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## Markov Switching Model With Bounce-Back Effect: An Application to Chinese Business Cycle

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### Abstract

Based on Markov switching model with a bounce-back effect, this paper analyzes the data of the economic growth in China. The findings suggest that Markov switching model with a rebound effect fits the macroeconomic growth data in our country better. What's more, we can also see that the economic fluctuation in our country not only is characterized by its obvious nonlinearity and asymmetry but has significant "bounce-back effect".

**Key words:** Bounce-back effect; Markov-switching model; Business cycle

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### INTRODUCTION

Macroeconomic business cycle is always a hot topic in academic research, which mainly focuses on the feature of nonlinearity and asymmetry. The researches adopts Markov switching model proposed by Hamilton (1989) when he described America's real output growth of nonlinear dynamic and asymmetric features. After that,

Markov switching model is widely used in the researches on the analysis of the feature of nonlinearity and asymmetry in macro economic business cycle.

Many scholars studied the feature of nonlinearity and asymmetry in macroeconomics business cycle. The study of these problems are mainly used that the Hamilton (1989) proposed Markov switching model to analyze them, the model is a nonlinear time series models currently prevalent in academia, contains multiple structural equation, which can depict the variation time series variables in different conditions. The conversion between different structure state, the Markov switching model is able to capture the dynamic evolution process of time series variable. Kim, Morley, and Piger (2005) developed this model, and they combined Markov switching model and rebound factor to develop for Markov switching model with bounce-back effect, and used to expanded model to analyze the fluctuations of business cycle of USA. They found America's business cycle in the economy from the downturn into economic growth, with a bounce-back effect.

About the papers of nonlinear and asymmetry of China business cycle fluctuation characteristics, Liu and Liu (2006) used Markov switching vector error correction model (MS-VEC) to analyze the relationship between actual output and the nominal price of the long-term equilibrium and the short-term fluctuation mode from the first quarter of 1990 to the third quarter of 2005. The empirical results showed that China's business cycle has two kinds of switching characteristics significantly, and in a different economic system, with different "Phillips" curve. Wang (2007) by introducing dummy variables in the Markov switching regression model, captured the periodic changes of the real output growth rate from 1953 to 2005 in China, and confirmed different cycle mode and the state transfer mechanism before and after the reform and opening-up of China. Cai (2009) using the panel data of Markov switching regression model accurately identify

the inflection point of China's business cycle. Tang (2010) analyzed the nonlinear and asymmetry of China's business cycle using the state space model with Markov switching, and showed that Chinese business cycle has obvious nonlinearity and asymmetry, and the expansion periods of economic growth was significantly higher than the contraction period of that. Bai and Zhao (2012) used Markov switching model with panel data to analyze 10 OECD countries business cycle, analysis result shows that the business cycle has the obvious asymmetric between the "recession" and "expansion" two mechanisms of the conversion of the business cycle.

In summary, research about the business cycle of China, most scholars mainly concentrated in the nonlinear and asymmetric characteristics of China's business cycle fluctuation, but almost no scholars researched the rebound effect of China's business cycle fluctuation. In order to improve the shortcomings of previous studies and the thoroughly understand and judge the bounce effect in our business cycle, based on the mechanism of Markov switching model with the bounce-back effect, this paper do a research on China's economic growth data fitting analysis, In order to reveal the nonlinear, asymmetry, and the bounce-back effect of the economic cycle fluctuation.

In this paper, we adopt Markov-switching model with bounce-back effect of Kim (2005) and analyze the characteristic of China's business cycle for China using annual Gross Domestic Product (GDP) data since the reform and opening-up of China. The paper is outlined as follows. Section 2 describes the Markov-switching model with bounce-back effect discussed by Kim (2005) and specifies the model for Chinese business cycle. Section 3 describes the data sets used and Section 4 presents empirical analyses. Finally, Section 5 summarizes our main conclusions.

## 1. MARKOV SWITCHING MODEL WITH A BOUNCE-BACK EFFECT

On the basis of the traditional Markov switching model, the model is set to follow Markov switching model with the "rebound effect", the form is:

$$\varphi(L)(y_t - \beta_0 - \beta_1 S_t - \tilde{S}_t) = v_t, v_t \sim i.i.d.N(0, \sigma^2), \quad (1)$$

where,  $\varphi(L)$  is K-Order lag operator,  $y_t$  is the first order differential logarithm of GDP,  $v_t$  is a random perturbation terms, and  $\beta_0, \beta_1$  are the unknown estimated parameters.

