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A Markov Model on China's Export Cycles: Regime Division and Regime Switching

UN MODELE DE MARKOV SUR LES CYCLES D'EXPORTATION DE LA CHINE: LA DIVISION DU REGIME ET LE REGIME DE COMMUTATION

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Abstract

Based on Hamilton' Markov regime-switching model applied to postwar U.S. business cycle, the paper uses Chinese export data from January 1999 to November 2010 to describe and investigate the dynamic growth path of China's export cycles. The empirical results show that the growth path of China's export can be classified as long-term expansion regime and short-term recession regime, which means the growth path of China's export may experience a shift of regime. The global economic situation, especially the 1997 Asian financial crisis and 2008 global financial crisis, and Chinese macroeconomic policy during these periods may explain the move of regime. Chinese economy needs to shift from export-oriented economic growth to more reliance on indigenous innovation of firms and domestic demand-pulled growth, which maybe not only the result of the 2008 global financial crisis, but also reflects the need for continual growth of Chinese economy in the future.

Key words: Export cycles; Markov regime-switching model; Smoothing probabilities

Résumé

Basé sur Hamilton à changement de modèle du régime Markov appliqué à la conjoncture d'après-guerre américain, l'étude utilise les données des exportations chinoises de Janvier 1999 à Novembre 2010 à décrire et à enquêter sur le chemin de la croissance dynamique des cycles de l'exportation de la Chine. Les résultats empiriques montrent que le chemin de la croissance des exportations chinoises peuvent être classés comme régime de l'expansion à long terme et le régime de la récession à court terme, ce qui signifie que le chemin de la croissance des exportations de la Chine, peuvent constater un changement de régime. La situation économique mondiale, en particulier la crise financière asiatique 1997 et 2008 la crise financière mondiale, et les Chinois de la politique macroéconomique durant ces périodes peut expliquer le passage du régime. L'économie chinoise a besoin de passer d'exportation de la croissance économique à s'appuyer davantage sur l'innovation des entreprises et des indigènes par la demande intérieure tirée de croissance, qui peut-être pas seulement le résultat de l'exercice 2008 la crise financière mondiale, mais reflète également la nécessité d'une croissance continue de l'économie chinoise dans le futur.

Mots clés: Les Cycles d'exportation; Le Changement de modèle du régime Markov; Les probabilités de lissage

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INTRODUCTION

Chinese economy has been expanding since China's economic reform and opening-up policy have been carried out in 1978. From 1985, except for the late 1980s, the average economic growth rate ranges from 8 percent to 12 percent, which is very rare in the world. The economic growth model in China is characterized by production-

driven, high investment, export and external balance, is similar to that of Japan and South Korea.

China's foreign trade barriers were lowered after its entry into the WTO in 2001, which contributes to a substantial growth of foreign trade in China. According to WTO, the share of China in world merchandise trade raised from 8.9% in 2008 to 9.6% in 2009, surpassing Germany as the biggest exporter in the world; meanwhile, China's strong economic growth has created considerable market opportunities for other countries. In 2009, the percentage of China in world merchandise imports increased from 6.9% in last year to 7.9%, becoming the second largest importer in the world. At the same time, China has become the largest victim of anti-dumping and anti-subsidy practices. By the end of April 2001, there have been 32 countries and regions that launched 494 anti-dumping investigations against Chin's export merchandise, the value of which reached 15 billion US dollars.

In 2008, the subprime mortgage crisis originated in the U.S. eventually evolved into global crisis, causing low economic growth and sluggish market demand. The trade level in European Union fell about 16% in the fourth quarter of 2008 compared to the same period in 2007, North America and Asia fell about 7% and 5% respectively.

As one of three pillars for short- term economic growth, merchandise exports play an important role in China's economic growth. Hence, how to predict precisely the huge fluctuations of export cycles is becoming a critical matter for China's foreign trade policy. This paper will try to employ a nonlinear Markov regime-switching model to predict the turning points of the export cycles.

The paper is organized as follows: Section 2 depicts the data source and characteristics of merchandise export in China. Section 3 sets up a Markov switching model on export cycles and estimates coefficients in the model with Gauss 7.0. Section 4 conducts a specification test to check the appropriateness of Markov regime-switching model. Section4 concludes the paper.

