International Business and Management
Vol. 1, No. 1. 2010, pp. 41-47
www.cscanada.net

ISSN 1923-841X [PRINT]
ISSN 1923-8428 [ONLINE]
www.cscanada.org

Long-rang Correlation for USD/EUR based on Semi-parametric Estimation[1]

HUANG Fei-xue[2]

SU Jing-qin[3]

Abstract: This paper chooses closing price return rate series of EUR/USD to study. Sample interval covers from 22th July 2005 to 15th Sep 2008(before the financial crisis) and from 16th September 2008 to 19th May 2010(after the financial crisis).The author put forward semi-parameter estimation methods (Standard GPH Method, Tapered GPH Method), and concluded through comparable analysis that: In the conditions of V using $T^{0.5}$、$T^{0.525}$、$T^{0.55}$、$T^{0.575}$、$T^{0.6}$ samples, standard GPH and tapered GPH tests are adopted. The results show that Fractal dimension parameter d is significantly greater than 0 and the statistics are more than critical value of 1% level before financial crisis both EUR/USD. After financial crisis, the parameter has become smaller than that before financial crisis, which is near 0 significantly. In the long term, there is no trend or structural breaks in the exchange market. This study's conclusion was that long-term memory exists in daily return time series of EUR/USD become smaller after financial crisis.

Key words: EUR/USD; semi-parameter estimation methods; financial crisis

1. INTRODUCTION

At the present stage, the scholars in and abroad mostly define Long Memory by Autocorrelation Function and Spectral Density. This paper tries to study Long Memory Semi-parametric Estimation:

1.1 Classical GPH tests

Geweke and Porter-Hudak (GPH, 1983) put forward a semi-parametrical method to test long memory. (Geweke & Porter-Hudak, 1983) Berg and Lyhagen (1998) used GPH method to study Swedish Stock Market. They tested monthly return series between 1919 and 1995, and daily return series and weekly return rate series between 1980 and the middle of 1990, and concluded that monthly return series had

[1] **The research is financed the funds project under the National Science Foundation under Grant No. 71033002; the Ministry of Education of the PRC for young people who are devoted to the researches of humanities and social sciences under Grant No. 09YJC790025.**
[2] Faculty of Management and Economics, Dalian University of Technology, Dalian 116024, China. Email: Software666@dlut.edu.cn.
[3] Faculty of Management and Economics, Dalian University of Technology, Dalian 116024, China.
*Received 5 August 2010; accepted 18 October 2010

significant long memory.（Berg & Lyhagen, 1998） Hongjun Shi, Yulin Ma, and Weizhong Chen (2004） used GPH method to study Shanghai and Shenzhen A share indexes, Shanghai A share 180 indexes, and certain samples of Shenzhen stock indexes. They concluded that, return rate series of Shanghai market did not have long memory, and that of Shenzhen market had some long memory characteristics; return rate fluctuation series of both Shanghai and Shenzhen markets had highly significant long memory characteristics. (SHI et al., 2004) Renhai Hua and Baizhu Chen (2004) used GPH method to test China future market. They used the series of future price returns and fluctuation variance of copper, aluminum, soybean, rubber and maize to do an empirical study and concluded that, future price return series of copper and aluminum did not have long memory, while the fluctuation variances series of which had long memory; future price series and the fluctuation variance series of soybean were neither with long memory characteristics. (LUO, 2005) Xingqiang He (2005) used GPH method to study the closing price index series of Shanghai A and B shares between 1st March, 1993 and 24th September, 2004, and closing price index series of Shenzhen A and B shares between 1st January, 1996 and 24th September, 2004, and concluded that, daily return rates and weekly return rates were with no significant long memory. (CAO, 2008)

1.2 Tapered GPH tests

Dengyue Luo (2005) used GPH and tapered GPH methods to study index return rates of Shanghai and Shenzhen stock markets and the fluctuation of which, and concluded that, return rate series of Shanghai market were without long memory, while series of return rate on Shenzhen market were with some kind of long memory characteristics. (Cajueiro & Tabak, 2005)

Semi-parametric estimation has advantages that the fractal degree d is more precise, which provides a found basic of the latter model building. There are also some shortcomings that when the time series are caused by structural or trend break, there might be larger errors through GPH tests. Tapered GPH method could just make up the shortage. Meanwhile, this could be used to determine whether there are structural breaks in the time series. In a word, spectral density method is mainly used to further modeling work, of which the calculations are more complex.

