issuance, government provided loans for the treasury bond projects and removed lending constraints for commercial banks. In addition, the bank of China issued the "notices on increasing housing credit investment to support housing construction and consumption" and other policies to develop individual housing and automobile credit. The balance of consumer credit in commercial banks increased from 45.6 billion yuan in 1998 to 104.6 billion yuan in 1999. With the promotion of financial and monetary factors, the coincident composite index was moved to the high growth regime in August 2000 and the corresponding conversion probability of the financial leading synthetic index is 0.224.

The period from 2007 to 2008 was the main stage of tightening monetary driving the state transition of economy. Table 4 shows that the coincident composite index raises to the high growth regime in February 2007. China's industrial production grew rapidly and the fixed asset investment was in a better operation. In June 2007, the added value of industrial enterprises had a growth rate of 19.4%. The growth rate of the fixed asset investment amount from January to June in 2007 is 26.7%. The trend of macro economic growth from the fast growing to overheating is obvious. In addition, China's banking system liquidity surplus and credit expansion pressures continue to be obvious. To stabilize the economy, government began the implementation of "anti overheating and anti inflation" as the goal of moderately tight monetary policy. In 2007, the people's Bank of China has raised the RMB deposit reserve rate for 10 times, increasing from 9% to 14.5%. The central bank controlled the flow through issuing central bank bills and tightening consumer credit.

Since the domestic tightening monetary policy began to play a role, the global financial crisis triggered by the U.S. subprime mortgage crisis led to a huge impact on Chinese economy and the Chinese economy began to fall sharply. Table 4 shows that the coincident composite index directly falls from the high growth regime to low growth regime in February 2008. The corresponding conversion probability of the financial leading synthetic index in this period is 0.7682. In the role of domestic and international factors, the tightening effect of the monetary policy on the economic contraction is much higher than the loose monetary policy on the economic expansion from 1998 to 2000.

5.2. The cumulative effect of investment factors on the state transition in economic cycle

From Table 4, the driving effect of investment leading synthetic index that lags for 2 or 3 phases on the economic growth cycle from the high regime to the moderate regime is most significant while the driving effect of investment leading synthetic

index that lags for 5 phases on the coincident composite index from the moderate regime to the high regime is most significant. Investment has a direct effect on the aggregate demand and it is closely related with Chinese economy growth. When the economy is downturn, the effect of the decline investment on economy is quick. However, when the economy picks up, the lag that plays a role is lengthened due to the investment cycle and fixed capital formation.

The impact of the investment factors x_t^{LI} on economic cycle conversion is mainly reflected through the cumulative effect. As shown in table 4, in most of the conversion period, the corresponding probability of the investment leading synthetic index is less than 0.1. The results show that the corresponding probability of other lag of the index is similar, which indicates the regime conversion of the economic growth cycle is the results of cumulative effect of investment in each period. For example, the coincident composite index moved from the moderate growth into the high growth in February 2004. Although the corresponding probability of the investment leading synthetic index (lag for 5 periods) is 0.0661 and the lag for 2, 3, 4 periods is 0.0492, 0.0523 and 0.0566 respectively, the effect of each lag has little difference. The cumulative effect of investment in each period promotes the state conversion of economic cycle.

In addition, through the comparison of the corresponding probability of investment leading synthetic index of the 6 times that is before February 2008 and of that the 3 times that is after February 2008, the corresponding conversion probability is significant increased in the regime conversion from September 2009 to the July 2012, which indicates the role of the investment on the state conversion of economic cycle is increased. To a certain extent, this indicates that the slowdown in the investment growth is an important way to stabilize economic growth. After 2011, the drawbacks of the stimulus plan that is over conventional began to show. The overcapacity problem caused by the formation of large-scale investment is obvious and central government began to implement a series of policies to control the blind investment. Since 2012, the growth rate of China's asset investment has slowed down with growth rate of 20%. The coincident composite index is moved from the high growth regime to the moderate regime in July 2012 and the corresponding probability of investment leading synthetic index is 0.266. The stable investment factor will maintain the economic growth cycle operation at the moderate intervals.

Compared with the driving effect of the situation that takes only the financial factor or investment into consideration, the common driving effect of the financial and investment index on economic cycle state conversion is more significant. Taking the global financial crisis of 2008 as the example, Chinese government has taken the stimulus plan of 4 trillion to maintain growth and promote investment. The robust monetary policy in the first half of 2008 quickly adjusted to the moderate loose monetary policy in the second half of the year. People's bank of China has lowered the deposit reserve rate for four times and cut the benchmark deposit and lending interest rate for five times from September to December in 2008. The rapid growth of money supply and loan size, factors of financial and investment jointly promote China's economic stabilization and recovery. Table 4 shows that the coincident composite index moved from the low growth regime to the moderate growth regime

in September 2009. The conversion probability of the financial leading synthetic index and investment leading synthetic index is 0.6256 and 0.7043 respectively and after three months, the coincident composite index again return to the range of high growth regime in December 2009. The common driving effect of financial and investment factors is significant and sustainable.