1. DATA

We use monthly data of merchandise export from January 1999 to November 2010 as an indicator of merchandise export. All data are from Chinese Macroeconomic Database. The Export price index is collected from the open database of World Bank. The time series of exports (EX) display obvious seasonal characteristics (See Figure 1). The growth rate of EX series adjusted with X12 method demonstrates with no obvious seasonal characteristics (See Figure 2). Figure 2 depicts that export varies substantially in February 2001, January and February 2004, February, March and April 2007, while remaining relatively stable in other time period.

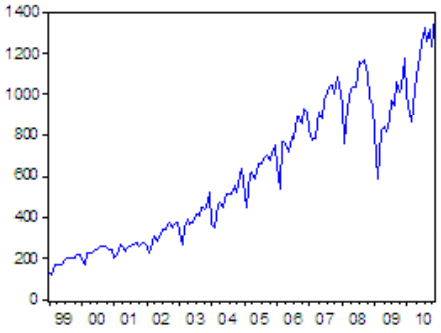

Figure 1
The Growth of China's Export (Jan.1999 –Nov.2010)

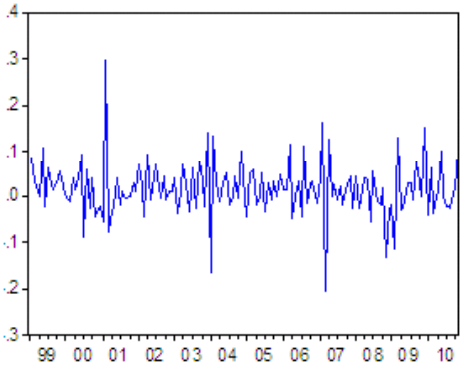

Figure 2
The Growth Rate of China's Export After Seasonal Adjustment (Jan.1999 –Nov.2010)

2. EMPIRICAL MODEL AND RESULTS

2.1 Model Setup

We follow Hamilton's (1989) switching model, allowing that the mean of growth rate in China's export to be evolving according to a two-state Markov regime-switching process. We set up Hamilton's (1989) Model with AR (2) process as follows:

$$y_t - \mu_{s_t} = \varphi_{1,s_t}(y_{t-1} - \mu_{s_{t-1}}) + \varphi_{2,s_t}(y_{t-2} - \mu_{s_{t-2}}) + \varepsilon_{s_t} \quad (1)$$

Where y_t represents the growth rate of export in month t, μ_{s_t} denotes the conditional mean of y_t in state s_t . s_t denotes the unobserved state variable, s_t=1 stands for expansions of the export and s_t=0 stands for contractions of export.ε_t is a white-noise shock with normal distribution. The variance is σ_1^2 when export is expanding, and σ_0^2 when export is contracting.

The transition between states is governed by a first-order Markov process, which means the value of s_t is only related to s_{t-1}. The transition probabilities are as follows:

$$\Pr[s_t = 1 \mid s_{t-1} = 1] = p,\ \Pr[s_t = 0 \mid s_{t-1} = 1] = 1 - p,$$
$$\Pr[s_t = 0 \mid s_{t-1} = 0] = q,\ \Pr[s_t = 1 \mid s_{t-1} = 0] = 1 - q, \quad (2)$$

In order to write the likelihood function of y_t, we define a new regime variable s_t^* so that:

$$s_t^* = 1 if s_t = 0, s_{t-1} = 0, s_{t-2} = 0; s_t^* = 2 if s_t = 0, s_{t-1} = 0, s_{t-2} = 1;$$
$$s_t^* = 3 if s_t = 0, s_{t-1} = 1, s_{t-2} = 0; s_t^* = 4 if s_t = 0, s_{t-1} = 1, s_{t-2} = 1;$$
$$s_t^* = 5 if s_t = 1, s_{t-1} = 0, s_{t-2} = 0; s_t^* = 6 if s_t = 1, s_{t-1} = 0, s_{t-2} = 1;$$
$$s_t^* = 7 if s_t = 1, s_{t-1} = 1, s_{t-2} = 0; s_t^* = 8 if s_t = 1, s_{t-1} = 1, s_{t-2} = 1;$$

