Temporal Changes in Shiller's Exuberance Data

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Abstract:

Robert Shiller's' Paper on 'The Volatility of Stock markets Prices' published in 1987 uses dividend data and real interest rates to seek evidence that true investment value changes through time sufficiently to justify the price changes. His paper concluded that most of the volatility of the stock market prices appears unexplained. Shiller volatility or fluctuations prove that behavior of markets is not normal. Non normal distribution series is a widely followed proof of inefficiency in prices.

The authors of the current paper reanalyze Shiller's data not for the change but for rate of change. The rate of change in dividend values, interest rates and market price is used to isolate temporal changes (time durations) defined in days. Though on one side the time duration data illustrate a non normal distribution and confirms Shiller's non normalcy finding within value (fundamental data) and market data, it opens a larger debate suggesting temporal changes to be the reason for market volatility and inefficiency.

Keywords: Stock market volatility, Temporal Changes, Non Normal Distributions

JEL Classification: G10
REL Classification: 11B

Introduction

We took data series Long Interest Rate Rates GS10, Real Price, Real Dividend, Real Earnings (Column G,H, I, J) from Shiller's data available on his Yale page (Copy of ie_data.xls) and plotted the rate of change for the respective data series. From this rate of change date we isolate the temporal changes as explained by Nistor, Pal in their paper on 'Time Duration Decay'2010. After isolation the time duration data we created the time duration plot and tested the data for normal distribution.

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1. Long Interest Rates

Here we analyze monthly series of Long Interest rates from January, 1871 to November, 2010. 14 months Interest rates ratio is plotted below.

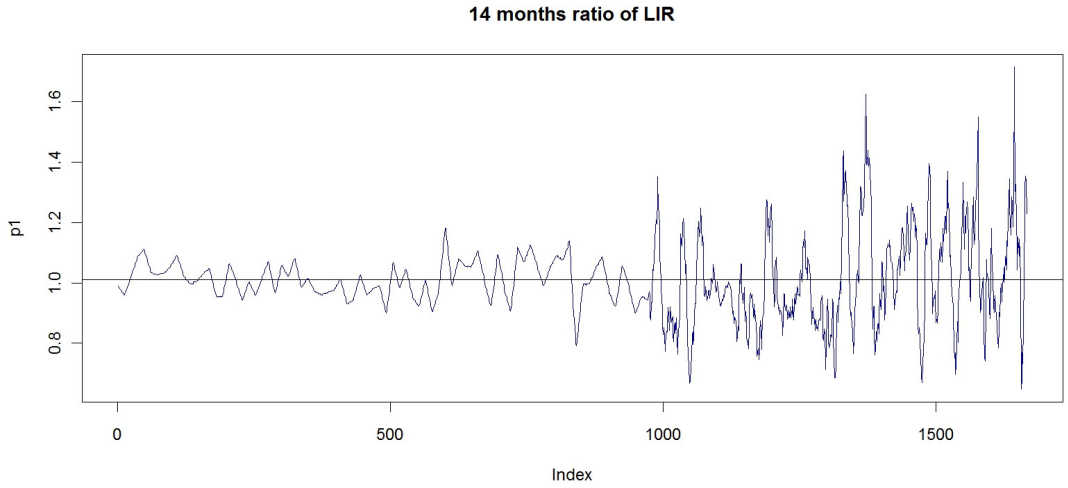

Figure 1:14 months ratio of Long Interest Rates

Above we see that the 14 months ratio of interest rates continuously reverts back to its mean of 1.010558 (horizontal black line). Oscillation of the ratio series is not very volatile initially but in the second half of the series, from 1987, we see that the ratio of the interest rates is very high indicating large movements in interest rates. The number of months taken by the interest rates ratio series to cross the mean value of 1.010558 each time is plotted below, with values in ascending order.

