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# An empirical study of the cyclic fluctuation of forestry economy in China

**Yang Gao[1], Zheng Zhao[2], Ya-li Wen***

**Department of Economics and Management, Beijing Forestry University, Beijing 100083, (P.R.CHINA)**

**E-mail : gao_orange@126.com; wenyali2003@163.com**

## ABSTRACT

The fluctuation of forestry economy is considered as an imperative issue in forestry economy. In this paper, statistical description, Hodrick-Prescott Filter and Chow test are applied to examine the short-run fluctuation and long-term fluctuation of annual growth rate of output value of forestry in China with data covering 1993-2012. Empirical evidence reveals there are five cycles which is associated with the average wave length up to 3 years regarding to short-run analysis of forestry fluctuation. And two long-term fluctuation of forestry economy, which is associated with Juglar cycle, can be recognized based on Chow test. Moreover, it is shown that all fluctuation of forestry economy is in accordance with implementation of forestry policy. With the purpose of promoting the growth of output value of forestry, Chinese government needs to be extra careful in implementing relevant investment policies.

## KEYWORDS

Cyclic fluctuation; The output value of forestry; Hodrick-Prescott Filter; Chow test.



## INTRODUCTION

Since the 1998 Yangtze River floods, China has undertaking a great economic transition of forestry. During this period, the design and implementation of forestry policies takes account of economic benefit, social benefit and ecological benefit. And the focus of public policy has gradually changed from promoting the production of wood to protecting the environment. Meanwhile, remarkable achievements in various aspects of Chinese forestry has been made from 1998 to 2012, including starting China six vital forestry projects in 1998, implementing collective forest tenure reform from 2003 and building ecological civilization centered on forestry from 2012. More specifically, forestry investment over time has grown at a compound annual growth rate (CAGR) of about 27.49% which is more than that of the output value of forestry (10.77%) during the last 15 years in China. Nowadays, with the implementation of a series of policies which responses to the environmental crisis in 1998 and financial crisis in 2008, forestry sector has been becoming one of the newest drivers ofChinese economy. On one hand, environment continues to deteriorate in most part of China. With a serious shortage of forest,soil erosion and desertification, along with frequent natural disasters, have caused tremendous damage to theenvironment of China. On the other hand, with the acceleration of urbanization advancement in China, demand for forestry products is increasing rapidly. Taking demand for wood as an example, the output gap of wood production in China will keep extending according to ICBC's report. More specifically, the wood production is 81.748 billion cubic meter in 2012 while the import of wood production is up to 75.785 billion cubic meter in the meantime. So this creates the importance of studying forestry economy.

Analysis on economic cycle, which has been widely used on many aspects of macro-economic, is an important way to find regular pattern and internal connection of an economy. Krupkina, Deryugina and Ponomarenko analyzed the cyclical fluctuation of GDPand pointed out the trend of output growth rates[1]. Nekarda and Ramey discussed cyclicality of markups in the private economy and manufacturing industries and suggested that markups are pro-cyclical conditional on a technology shockbut not the same on demand shocks[2]. Cui and Wan discussed the fluctuation of agricultural economy from 1987 to 2010, which indicated that the characteristics of fluctuation of the output value of agriculture in China are of low volatility, low amplitude and high frequency. Regarding to forestry sector, Wen Su and Wen Ya-li studied the cyclical fluctuation in forestry economy and concluded that related policies, forestry industrial structure and forestry investment are major shocks and sources of forestry economic fluctuation.

The overwhelming majority of the aforementioned researches concentratedon the long-run fluctuation. However, the short-run fluctuation of forestry economy, as expressed by the cyclical fluctuations in economic activity, has not been fully examined yet. This creates the room for us to analyze the regular pattern and characteristics of forest economy in recent years. In this paper, business cycles are used as they are important tools to study the different behaviors of economy during the expansions and contractions; that is, they are components of the short-run fluctuations, according to Burns and Mitchell[3].

In this paper, we carefully consider the issue about the characteristics of fluctuation of output value of forestry, examining the regular patterns and potential links of sectorial shocks and aggregate fluctuations. For the sake of aiding the policy design and implementation, our study focuses on China from 1998 to 2012 in a hope to provide more definitive evidence between forestry investment and the output value of forestry under the new background of forestry reform and ecological civilization building.

The rest of this paper is organized in the following fashion. Section 2 briefly describes the methodologies and data sources. Section 3 presents and discusses the empirical results. Section 4 draws the conclusions and policy recommendations. Section 5 is acknowledgement.