then s_t^* is an 8 state Markov process. The transition probability matrix, denoted by P, can be obtained from (2). Therefore, when s_t^*=1, the conditional probability density function of y_t is written as follows:

$$f(y_t \mid s_t^* = 1, Y_{t-1}; \Phi) = \frac{1}{\sqrt{2\pi}\sigma_0} \cdot$$
$$\exp\{-\frac{[(y_t - \mu_0) - \varphi_{1,0}(y_{t-1} - \mu_0) - \varphi_{2,0}(y_{t-2} - \mu_0)]^2}{2\sigma_0^2}\}$$

where $Y_t = (y_t, y_{t-1}, \cdots, y_0)$, $\Phi = (\mu_0, \mu_1, \mu_{1,0}, \mu_{1,1}, \mu_{2,0}, \mu_{2,1}, \sigma_0, \sigma_1, p, q)$. Similarly, we can obtain the conditional probability density function of when $s_t^* = 2, 3, \cdots, 8$.

Let

$$\xi_t = \begin{cases} (1,0,0,\cdots,0)' s_t^* = 1 \\ (0,1,0,\cdots,0)' s_t^* = 2 \\ \cdots \\ (0,0,0,\cdots,1)\ s_t^* = 8 \end{cases}, \eta_t = \begin{cases} f(y_t \mid s_t^* = 1, Y_{t-1}; \Phi) \\ f(y_t \mid s_t^* = 2, Y_{t-1}; \Phi) \\ \cdots \\ f(y_t \mid s_t^* = 8, Y_{t-1}; \Phi) \end{cases}$$

and vector $(\hat{\xi}_{t|t})_{8\times 1}$ gives the inference of s_t^* based on innovation in time t and population parameters, with $\Pr(s_t^* = j \mid Y_t, \Phi)$ as the jth element. The optimal inferences and forecasts in time t can be obtained by the following two iterate equations (See Hamilton (1994: 690-695) for Derivation of the two iterate equations):

$$\hat{\xi}_{t|t} = \frac{\hat{\xi}_{t|t-1} \otimes \eta_t}{1'(\hat{\xi}_{t|t-1} \otimes \eta_t)}$$
$$\hat{\xi}_{t+1|t} = P \bullet \hat{\xi}_{t|t}$$

The log-likelihood function for population Y_T can be written as:

$$L(\Phi) = \sum_{t=1}^{T} f(y_t \mid Y_{t-1}; \Phi)$$

Where $f(y_t \mid Y_{t-1}, \Phi) = \sum_{i=1}^{8} f(y_t, s_t^* = i \mid Y_{t-1}; \Phi)$

$$= \sum_{i=1}^{8} f(y_t \mid s_t^* = i, Y_{t-1}; \Phi) \Pr(s_t^* = i \mid Y_{t-1}; \Phi)$$
$$= 1'(\hat{\xi}_{t|t-1} \otimes \eta_t)$$

2.2 Estimation Results

Maximum likelihood method was used for estimation. The Maximum likelihood (ML) estimation of our model is developed from the Expectation–Maximization (EM) algorithm discussed in Hamilton (1990). The estimations of p, q, μ_0, μ_1, $\varphi_{1,0}$, $\varphi_{2,1}$, $\varphi_{1,0}$, $\varphi_{2,0}$ in the AR(2) process are reported in Table 1. The results are given by Gauss7.0 procedure.

Figure 3 depicts the smooth probability of an expansion of export being in expansion and contraction. The mean duration of export being in expansion (S_t=1) is far longer than the state being in contraction (S_t=0). The estimates of p and q in Table 1 represent the transition probability from expansion to expansion and the transition probability from contraction to contraction, respectively. We may calculate the expected durations of expansion and contraction as follows:

Expected duration of expansion = 1/(1-0.9753) =38.9105 (months) (3)

Expected duration of contraction =1/(1-0.4710) = 1.8904 (months) (4)

Table 1
Maximum Likelihood Estimates of Export Cycle Model

	Coefficient	t_Value		Coefficient	t_Value
μ_0	-12.0270	-14.9946	μ_1	3.3802	7.6626
$\varphi_{1,0}$	-0.6163	-8.5064	$\varphi_{1,1}$	-0.5694	-7.0429
$\varphi_{2,0}$	-0.5492	-4.3279	$\varphi_{2,1}$	-0.2472	-3.1881
σ_0	2.7668	1.7027	σ_1	17.9348	7.6191
p	0.9753	65.5034	q	0.4710	2.0783
Log likelihood	-413.461 2				