6. Conclusion and policy recommendations

Based on the Keynesian IS curve, this paper studies the phase operating characteristics by specifying output gap series through coincident composite index and estimating expected variable with state space model. In addition, the financial and investment leading synthetic index are constructed as the state transition variables of economic growth cycle to analyze the driving mechanism of economic growth cycle state transition through estimating the transition probability. The main conclusions are as follows.

The expectation of output gap has a significant positive effect on the economic growth cycle fluctuation and it has a significant asymmetric feature in different regimes. The expectation in the high economic growth forms a false demand in a certain extent, which leads to the investment expansion and excessive consumption. For the expectation in the moderate stable development, it contributes to a reasonable interval of investment and consumption. When the economy is in the low growth phase, the declining aggregate demand caused by the expectation leads to economic decline with multiplier effect. Overall, the effect of the real interest rate on coincident composite index is significant negative. Compared with the stable economic growth phase, the impact of interest rate in the high economic growth is relative small, which is due to the inertia of high economic growth weakening the effect of monetary policy.

The estimation of smooth probability and transition probability shows that the characteristic of Chinese economic growth cycle fluctuation in each regime is obvious. The lagged financial and investment leading composite indexes are important driving factors in the growth cycle state transition. The lag reflects the lag of macro economic regulation policy. Overall, compared with the economic recovery, the “cool” role of the monetary policy on economy is more effective. Investment has a direct effect on aggregate demand. The declining investment in the phase of economic slowdown has an immediate effect on economic growth cycle. However, due to the investment cycle and fixed asset formation, the lag of investment that plays the role in the phase of economic recovery is lengthened.

Stabilizing the expectations, releasing the reform dividend and avoiding the short-term economic stimulus are the important ways to realize the Chinese stable economic growth. Expectation is the prediction according to the judgment for future economic situation by historical experience and facts, which has an increasingly significant role in the formation of Chinese economic cycle fluctuation. The economic stimulus policy that is in contrast with the economic situation is the import factor to promote the formation of expectation. Therefore, in the period that economic fluctuation degree is not high, government should try not to take the short-term economic stimulus policies.

Deepening the economic reform, promoting the economic structure adjustment and releasing the internal driving force are the approaches to achieve the moderate economic growth.

From the perspective of investment, government should take the “optimization” and “efficiency” as the goal, deepen the investment system reform and establish the investment system with the enterprises as the main body. Except for narrowing the scope of government approval, simplifying the formalities of examination and approval for investment, relaxing the requirement for investment access, government should pay attention to optimize the investment structure and guide the various types of investment flows to strategic emerging industries, high-end equipment manufacturing industry, modern service industry and other fields. On the other hand, capital allocation efficiency should be improved, regional investment should be overall planned to avoid the low-level redundant construction. Government should encourage the integration of state-owned capital, private investment and other various forms of capital, optimize the investment structure to drive the industrial structure and improve the quality of economic growth in China.

To reform and improve the financial market system, promote marketization of interest rate and to play the role of regulation in market, are important ways to stabilize economic growth. To implement of macro prudential management, to control the financial driving factors of economic cycle fluctuation and to ensure the safety and stability of financial system, can provide good conditions for steady economic growth. Government should pay close attention to the trend of financial system, analyze and correct the weakest part of financial system. Based on the financial system stress test and vulnerability analysis, improving the remaining capital buffer and emergency mechanism of capital, can improve gradually the macro prudential policy framework to maintain the stability of financial system and defuse the risk of financial system. The combination of macro prudential policy and micro prudent policy can provide capital support for economic growth.

Enhancing the forward-looking and effectiveness of macroeconomic policy are important measures to stabilize the fluctuation of economic cycle. Lag exists in the process from the implementation to the true function. The judgment and grasp of economic situation in advance can shorten the lag period of macro policy and enhance the macro-control effect. The forward-looking of policy is based on the well understanding of international and domestic situation. International factors, such as the slow global economic recovery, recombination of international value chain and the domestic factors, such as potential financial risk and China’s local debt crisis problem should all be taken into the consideration of macroeconomic policy formulation. It is advisable to construct the forward-looking macro view of regulation and control policy system with the benefits of current and long-term.