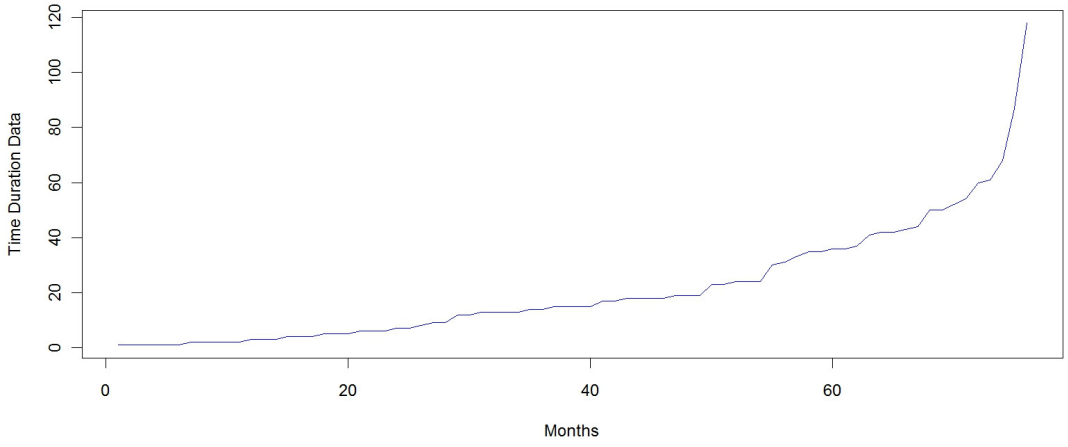

Figure 2: Time Duration Plot

The empirical density plot of the time duration data of long interest rates in months against

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Normal density is plotted below. Parameters for Normal density are obtained using Maximum Likelihood Estimation (MLE). Parameters of the series in figure 2 is : $\mu = 21.58287$ and $\sigma = 21.64931$.

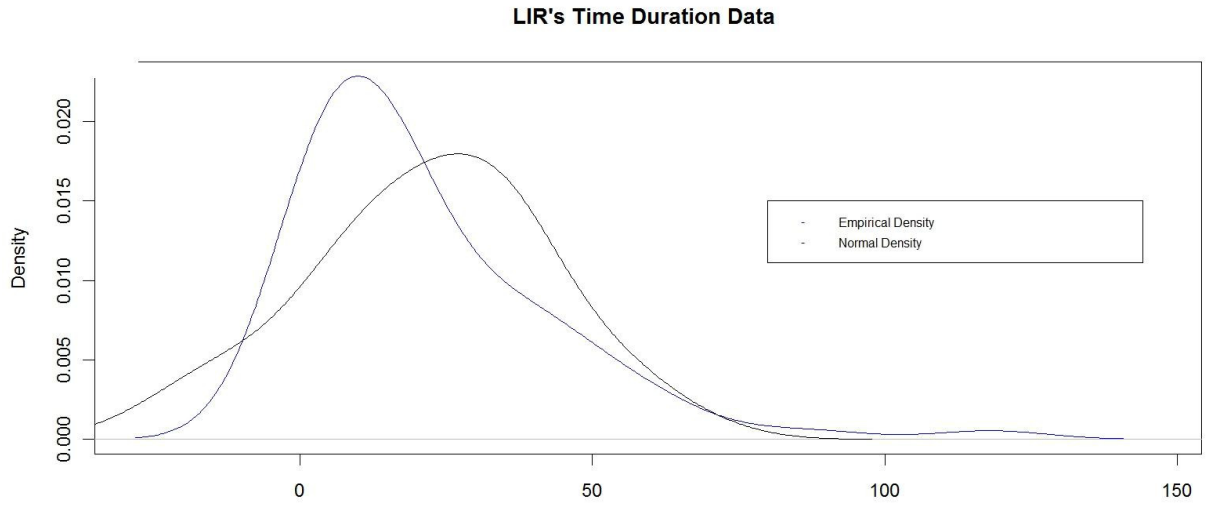

Figure 3: Density Plot

The Normal density plot in black has a slightly different shape. This is because of the high standard deviation of 21.64931 against the mean of 21.58287. The plot above suggests that the time plot is not normal. In order to confirm our results we look at the Q-Q plot of the series as well as test for normality using Shapiro–Wilk test.