2. METHOD

2.1 Histogram test on distribution of returns

This is a kind of direct test of normality, which could directly check the differences between histograms and normal distribution curves. If return histograms and normal distribution curves are obviously different, then we could not consider the return series on the focused exchange market are normally distributed. (CAO, 2008)

2.2 Jarque-Bera (JB) test

As to exchange return series $\{R_t\}(1 \le t \le N)$, sample mean value is $\hat{\mu}$, sample standard deviation is $\hat{\sigma}$, while the sample skewness and sample kurtosis are:

$$\hat{S} = \frac{1}{\hat{\sigma}^3}\frac{1}{N}\sum_{t=1}^{N}(R_t - \hat{\mu})^3 \qquad (1)$$

$$\hat{K} = \frac{1}{\hat{\sigma}^4}\frac{1}{N}\sum_{t=1}^{N}(R_t - \hat{\mu})^4 \qquad (2)$$

If $\{R_t\}(1 \le t \le N)$ is part of normal population, then $\hat{S} / \sqrt{6/N}$ and $(\hat{K}-3) / \sqrt{24/N}$ are approximate standard normal distributions. If tested sample skewness and sample kurtosis are far more than 3times of standard deviation, the return series distribution is far beyond normal distribution, which is one of the important characteristics of nonlinearity.

JB statistics are:

$$JB = N[\hat{S}^2 + (\hat{K}-3)^2 / 4] / 6 \qquad (3)$$

$H_0 : R_t \sim N(0, \delta^2), \hat{S} = 0, \hat{K} = 3, JR \sim \chi^2(2)$. JB test is a joint test of sample skewness and sample kurtosis.

2.3 Standard GPH (Logarithm Period Gram) method

Geweke and Porter (1983) put forward a semi-parametrical method to calculate long memory coefficient *d*. They set a logged series as $\{X_t\}$, t=1,2,.....,T.

$$I(\xi) = \frac{1}{2\pi T}\left|\sum_{t=1}^{T} e^{it\varepsilon}(X_t - \bar{X})\right|^2 \qquad (4)$$

In order to get period figure of $\{X_t\}$ at the frequency of ,the definition of spectral regression is as function (21) .

$$\ln\{I(\xi)\} = \beta_0 + \beta_1 \ln\left\{4\sin^2(\frac{\xi_j}{2})\right\} + \eta_j \qquad (5)$$

$\xi_j = \frac{2\pi j}{T}$, j=1, 2 , ... v, is sample Fourier frequency; $v = g(T) < T$ is the number of Fourier frequency; $d=-\beta_1$ is the coefficient to check out long memory of series.

2.4 Tapered GPH Method

When slowly fading trend or structural sudden break occur, the above GPH estimated value would appear enormous bias. Under this situation, tapered GPH estimation turns out to be very stable [21]. The after tapered process { $\omega_t e^{it\xi_j}$ } could be define by period gram as below.

$$I_\omega(\xi_j) = \frac{1}{2\pi\sum_{t=1}^{T} w_t^2}\left|\sum_{t=1}^{T} w_t e^{it\xi_j}(X_t - \bar{X})\right|^2 \quad (6)$$

$w_t = \frac{1}{2}\left[1 - \cos(\frac{2\pi(t+0.5)}{T})\right]$, and the fractal regression would be as below.

$$\ln\{I(\xi)\} = \beta_0 + \beta_1 \ln\left\{4\sin^2(\frac{\xi_j}{2})\right\} + \eta_j \quad (7)$$

3. EXPERIMENTAL PROCEDURES AND THE RESULTS

3.1 Data Sources and preprocessing

This paper uses daily exchange closing price series of EUR/USD, since the begging when euro was put into use. The sample covers from 22th July 2005 to 15th Sep 2008(before the financial crisis) and from 16th September 2008 to 19th May 2010(after the financial crisis).. The data source is from Shihua Financial Report. In the experimental analysis, original data forms a time series as $\{P_t\}$. First, take the series of logged returns as below.

$$R_t = \log(P_t / P_{t-1}) \qquad (8)$$

R_t represents logged returns a the moment of t; P_t represents closing exchange prices at the moment of t.

