A Characterization of the Postwar Japanese GDP Volatility by Alternative Detrending Methods

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Abstract

In this paper we examine the postwar Japanese GDP volatility by alternative detrending methods. We also investigate the effects of the choice of detrending methods on the properties of GDP volatility under two different exchange rate systems. Detrending methods we use are: (i) the Hodrick-Prescott Filter, (ii) First Difference Filter, (iii) Linear Trend Filter, and (iv) Quadratic Trend Filter. We find that the qualitative stylized fact that the GDP volatility in the fixed exchange rate period is larger than that in the flexible exchange rate period is robust to alternative detrending methods. We also find the quantitative stylized fact that the degree of extracted GDP volatility for any period is sensitive to the detrending methods.

1. Introduction

The purpose of this paper is to examine the postwar Japanese real GDP volatility by alternative detrending methods, and to investigate the effects of the choice of detrending methods on the properties of real GDP volatility under two different exchange rate systems. The volatility of real GDP is defined as the deviations from the long-run trend of GDP. Thus, to evaluate the volatility of real GDP, we must specify the trend of GDP in the first place. Then, after extracting the trend component from the actual move-

ment of GDP, we can measure the volatility of GDP around the trend.

There exist many accepted detrending methods. Needless to say, however, we cannot apply all the detrending methods in this paper. We limit only a portion of available detrending methods. Detrending methods we use are: (i) the Hodrick-Prescott Filter, (ii) First Difference Filter, (iii) Linear Trend Filter, and (iv) Quadratic Trend Filter.

For the U. S. economy, Baxter (1990) studies the robustness of stylized facts on business cycles to the alternative commonly-used detrending methods. Her research suggests that the stylized facts on business cycles are sensitive to the choice of the detrending methods applied. For the Japanese economy, on the other hand, we have never seen the corresponding research so far. In this paper we follow the same concern as Baxter (1990) has, but the scope of the analysis is limited to the GDP volatility.

Data we use are annual data from 1955 to 1992 calendar year. By using annual data, we are free from seasonal adjustment problems. The whole sample periods are devided into two subperiods, the fixed exchange rate period (1955-1972) and the flexible exchange rate period (1973-1992). By this simple division, we investigate the effects of the choice of detrending methods on the properties of GDP volatility under two different exchange rate systems.

The rest of the paper is organized as follows. In Section 2, we briefly describe the detrending methods we use in the analysis. In Section 3, we report the results of GDP volatility analysis, and examine the effects of the exchange rate regime shift and the choice of detrending methods on the GDP volatility. Finally, in Section 4, concluding remarks are provided.

2. Detrending Methods

In this section, we briefly describe the detrending methods we use in the

analysis. Detrending methods we use are: (i) the Hodrick-Prescott Filter, (ii) First Difference Filter, (iii) Linear Trend Filter, and (iv) Quadratic Trend Filter.

2.1. The Hodrick-Prescott Filter

This detrending method is widely used in the Real Business Cycle approach, and recently applied to find the stylized facts on business cycles in various countries.[1] Let $\{y_t\}$ be the sequence of real GDP (in logarithm), and $\{\tau_t\}$ be the sequence of the trend component (in logarithm). In the Hodrick-Prescott filter, the trend (we call the HP trend) $\{\tau_t\}$ is defined as the optimizer of the following concave minimization problem.

$$\text{Min} \sum_{t=1}^{T} (y_t-\tau_t)^2+\lambda \sum_{t=2}^{T-1} [(\tau_{t+1}-\tau_t)-(\tau_t-\tau_{t-1})]^2, \tag{1}$$

where λ is the smoothing parameter. For the annual data, either $\lambda=400$ or $\lambda=100$ is commonly used.[2] In this paper we apply both smoothing parameter values. Deviations from the trend, i.e., filtered series $\{x_t\}$ is given by a sequence $\{y_t-\tau_t\}$.