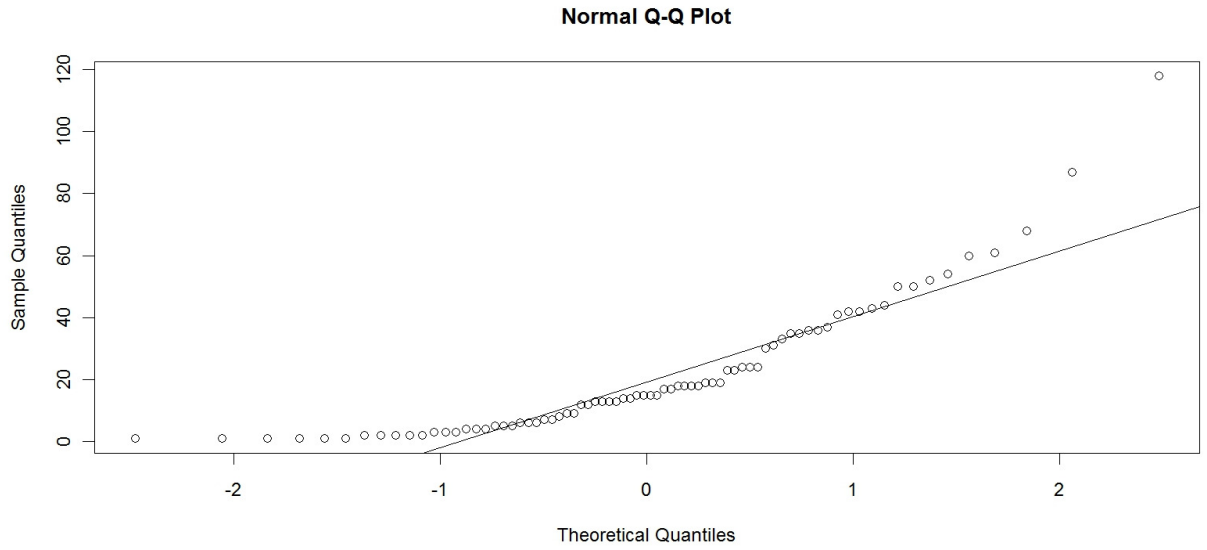

Figure 4: Q-Q plot

We see that the data points towards both the tails are extremely away from the straight line at 45 degrees. Thus confirming our initial guess of non-normality in the series.

Shapiro–Wilk test has the following output.
Test Statistics : W = 0.8222 and p-value = 3.836e − 08

Since the p-value is well below any significance level we would like to select, we reject the Null hypothesis of Shapiro-Wilk test of normally distributed data. Thus we conclude that time duration data of long interest rate to cross over its mean is not normally distributed.

2. Real Prices

Here we analyze monthly series of Real Prices rates from January, 1871 to December, 2010. 14 months Real Prices ratio is plotted below.