3.2 Normality test

Some basic statistics of daily return rate of EUR/ USD and JB test results are shown in Figure 1、2. The bias of daily exchange return rate distribution is not 0; kurtosis of the three are larger than3, showing a peak situation. The estimated value of JB test statistics is far larger than threshold values by 1%, 5%, thus null hypothesis of normal distribution is rejected.

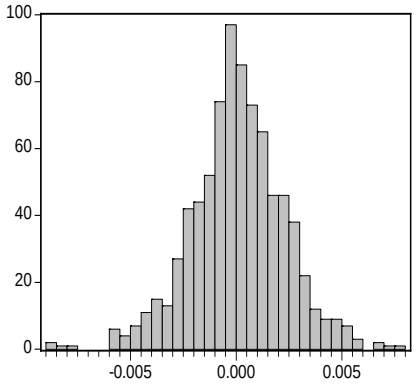

Fig.1: Histogram of daily return of EUR/USD before financial crisis

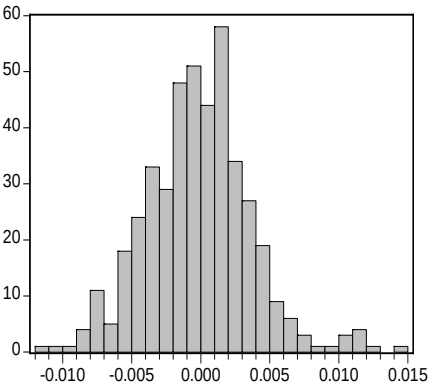

Fig.2: Histogram of daily return of EUR/USD after financial crisis

Figure 1, 2, Separately show that there are obvious shortages using normal distribution method to picture the distribution characters of exchange prices. And that shows that:

3.3. Standard and tapered GPH tests

Using GPH test method, this paper estimates EUR/USD daily return rate series with the fractal degree d, under 5 conditions when $V= T^{0.5}$, $V= T^{0.525}$, $V= T^{0.55}$, $V= T^{0.575}$, and $V= T^{0.6}$, in order to form a t statistic to test the significance.

Table 1: Test results of daily return of EUR/USD before financial crisis

Sample T	V=T^0.5	V=T^0.525	V=T^0.55	V=T^0.575	V=T^0.6
Standard GPH d_1	0.167(-2.2)	0.135(-1.74)	0.093(-1.1)	0.18(-1.38)	0.047(-2.53)
tapered GPH d_2	0.153(-3.12)	0.08(-1.87)	0.082(-1.35)	0.173(-2.11)	0.052(-2.36)

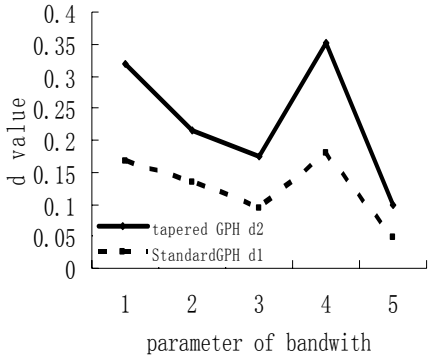

Fig. 3: GPH Test of Daily Return of EUR /USD before financial crisis

Table 2: Test results of daily return of EUR/USD after financial crisis

Sample T	V=T^0.5	V=T^0.525	V=T^0.55	V=T^0.575	V=T^0.6
Standard GPH d_1	0.124(-19.2)	0.141(-16.3)	0.079(-5.18)	0.079(-1.38)	0.06(-3.86)
tapered GPH d_2	0.113(-4.30)	0.121(-2.17)	0.063(-2.51)	0.061(-2.27)	0.045 (-2.36)