$S_t$  is an unobservable state switching variable and satisfies the first-order Markov process, and its value equal to 0 or 1. When  $S_t=0$ , this indicates that the economy is in the downward state, while  $S_t=1$ , the economy is in the upward state. The state transition probability of can be  $S_t$  expressed as:

$$\begin{aligned} \Pr(S_t=0|S_{t-1}=0) &= p, \Pr(S_t=1|S_{t-1}=0) = 1-p, \\ \Pr(S_t=1|S_{t-1}=1) &= q, \Pr(S_t=0|S_{t-1}=1) = 1-q. \end{aligned} \quad (2)$$

The fundamental difference of this model and the traditional Markov switching model is that this model has a the "bounce effect" of the economic growth,  $\tilde{S}_t$ , while the tradition Markov switching model has not this term, and the bounce-back effect term,  $\tilde{S}_t$ , satisfy the following expression:

$$\tilde{S}_t = \eta \sum_{j=1}^n S_{t-j} . \quad (3)$$

Where,  $n$  represents the persistent period an expansion regime of the economic growth is more than that of the average level. If  $\eta > 0$ , this indicates the economic growth posses the bounce-back effect, while in the traditional Markov switching model,  $\eta = 0$ .

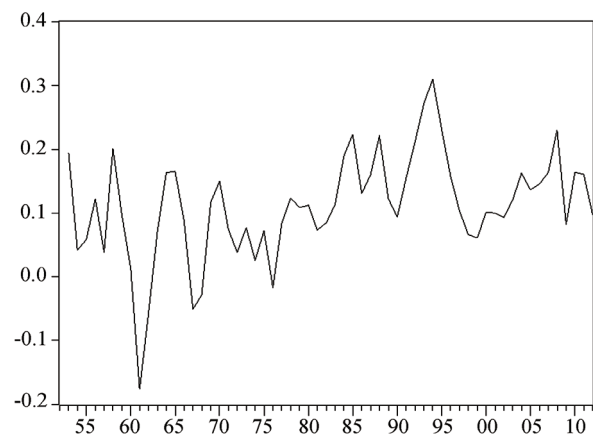
The estimation method of Markov switching model With bounce-back effect and the traditional Markov switching model has the same estimation principle, both adopt the maximum likelihood estimation combining Hamilton filtering method. The difference is: Markov switching model With bounce-back effect produce  $2k+n$  kind of state in each phase of the logarithm likelihood function value iteration, while traditional model produce  $2k$  kind of state. Its specific estimation method sees the kim (2005).

## 2. THE DATA

Our annual GDP and GDP index series data come from the 2013 Chinese Statistical Yearbook published by the China Statistics Press. We use the data on the difference in the logarithm of the annual GDP of China to measure the growth rate of GDP (see Figure 1). It is given by

$$\text{GDP Growth Rate} = \text{Ln}(\text{GDP}_t) - \text{Ln}(\text{GDP}_{t-1}).$$

The Figure 1 shows the change trend of the 1952-2012 China's GDP growth rate, and the sample range is 1952-2012, a total of 61 sample data.



**Figure1**  
 1952-2012 China's GDP Growth Rate Change Trend

## 3. THE EMPIRICAL ANALYSIS

Combining with GAUSS 9.0 software, We input China's GDP growth rate data from 1952 to 2012 into the Markov

switching model with the rebound effect to estimate the unknown parameter, the estimated results are shown in Table 1.

**Table 1**  
**The Parameter Estimation Results**

Parameter	Estimated value	Standard error	T value
$\beta_0$	10.4376	3.5659	2.9271***
$\beta_1$	-9.2932	8.0432	1.554*
$\eta$	2.6866	1.0521	2.5536**
$q$	0.8560	0.0805	10.6335***
$p$	0.5089	0.2036	2.4995**
$\sigma$	5.6938	0.6976	8.1620***
Log likelihood function value		-197.7065	