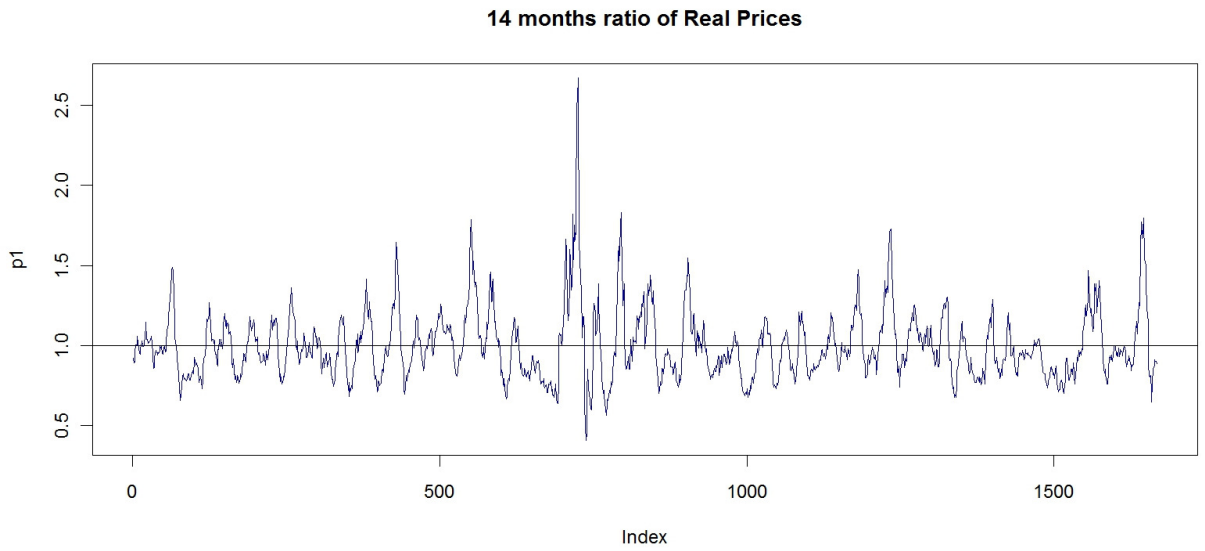

Figure 5: 14 months ratio of Real Prices

Above we see that the 14 months ratio of real prices continuously reverts back to its mean of 1.000029 (horizontal black line). The number of months taken by the interest rates ratio series to cross the mean value of 1.000029 each time is plotted below, with values in ascending order.

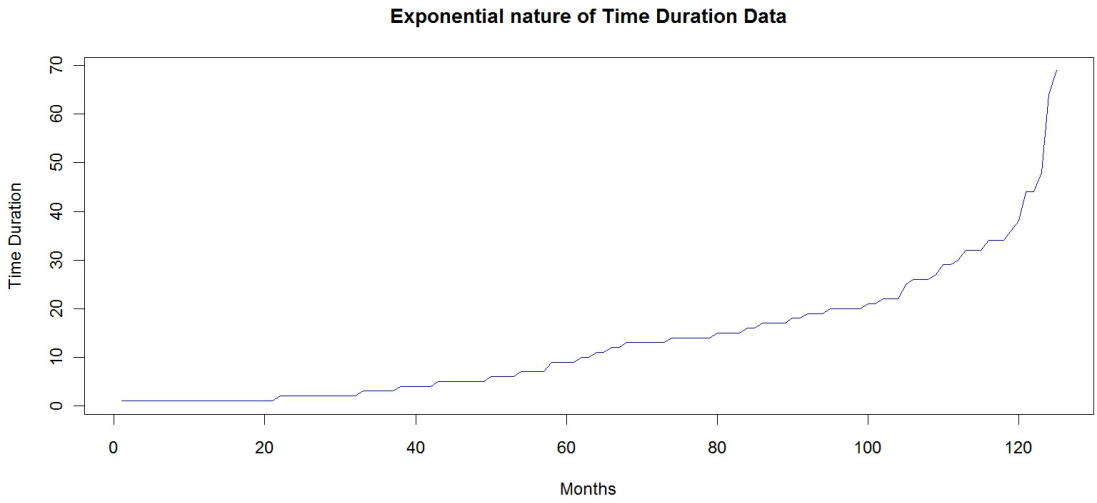

Figure 6: Exponential Nature of Time Duration Data

The empirical density plot of the Time duration data of Real Prices in months against Normal density is plotted below. Parameters for Normal density are obtained using Maximum Likelihood Estimation (MLE). Parameters of the series in figure 6 is : $\mu = 13.19291$ and $\sigma = 12.99212$.