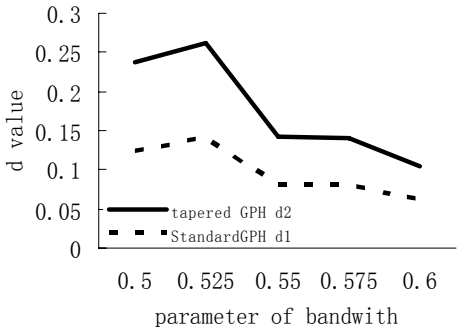

Fig. 4: GPH Test of Daily Return of EUR /USD after financial crisis

Through Table 1, 2 , we can see that, no matter we take standard GPH method or tapered GPH method, fractal degree d is larger than 0 and the t test is significant before financial crisis . After financial crisis, the parameter has become smaller than that before financial crisis, which is near 0 significantly. Furthermore, under the condition of small sample this situation is extremely obvious. As we enlarge the scale of sample, d has a trend to become smaller, which, could explain there is long memory in the series of EUR/USD, daily return rate, on the other hand, using the fractal function density method. Meanwhile, the results above also shows that when that sample is small, standard GPH and tapered GPH have some differences; while the sample grows, d becomes similar, meaning that in the long term, there is no trend or structural breaks.

Explanation:

(1) During the financial crisis lots of people suffered considerable losses from the exchange rate market, so they adopted more cautious attitude, collected more information to make their decisions .In a word, people become more rational.

(2) After the financial crisis all kinds of information rushed into the exchange rate market, making the impact at beginning having little effect to the changes following.

4. CONCLUSIONS

This paper chooses closing price return rate series of EUR/USD to study. Sample interval covers from 22th July 2005 to 15th Sep 2008(before the financial crisis) and from 16th September 2008 to 19th May 2010(after the financial crisis). The research is based on long memory theories and takes the method of non-parametrical statistics, including classical R/S method, modified R/S method, and V/S method, and semi-parametric estimations, including classical GPH method, and tapered GPH method. The paper concludes as below.

(1) Normality test of daily return rate series between EUR/USD shows that the skewness of daily return rate distribution is not 0; kurtosis of which is greater than 3, Showing peak and fat tail postures.

There is quantity of values concentrated around mean value. On each side of the histogram, there are some points that could not be ignored. That means the daily return rate series of EUR/USD is not like that in the traditional effective markets, in which time series is random.

(2) Estimated value of JB test if far larger than the threshold values at 1%, and 5%, which means the null hypothesis of normal distribution is rejected.

This step reveals that daily return rate series of EUR /USD is not under normal distribution, which is the foundation of the Fractal Market Hypothesis, and the foundation of this paper in researching the long memory of daily return rate series of EUR / USD.

(3) Viewing through semi-parametric estimation, EUR/USD daily return rate series has long memory.

This paper estimates one of the fractal features, long memory, using standard GPH test and tapered GPH test, and concludes that d is obviously larger than 0, under 5 conditions when V are selected according to T0.5, T0.525, T0.55, T0.575, and T0.6. The d is significant even under the condition of 1%. Results show that EUR/USD daily return rate has long memory.

In the end, this paper compares among the 5 methods which all conclude to long memory existence of EUR/USD daily exchange return rate series. On the market of euro exchanges, EUR/USD daily return rate series has the characteristics of long memory, which predicts that some accidental events might influence the following return rates. EUR/USD daily return rate series has no structural breaks through standard GPH test and tapered GPH test.

There are some mighty explanations about the existence of long memory of EUR/USD return rates.

(1) EUR/USD exchange market has information asymmetry among participants.

International exchange market is the largest financial market in the world. As one of the main currencies in international exchange market, the changing process of EUR/USD return rates is the result of a game among many participants. The ones with private information have the motives to take advantages from the private information. That makes them the maker and the user of the information at the same time. That would be shown in their behaviors as not telling truth and not following promises, which lead to fraud and insider trading. The basic measure to solve the problem of information asymmetry is the designation of regimes (institutions). The government should set a whole bulk of regimes incentive people to tell the truth and to follow the promises.

(2) There are different responses among participants on exchange market to information.

Different participants may differ in responding to information, as they probably have different knowledge backgrounds, beliefs, preferences to risk, investment limits, capital scale and etc. Generally speaking, central bank and international exchange bank are more reasonable in dealing with the information; while international exchange agents and other small investors probably show unreasonably respond to the information. Thus under most situations, small investor would respond in a lagged or over reacted way, which leads to non-linear inconsistent response pattern, the long memory.

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