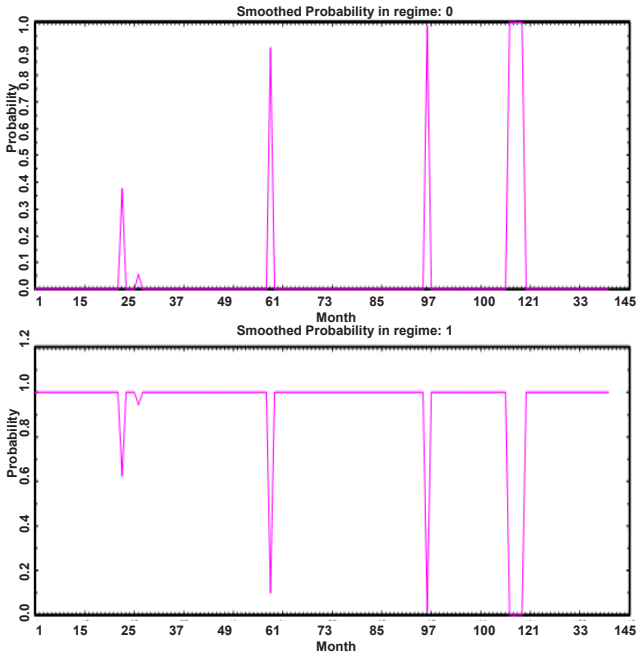

Figure 3
Smoothing Probability of China's Export Being in Expansion and Contraction

Figure 3 also depicts that China's export have been relatively stable in the state of expansion since 1999,

which means the merchandise export grows steadily during this period until August 2008, followed by a short contraction period before returning to expansion. The transition between the two states reflects the background of global economy and domestic policy in China.

2.2.1 The Expansion Regime of Export Cycles

The estimation results suggest that expansion regime of China's export cycles lasted about 39 months since 1999, which may be attributed to better global economic environment and stable economic growth in China. Global economic situation began to resume in the second half of year 1999. Because of North America and developing Asia's continuing expansion economies, a recovery from output stagnation in South America and Russia, and a pickup in economic activity in other regions, International trade and output in 2000 witnessed the fastest annual growth in the last 10 years. Therefore, China faced a favorable external environment which contributed to its export expansion. In July 1997, the devaluation of the Thai baht resulted in a cascade of currency depreciation of surrounding countries throughout Asia. After the crisis, Chinese leaders repeatedly promised that there will be no devaluation for RMB, which adversely affected China's competitiveness in the world market. In order to increase domestic demand and stimulate economic growth, Chinese government decided to implement a loose fiscal policy so as to create market opportunities, a prudent loose monetary policy to stabilize prices and international balance of payment. The measures taken by the government are as follows:

(1) Issuing long-term national construction debt. From 1998 to 2002, Chinese government have issued long-term national debt totaled 660 billion RMB, the total investment increased to 3.28 trillion RMB.

(2) Implementing flexible fiscal policy. From July 1st 1999, fixed asset investment regulation tax fell by half and terminated in 2000. From 1998 to 1999, tax rebates for exports were lifted three times, with the total tax rebates of over 400 billion RMB during 5 years. Moreover, Ministry of Finance issued 270 billion RMB special national debts to improve capital adequacy ratio of state-owned commercial banks.

(3) Lowering the required deposit reserve ratio and interest rate. In March1998, the People's Bank of China consolidated the required deposit reserve account and excess deposit reserve account under one reserve account, and lowered the reserve ratio from 13 percent to 8 percent. Meanwhile, China has cut the base interest rate for four consecutive times, with base deposit interest rate being lowered by 0.369 and base lending interest rate by 0.333.

(4) Promoting the financial regulation reform to improve the capability of credit expansion of commercial banks. Since 1998, the People's Bank of China consecutively canceled the mandatory credit control of working capital and fixed assets investment loan on commercial banks. Besides that, a series of specific policies have been put forward to encourage credit support for infrastructure construction, foreign-owned investment enterprises, and agriculture.