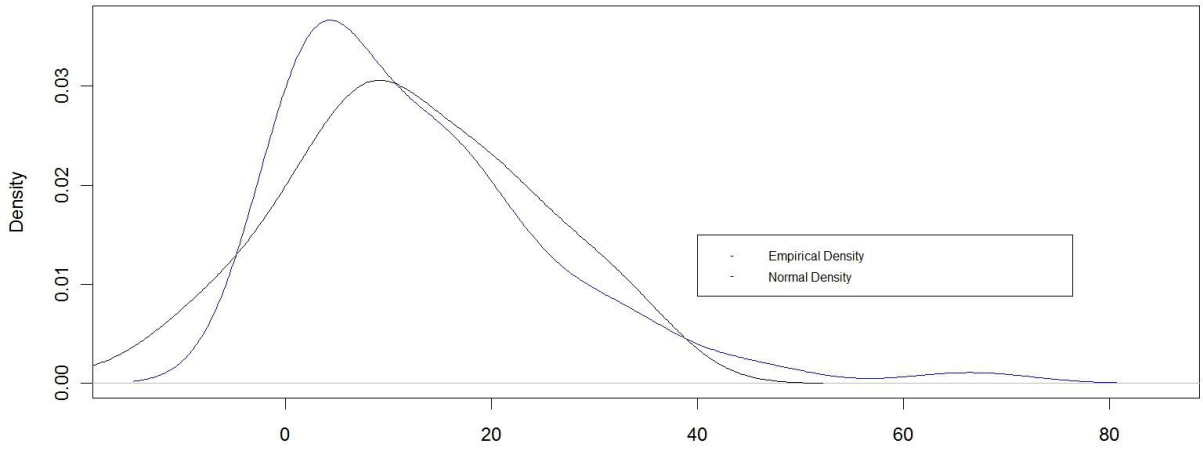

Figure 7: Density Plot

The Normal density plot in black has a slightly different shape. This is because of the high standard deviation against the mean. The plot above suggests that the time duration data is not normal. In order to confirm our results we look at the Q-Q plot of the series as well as test for normality using Shapiro–Wilk test.

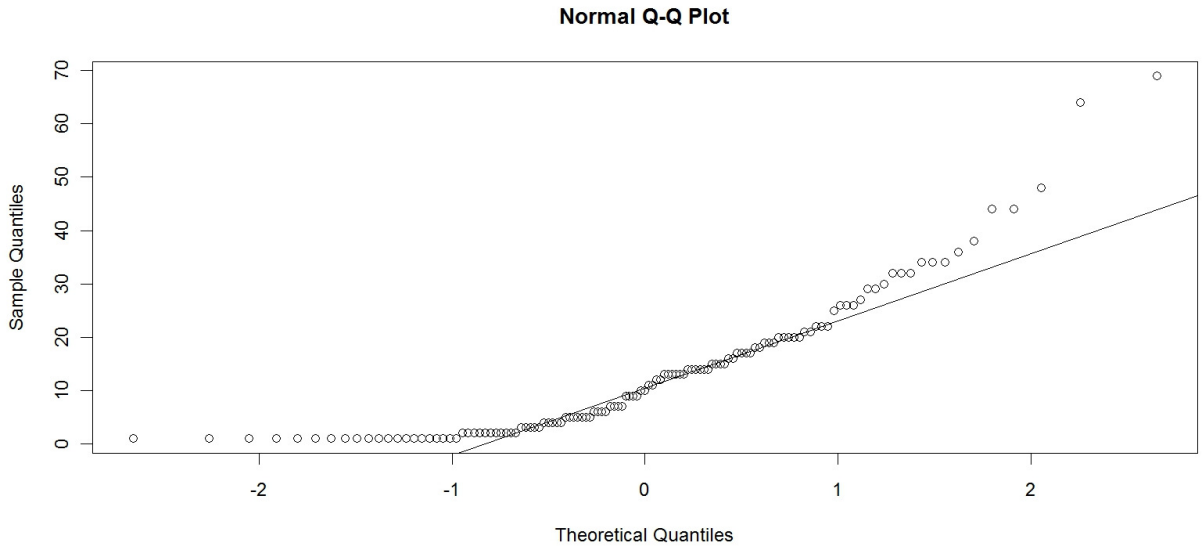

Figure 8: Q-Q plot

We see that the data points towards both the tails are extremely away from the straight line at 45 degrees. Thus confirming non-normality. Shapiro–Wilk test has the following output.

Test Statistics : W = 0.8383 and p-value = 2.189e – 10.

Since the p-value is well below any significance level we would like to
select, we reject the Null hypothesis of Shapiro-Wilk test of Normally distributed data.

Thus we conclude that time duration data of Real Prices ratios to cross over its mean is not normally distributed.

3. Real Dividends

Here we analyze monthly series of Real Dividends rates from January, 1871 to September, 2010. 14 months Real Dividends ratio is plotted below.