2.2. First Difference Filter

This detrending method gives the filtered series $\{x_t\}$ by taking the first difference of real GDP (in logarithm) $\{y_t\}$.

$$x_t=y_t-y_{t-1}, \qquad t=2,...,\text{T}. \tag{2}$$

This filter a priori assumes that the real GDP (in logarithm) follows the random walk process. The filtered series for the initial period is not

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1) For the U.S., see Kydland and Prescott (1990). For the U.K., see Blackburn and Ravn (1992). For the old U. S. and U. K., see Correia, Neves, and Rebelo (1992). For Switzerland, see Danthine and Girardin (1989). For Austria and Germany, see Brandner and Neusser (1992). For Sweden, see England, Persson, and Svensson (1992).

2) For the quarterly data, $\lambda=1{,}600$ is standard.

available in this filter.

2.3. Linear Trend Filter

This filter extracts the linear trend component $\{\tau_t\}$ from the real GDP.

$$\tau_t = \alpha_0 + \alpha_1 t, \qquad t = 1,...,T. \tag{3}$$

Deviations from the trend, i. e., filtered series $\{x_t\}$ is given by a sequence $\{y_t - \tau_t\}$. For estimating the linear trend, we assume that the stochastic disturbance follows the first-order serial correlation. We estimate the linear trend with the first-order serial correlated disturbance by maximum likelihood method.

2.4. Quadratic Trend Filter[3)]

This filter extracts the quadratic trend component $\{\tau_t\}$ from the real GDP.

$$\tau_t = \beta_0 + \beta_1 t + \beta_2 t^2, \qquad t = 1,..., T. \tag{4}$$

Deviations from the trend, i. e., filtered series $\{x_t\}$ is given by a sequence $\{y_t - \tau_t\}$. We estimate the quadratic trend by the ordinary least square method.

3. GDP Volatility Analysis

In this section we examine the GDP volatility extracted by four different detrending methods. We measure the GDP volatility in terms of the

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3) Ito (1992) suggests two kind of detrending methods. One is the quadratic trend filter. The other is the linear trend filter with an oil-shock dummy variable. We apply the first suggestion and discard the second, because the second detrending method imposes two ad hoc assumptions. They are deterministic trend and a priori given point in time (the oil-shock year) which corresponds to the timing of the structural change of the Japanese economy. Recent research by Takeuchi (1991) reports that the structural change of the Japanese economy is generated not by the first oil-shock but by a regime shift in the exchange rate system.

standard deviations of detrended series. The movement of the filtered series are shown in Figures 1-4. Summary statistics are described in Table 1.