Finally, for the differential operation characteristics of different stages in economic cycle and the transition characteristic of economic composite index in each regime, government should construct and improve the monitoring and early warning system of fluctuations in the economic cycle, pay attention to fluctuation of financial and investment fields closely, especially the economic operation characteristics of low growth and recovery phase in economic cycle. On the base of understanding the

economic cycle fluctuation, understanding the leading periods of driving factors of financial and investment as well as the related characteristics, taking the uncertainty and asymmetric features of effect of factors on economic cycle fluctuation in the growth and recovery phase into consideration can improve the science of macroeconomic policy and maintain the sustainable and rapid development of China's economy.

References

- Castillo, P., & Humala, A. (2012). Regime Shifts and Inflation Uncertainty in PERU. *Journal of Applied Economics*, 15(1), 71-87.
- Dong, W. Q., Gao, T. M., Jiang, S.Z., & Chen, L. (1998). *Analysis and forecast method of economic cycle fluctuation*. Jilin University press.
- Durland, J. M., & McCurdy, T. H. (1994). Duration-dependent Transitions in a Markov Model of US GNP Growth. *Journal of Business and Economic Statistics*, 12(3), 279-288.
- Filardo, A. J. (1994). Business-Cycle Phases and Their Transitional Dynamics. *Journal of Business&Economic Statistics*, 12(3),299-308.
- Friedman, M. (1993). The "Plucking Model" of Business Fluctuations Revisited. *Economic Inquiry*, 31(2), 171-177.
- Fuhrer, J. C. (2000). Habit Formation in Consumption and its Implications for Monetary-policy Models. *American Economic Review*, 90, 367-390.
- Hamilton, J. D. (1989). A New Approach to Economic Analysis of Nonstationary Time Series. *Econometrica*, 57, 357-384.
- Harding, D., & Pagan A. (2002). Dissecting the Cycle: A Methodological Investigation. *Journal of Monetary Economics*, 49, 365-381.
- Kim, C. J. (1999). Has the U.S. Economy Become More Stable? A Bayesian Approach Based on a Markov-Switching Model of the Business Cycle. *The Review of Economics and Statistics*, 81(4), 608-616.
- Krolzig, H. M. (2001). Business Cycle Measurement in the Presence of Structural Change: International Evidence. *International Journal of Forecasting*, 17, 349-368.
- Layton, A. P. (1998). A Further Test of the Influence of Leading Indicators on the Probability of US Business Cycle Phase Shifts. *International Journal of Forecasting*, 14, 63-70.
- Layton, A. P. , & Smith, D. R. (2007). Business Cycle Dynamics with Duration Dependence and Leading Indicators. *Journal of Macroeconomics*, 29, 855-875.
- Liu, J. Q., & Fan, J. Q. (2001). The asymmetry and relevance research on the Chinese economic cycle. *Economic Research(Jingji Yanjiu)*, 5, 28-37
- Liu, J. Q., & Liu, Z. G. (2005). The dynamic model and factor analysis of actual output fluctuation in Chinese economic cycle fluctuation. *Economic Research(Jingji Yanjiu)*, 3, 26-35
- Liu, S. C. (2006). *China's Economic Cycle Research Report*. Social science literature

- press.
- McCallum, B. T., & Nelson, E. (1999). An Optimizing IS-LM Specification for Monetary Policy and Business Cycle Analysis. *Journal of Money, Credit and Banking*, 31(3), 296-316.
- McCulloch, R. E., & Tsay, R. S. (1994). Statistical Analysis of Economic Time Series via Markov Switching Models. *Journal of Time Series Analysis*, 15(5), 523-538.
- Plessis, S. A. D. (2006). Reconsidering the Business Cycle and Stabilization Policies in South Africa. *Economic Modelling*, 23, 2006, 761-774.
- Ren, Z. P., & Chen, C. S. (2012). Economic cycle fluctuation and trade boom change: causal connection, transmission mechanism and policy implication. *Economic Perspectives (Jingjixue Dongtai)*, 1, 19-27.
- Simone, F. N. D., & Clarke, S. (2007). Asymmetry in Business Fluctuations: International Evidence on Friedman's Plucking Model. *Journal of International Money and Finance*, 26, 64-85.
- Simpson, P. W., Osborn, D. R., & Sensier M. (2001). Business Cycle Movements in the UK Economy. *Economica*, 68, 243-267.
- Wang, J. J. (2007). Research on the Markov mechanism conversion model—application of China's macro economic cycle analysis. *The Journal of Quantitative & Technical Economics (Shuliangjingji Jishujingji Yanjiu)*, 24(3), 39-48.
- Wang, Y. W., & Wang, J. H. (2011). The source of Chinese economic fluctuation is supply or demand—based on the new Keynesian model. *Nankai Economic Studies (Nankai Jingji Yanjiu)*, 1, 24-37.