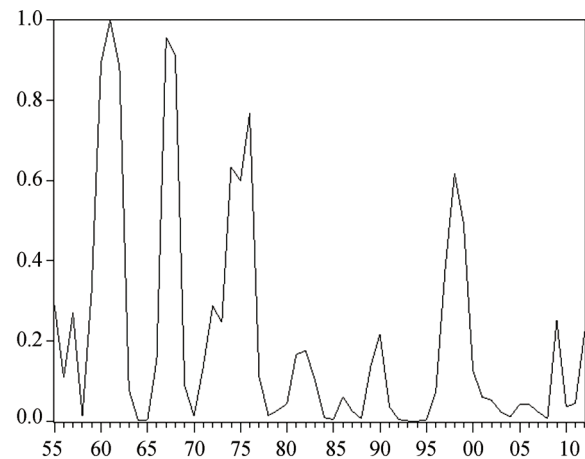
Note. \* means through the inspection under the 10% significant level,\*\* means through the inspection under the 5% significant level,\*\*\* means through the inspection under the 1% significant level.

Parameter estimation results of Table 1 shows: In addition to  $\beta_1$  estimate value pass through the test under the 10% significant level, the rest of the estimated parameter values through the test under 5% level. The overall estimate effect of model is significant. All the estimate value of the unknown parameters passes through the test. Note when  $\beta_0 + \beta_1 > 0$ , which suggest  $S_i = 1$ , regime effect in a state of Economic expansion is greater than in the contracting state.  $\eta = 2.6866$  suggests the economic cycle fluctuation rebound effect is obvious in China, economic cycle fluctuation expansion is persistence.

$p$  and  $q$  are the regimes transition probability of the economy from contractive state to contractive state and the economy from expansive state to expansive state. Where  $p = 0.5089$ , this indicates that the probability which China's current economy is in contractive state, the next period of economy still is contractive state is 0.4891, and  $q = 0.8560$ , this indicates that the probability which China's current economic is in expansive state, the next period economy still is expansive state is 0.8560. The durative average period which China's economy is in contractive state is about  $2(1/(1-p))$  years, and the durative average period that China's economy is in expansive state is about  $7(1/(1-q))$  years. This means that China's economy produces the possibility of the expansive effect is greater than that of China's economy produce the contractive effect, and the durative period of China's economy is in expansion period is obviously more than the durative period of China's economy is in contractive period. China's business cycle shows the asymmetry of business cycle fluctuation.

What's more, On the basis of the model estimate, we get the smooth probability graph in a state of decline of China's economy (see Figure 2). From Figure 2, we can see that, before 1978, China's economy is in a state of decline, economic fluctuated greatly, after 1978, there is

a smooth economic operation situation in our country, economic expansion is obvious; China's economy is in an obvious state of decline from 1997 to 1999, this is due to the influence of the Asian economic crisis, but after 1999, Chinese government has implemented effective macroeconomic regulation and control policy which secures a smooth and extension economy.



**Figure 2**  
**Economic Downturn ( $pr(s_t = 0)$ ) of Smooth Probability Graph**

The main reason for China's economic cycle fluctuations show the above features are as follows: Before the reform and opening up, China adopts strict planned economy, in a strictly under the planned economy system, the government is mainly through to the economy to adjust to change the plan and use a variety of administrative means, in the process of adjustment of the economy, the government due to the lack of effective information systems and competitive mechanism, the complete mandatory regulation mode is bound to cause change radically the macro-economy. After the reform and opening up, characteristic of China's economic cycle fluctuation takes place obviously change, and the fluctuation and characteristic of asymmetry of the business cycle has slowed significantly weakened. The main cause of these changes can be attributed to the after the reform and opening up, the Chinese government has introduced a series of policies of macro-economic stability, largely curbed economic fluctuations, to a certain extent, ironing the peak and valley of economic fluctuation, and promote the stable development of China's economy, the continuous development of economic stability policy and perfection is bound to have a huge impact on the characteristics of China's business cycle fluctuation.

## CONCLUSION

This paper applies Markov switching model with "rebound effect" to the analysis of China's GDP growth rate data fitting, the important conclusion is as follow:

Firstly, Markov switching model with “bounce-back effect” fits China’s GDP growth rate data. Secondly, China’s economic expansion regime effect is greater than when the economy was in contracting state, China’s economic cycle fluctuation has obvious feature of nonlinear and asymmetric. Lastly, China’s business cycle fluctuations show significant difference before and after the reform and open-door policy. Economy Cycle in China has not only obvious nonlinearity and asymmetry characteristics, but also the obvious bounce-back effect.

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