Through adopting various policies to increase domestic demand, Chinese economy maintained a healthy and stable development. According to the National Statistical Bureau of China, although GDP growth rate in 2001 is only 7.3 percent, the growth rate keeps over 8 percent from year 2002 to 2008, and around 10 percent from year 2003 to 2007. The situation paved the way for rapid development of merchandise export in China. After China's entry into the WTO on 11th, December 2001, lowered tariff trade barriers and commodity price advantages contributed to continuing expansion of China's export.

2.2.2 The Contraction Regime of Export Cycles

In the second half of 2007, the subprime crisis originated in the US became a global financial crisis, which continued to affect the real economy. During April 2008, International Monetary Fund (IMF) estimated that global losses for financial institutions would approach $1 trillion. The subprime crisis rapidly spread to developed countries, such as the EU and Japan, and caused a slow growth rate in developed economies, which led to an obvious slump on consumption and import demand. IMF pointed out in *World Economic Outlook* that real GDP growth rate in the US, Euro zone, and Japan in 2008 declined to 1.7 percent, 0.9 percent and -0.6 percent from 2.7 percent, 2.0 percent and 2.4 percent in 2007 respectively. Suffered by the slow growth rate in advanced economies, the growth rate in developing and emerging economies began to slow down. The direct and indirect export to the US, EU and Japan accounted for about 60 percent of China's total export, which reversed the expansion regime of China's export cycles.

2.3 Testing the Markov Regime-switching Model

The linear model can be seen as a special case of Markov regime-switching model. If the Markov regime-switching model only has one instead of two state, then it can be reduced to AR (2) process. Therefore, it is theoretically possible to test the choice between linear model and Markov regime-switching model. Table 2 shows the estimation results of AR (2) process. According to Hansen (1992), the LR statistics can be used to test the nonlinear specification. The specific hypotheses to be tested are: H_0: $\mu_1 = 0$ versus H_1: $\mu_1 = 0$. The LR statistics is $LR = L_m(q_m)-L_0(q_0)\sim\chi^2(k)$, where k denotes difference in the number of parameters between two models. Given an estimate of q_m and q_0, we have $L_m(q_m)$ and $L_0(q_0)$ as the LR values for Markov regime-switching model and AR model respectively. LR has the asymptotic Chi-square distribution with degree of k. We have $LR = L_m(q_m)-L_0(q_0)= -627.7255$, which obviously is not Chi-square distribution. Therefore, we reject H_0.

Table 2
Estimation Results for AR(2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.016826	0.002618	6.426380	0.0000
VEX_S(-1)	-0.539812	0.084789	-6.366516	0.0000
VEX_S(-2)	-0.169157	0.084408	-2.00403	10.0470
R-squared	0.232830	Mean dependent var		0.016989
Adjusted -squared	0.221631	S.D. dependent var		0.060007
S.E. of regression	0.052942	Akaike info criterion		-3.018061
Sum squared resid	0.383985	Schwarz criterion		-2.955026
Log likelihood	214.2643	F-statistic		20.78926
Durbin-Watson tat	1.952231	Prob(F-statistic)		0.000000

CONCLUSION

Export trade plays an important role in the growth of Chinese economy. The expansion and contraction of export cycles in China are greatly influenced by the global economy. How to predict precisely the huge fluctuations of export cycles is becoming a critical matter for Chinese foreign trade policy.

This paper attempts to employ a nonlinear Markov regime-switching model to predict the turning points of the export cycles. Based on Hamilton' Markov regime-switching model applied to postwar U.S. business cycle (1989,1994), the paper uses Chinese merchandise export data from January 1999 to November 2010 to describe and investigate the dynamic growth path of China's export cycles. The empirical results suggest that the growth path of China's export can be classified as long-term expansion regime and short-term recession regime, which means the growth path of China's export cycles may experience a shift of regime. The global economic situation and Chinese economic policy during these periods may explain the move of regime.

For policy makers, the economic growth in China should be transformed from export-oriented pattern to domestic demand-pulled pattern. More emphasis should be put on the indigenous innovation of firms, which maybe not only the results of the 2008 global financial crisis, but also reflects the need for continual growth of Chinese economy in the future.

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