## METHODOLOGY AND DATA

### Hodrick-prescott filter

In this paper, Hodrick-Prescott Filter is chosento analyze the trend and stationary components of fluctuation of forestry economy. The results of H-P Filter providea decomposition of fluctuation of forestry economy into a permanent (or trend) and a stationary (or cyclical) component[4]. Besides, the results of H-P Filter can not only contribute to identify long-run fluctuation but also help to recognize short-run fluctuation. Consider Eq.1 with the time series $GRF_t$.

$$Cycle_t = GRF_t - Trend_t \quad (1)$$

Where $GRF_t$ is annual growth rate of output value of forestry, $Trend_t$ is the permanent component of fluctuation of growth rate of output value of forestry, and $Cycle_t$ is the cyclical component of fluctuation of growth rate of output value of forestry.

### Chow test

Chow test is a typical statistical and econometrical test, which is initially invented by Chow[5]. It is widely used to test whether there are structural change of time series, that is, whether at least one parameter among mean, variance and trend of the time series changes or not. Consider a regression model with three time series, $x_1$ and $x_2$ in Eq.2

$$y = a + bx_1 + cx_2 + \varepsilon \quad (2)$$

Where [$a, b, c$] are parameters for estimation respectively, $\varepsilon$ is an error term.
Divide these time series into two groups and consider Eq.3 and Eq.4.

$$y = a_1 + b_1x_1 + c_2x_2 + \varepsilon \quad (3)$$

And

$$y = a_2 + b_2x_1 + c_2x_2 + \varepsilon \quad (4)$$

To test whether there is structural change or not, the null ($H_0$) hypothesis is $H_0: a_1 = a_2, \quad b_1 = b_2, c_1 = c_2$, and the selected hypothesis is $H_1: a_1 \neq a_2$ or $b_1 \neq b_2$ or $c_1 \neq c_2$. If $H_0$ is rejected, namely, $a_1 \neq a_2, \quad b_1 \neq b_2, c_1 \neq c_2$, then it reveals that there is structural change with some parameter including mean, variance and trend of the time series changed and vice versa. And F test is used. Consider the F-statistics of F-test of $H_0$:

$$\frac{(S_C - (S_1 - S_2))/k}{(S_1 + S_2)/(N_1 + N_2 - 2k)} \quad (5)$$

Where $S_C$ is the residual sum of squares of integrated regression equation (Eq.2), $S_1$ and $S_2$ are residual sum of squares of Eq.3 and Eq.4 respectively, $N_1$, $N_2$ are sample size of Eq.3 and Eq.4 respectively, and $k$ is numbers of parameters. If F-statistics is bigger than the critical value of F

distribution, $H_0$ is rejected, i.e.at least one of parameters including $a, b, c$ is not equal, then it suggests that there is a structural change, and vice versa.

## Data

Our empirical study uses the time series data of output value of forestry (FGDP) at current prices, annual growth rate of output value of forestry (GRF) and retail price index (RPI) for the 1993~2012 period of China. Among these time series, the output value of forestryis obtained from the China Forestry Statistical Yearbook published by State Forestry Administration of the People's Republic of China. While the China retail price index comes from the China Statistical Yearbook published by National Bureau of Statistics of the People's Republic of China. In this paper, the nominal output value of forestry at current prices is expressed in terms of billion yuan. For the sake of excluding price factor, the output value of forestry at current prices is deflated by China retail price index (using 1993 as the base year).

Figure 1 is a graphical representation of the time series of real output value of forestry. As we can see in Figure 1, output value of forestry increased from its bottom in 1993 to as high as 395 billion yuan in 2012, which suggests that the growth of output value of forestry has an increasing tendency to aggregate.