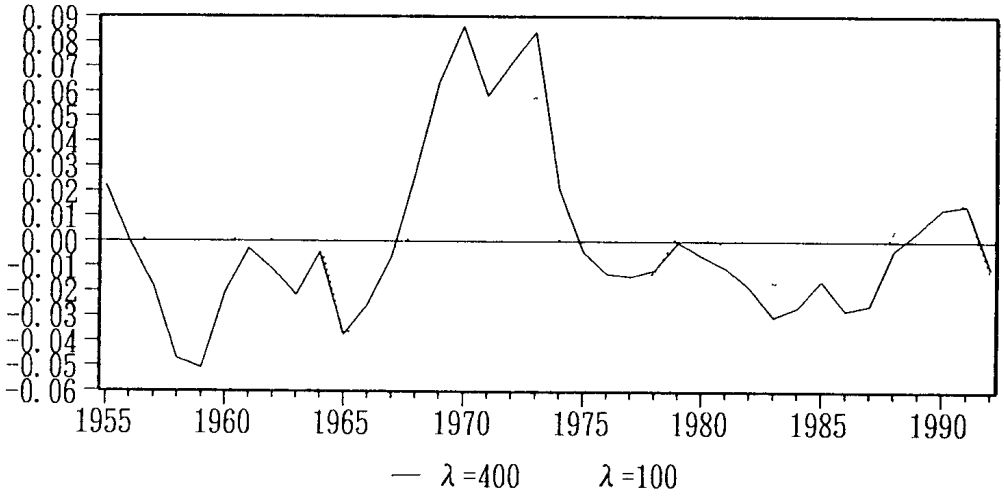

Figure 1. Filtered Series by the HP Trend

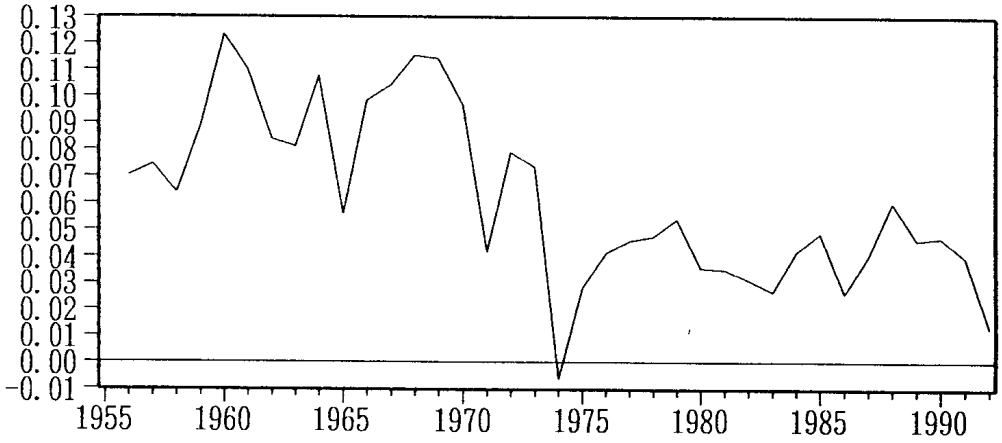

Figure 2. Filtered Series by the First Difference

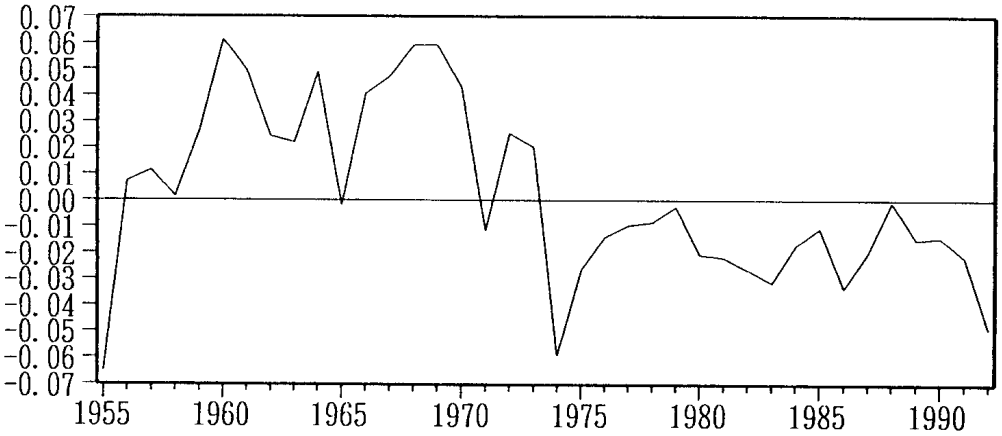

Figure 3. Filtered Series by the Linear Trend

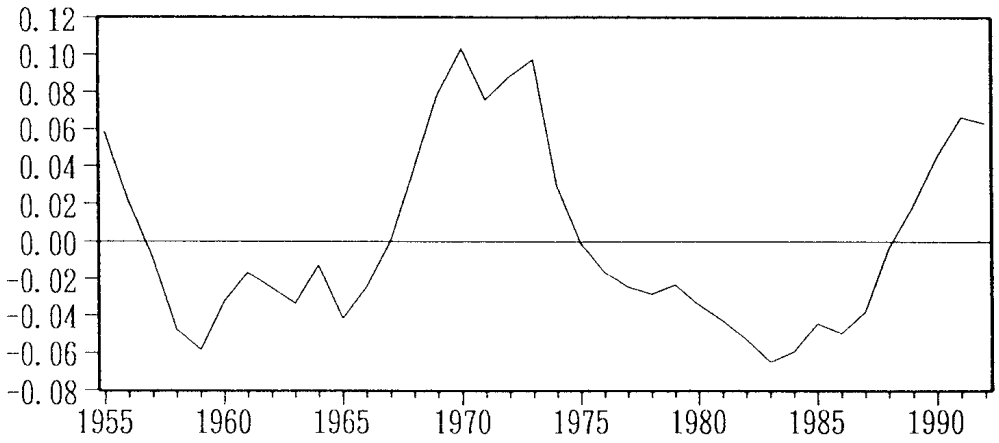

Figure 4. Filtered Series by the Quadratic Trend

Table 1. Postwar Japanese GDP Volatility

	HP Filter ($\lambda=400$)	HP Filter ($\lambda=100$)	First Difference Filter	Linear Trend Filter	Quadratic Trend Filter
1955−1992:	0.0332	0.0237	0.0316	0.0329	0.0486
1955−1972:	0.0403	0.0284	0.0222	0.0308	0.0503
1973−1992:	0.0245	0.0181	0.0165	0.0166	0.0456

From Figures 1-4, we obtain two characteristics of the filtered series for the whole period. First, the movement of the filtered series by the Hodrick-Prescott trend is similar to that by the quadratic trend. Second, the behavior of the filtered series by the first difference is similar to that by the linear trend. In spite of the similarity in the behavior pattern of the filtered series, however, each filter generates different magnitude of the GDP volatility. Roughly speaking, the properties of the filtered series, i.e., the GDP volatility is sensitive to the choice of detrending methods.

For any detrending methods, the GDP volatility in the fixed exchange rate period is larger than that in the flexible exchange rate period. For example, in the case of the Hodrick-Prescott filter with $\lambda=400$, the GDP volatility in the fixed exchange rate period is 0.0403, and the GDP volatility in the flexible exchange rate period is 0.0245. On the other hand, in the case

of the first difference filter, the GDP volatility is 0.0222 in the fixed exchage rate period, while that is 0.0165 in the flexible exchange rate period. The qualitative stylized fact that the GDP volatility in the fixed exchange rate period is larger than that in the flexible exchange rate period is robust to alternative detrending methods.