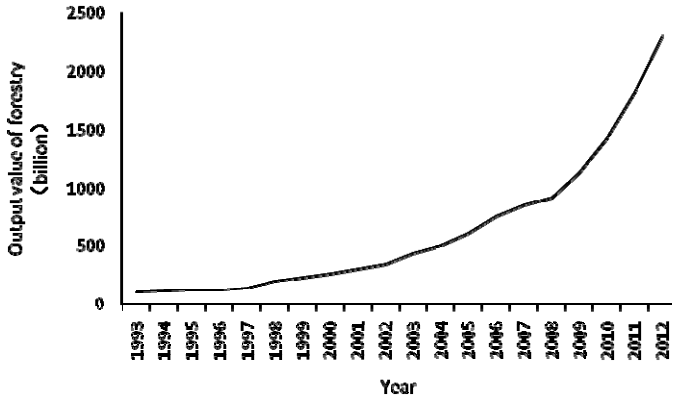


**Figure 1 : Output value of forestry in China**

## RESULT AND DISSCUSS

### Short-run analysis of forestry fluctuation

In this paper, some preliminary findings are initially reported by using descriptive statistics. Considering the operability and availability of data, annual growth rate of output value of forestry on a year-on-year basis is observed to represent the fluctuation of forestry economy. Figure 1 is a graphical representation of annual growth rate of output value of forestry from 1993 to 2012. As it is shown in Figure 1,the wave length, wave pattern, peak and trough can be identified. Wave length and average wave length reflect the state of fluctuation of forestry sector from time aspect. According to calculation of peek to peek method, there are five cycles during 1994 to 2012 of forestry sectors. With the average wave length up to 3 years, the five cycles became associated with Kitchen Cycles[6]. Among these cycles, the first cycle starts with duration of about 4 years and ends in 1998 and the characteristics of rest of these cycles is shown in TABLE 1. It can be seen in TABLE 1 that the five downward spikes in 1996, 2000, 2002, 2004, 2008 respectively are due to different reasons. Nevertheless the 3 upward spikes in 1998, 2003 and 2006 respectively are in accordance with changes in forestry policy including

China six vital forestry projects in 1998, collective forest tenure reforms starting from 2003 and constantly deepen reforms of national wide in 2006.

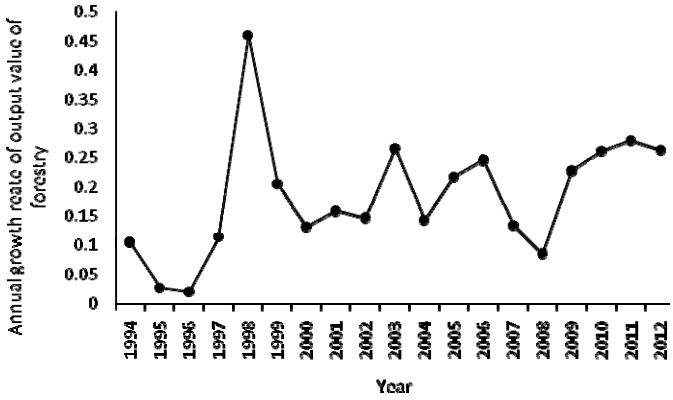


**Figure 2 : Annual growth rate of output value of forestry in China**

**TABLE 1 : Short fluctuation of forestry economy in China**

| Year | Length | Peak | | Trough | |
|---|---|---|---|---|---|
| | | Year | Peak value | Year | Trough value |
| 1994-1998 | 4 years | 1998 | 0.46 | 1996 | 0.02 |
| 1998-2001 | 3 years | 2001 | 0.16 | 2000 | 0.15 |
| 2001-2003 | 2 years | 2003 | 0.26 | 2002 | 0.13 |
| 2003-2006 | 3 years | 2006 | 0.25 | 2004 | 0.14 |
| 2006-2011 | 5 years | 2011 | 0.28 | 2008 | 0.09 |

Regarding to thelong-term fluctuation of forestry economy, Hodrick-Prescott Filter and Chow test are used to extract the cyclical component of growth rate of output value of forestry, and further, to test whether there are structural changes of time series or not.

## Hodrick-prescott filter

As is showed in Figure3, the results of H-P Filter provide a decomposition of fluctuation of annual growth rate of output value of forestryinto a trend and acyclicalcomponent. Cycle and trend in Figure3 represent the trend and the cyclical component of annual growth rate of output value of forestry respectively.