From Table 1, we can evaluate the effects of the choice of detrending methods on the properties of GDP volatility for any period.[4] For the whole period, we have: $QT > HP_{400} > LT > FD > HP_{100}$. For the fixed exchange rate period, we get: $QT > HP_{400} > LT > HP_{100} > FD$. For the flexible exchange rate period, we obtain: $QT > HP_{400} > HP_{100} > LT > FD$. Thus, except for the Hodrick-Prescott filter with the smoothing parameter $\lambda = 100$, the order of extracted GDP volatility is fixed among the alternative detrending methods regardless of picked-up periods. In other words, the degree of extracted GDP volatility is sensitive to the choice of detrending methods. For any period, the first difference filter gives minimum volatility of GDP. On the other hand, for any period, the quadratic trend filter provides maximum volatility of GDP. The Hodrick-Prescott filter with the smoothing parameter $\lambda = 400$ gives intermediate volatility of real GDP.

4. Concluding Remarks

In this paper we examine the postwar Japanese GDP volatility by

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4) Notations are defined as follows.
HP_{400} : Volatility of filtered series by the HP trend with $\lambda = 400$.
HP_{100} : Volatility of filtered series by the HP trend with $\lambda = 100$.
FD : Volatility of filtered series by the first difference.
LT : Volatility of filtered series by the linear trend.
QT : Volatility of filtered series by the quadratic trend.

alternative detrending methods. At the same time, we investigate the effects of the choice of detrending methods on the properties of GDP volatility under two different exchange rate systems. We find that the qualitative stylized fact that the GDP volatility in the fixed exchange rate period is larger than that in the flexible exchange rate period is robust to alternative detrending methods. We also find the quantitative stylized fact that the degree of extracted GDP volatility for any period is sensitive to the detrending methods.

Data Source

Economic Planning Agency (1991) *Report on National Account from 1955-1989.*
Economic Planning Agency (1992) *Annual Report on National Account 1992.*

Data on 1992 is the preliminary estimate available as of May 1993.

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