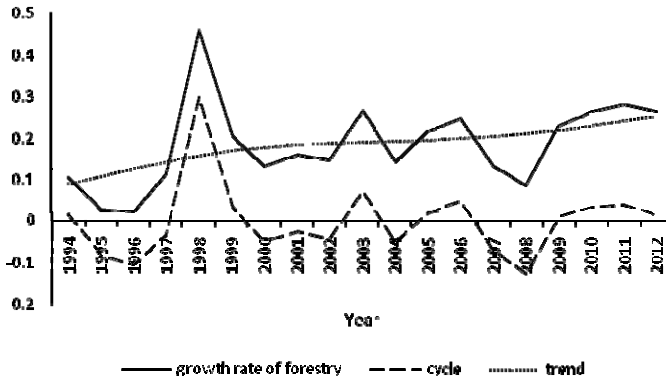


**Figure 3 : Cycle and trend of annual growth rate of output value of forestry in China**

As the figure showed, several characteristics of short-run fluctuation and long-term fluctuation of forestry economy can be identified. Prior to 2003, the standard version of fluctuation of annual growth rate of output value of forestry is fluctuating drastically. At the peak in 1998, implementation of China six vital forestry projectsincluding *Natural Forest Protection Project* and *Green for Grain Project*contribute a lot to the investment of forestry. After 2003, when collective forest tenure reform started implementing, the version of fluctuation of annual growth rate of output value of forestry exhibit relatively high frequency movements. Suppose the breakpoint year is 2002 and Chow test is used to test whether there are structural changes from 1993 to 2012.

**Chow test**

For structural change is pervasive in economic time series relationshipsand can be quite perilous to be ignored, a further study is made to investigate whether there are structural change or breakpoint in the time series of annual growth rateof output value of forestry in China. The first step of Chow test is to do a linear regression of annual growth rate of primary production of forestry ($PF_t$), annual growth rate of secondary production of forestry ($SF_t$) and annual growth rate of tertiary production of forestry ($TF_t$) on annual growth rate of output value of forestry in China ($GRF_t$) by the standard OLS method as Eq.6.

$$GRF_t = 0.0568 + 0.357 \times PF_t + 0.36 \times SF_t + 0.358 \times TF_t \quad \textbf{(6)}$$

$$R^2 = 0.87, \quad D.W. = 1.3$$

Adjusted R-squared=0.83 indicates that auto-correlation of the error term does not exist, so the form of regression is reasonable.

The second step of Chow Testprocedure is to test whether the breakpoint divide the time series into two time series with different parameter including mean, variance and trend or not. As it is shown in TABLE 2, $H_0$: *there is no structural change of time series* is rejected, namely F-statistic, Log likelihood ratio and Wald-statistic is significant at the 1% level. In other words, the result suggests that year 2002is Chow breakpoint of time series.

**TABLE 2 : Results for Chow Test**

| Chow Breakpoint Test : 2002 | | | |
|---|---|---|---|
| F-Statistic | 5.856*** | Prob.F (4, 11) | 0.00 |
| Log likelihood ratio | 21.676*** | Prob.Chi-Square (4) | 0.00 |
| Wald Statistic | 23.422*** | Prob.Chi-Square (4) | 0.00 |

**Note: the symbol *** indicate significance at the 1%; Prob. is the probability of F test, Log likelihood-ratio test and Wald test.**

In this case, two long-term fluctuation of annual growth rate of output value of forestry, which is associated with Juglar cycle[7], can be identified as is shown in TABLE 3. Prior to 2002, the source of fluctuation comes from implementation of China six vital forestry projects which bring a huge number of forestry investment and limitation of timber harvesting from the 1998 Yangtze River floods. After 2003, the source of fluctuation comes from forestry tenure reform and transformation of business operational mode in forestry.

**TABLE 3 : Characteristics of long-term fluctuation of forestry economy**

| Period | Average potential | Average amplitude (%) | Average length (year) | Frequency (%) |
|---|---|---|---|---|
| 1993-2002 | 0.152 | 0.376 | 3.5 | 0.286 |
| 2003-2012 | 0.213 | 0.148 | 4 | 0.25 |

## CONCLUSIONS

In this paper we examine the short-run fluctuation and long-term fluctuation of annual growth rate of output value of forestry in China with data covering 1993-2012. Regarding to short-run analysis of forestry fluctuation, there are five cycles which is associated with the average wave length up to 3 years according to statistical description. As for long-term fluctuation, the trend and cyclical components of annual growth rate of output value of forestry are identified based on results of H-P Filter. Moreover, two long-term fluctuation of forestry economy, which is associated with Juglar cycle, can be recognized based on Chow test.

Our findings suggest that there are obvious fluctuations in forestry economy. Prior to 2002, forestry economy fluctuated drastically, which is mainly contributed by the implementation of China six vital forestry projects and limitation of timber harvesting from the 1998 Yangtze River floods. Nevertheless, relatively high frequent fluctuations of forestry economy are due to forestry tenure reform and transformation of business operational mode in forestry after 2003. With the purpose of promoting the growth of output value of forestry, Chinese government needs to be extra careful in implementing relevant investment policies.

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