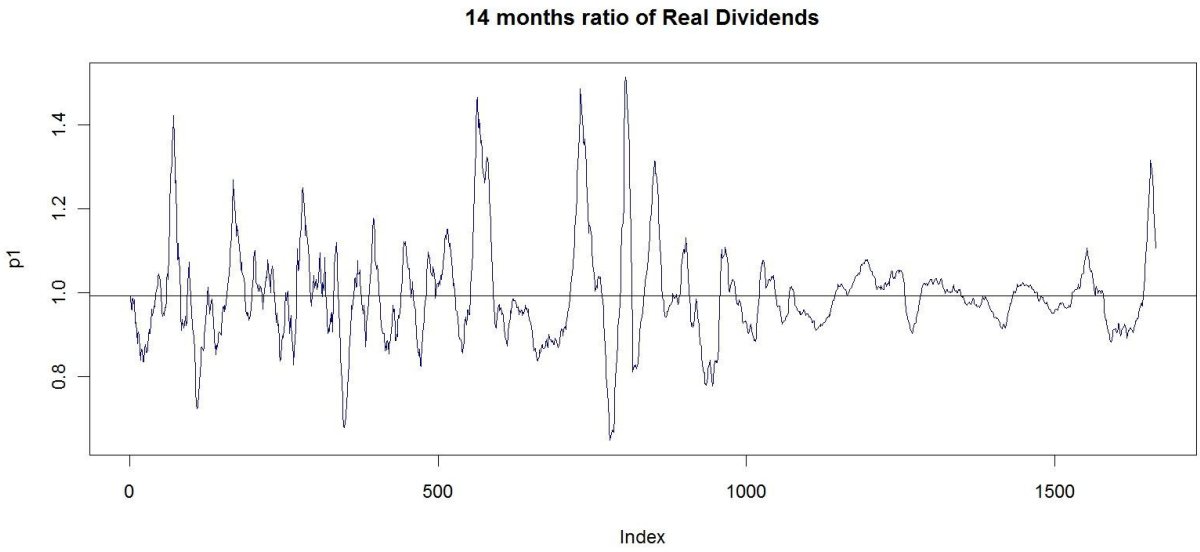

Figure 9: 14 months ratio of Real Dividends

Above we see that the 14 months ratio of real prices continuously reverts back to its mean of 0.9938736 (horizontal black line). The number of months taken by the interest rates ratio series to cross the mean value of 1.000029 each time is plotted below, with values in ascending order.

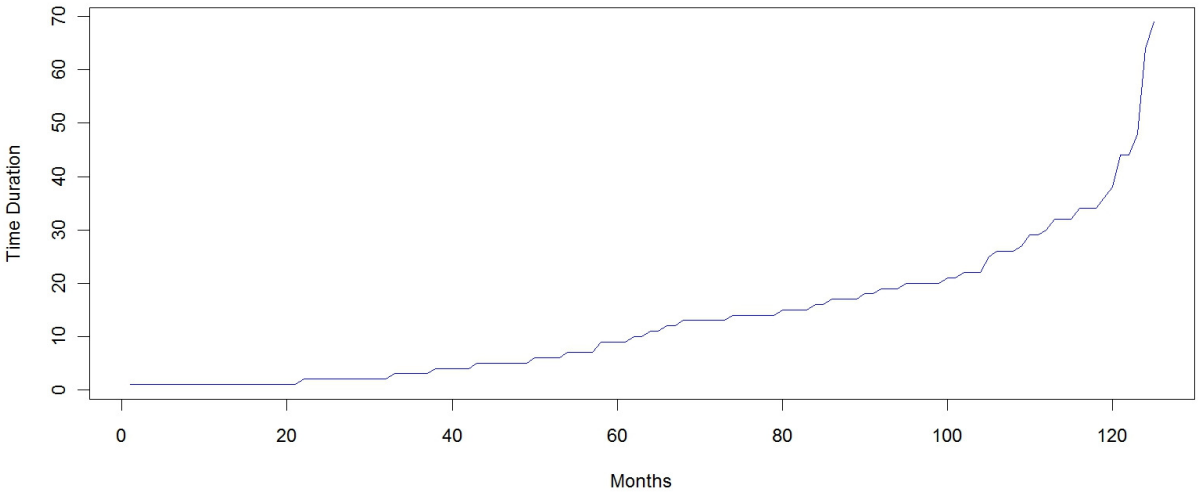

Figure 10: Exponential Nature of Time Duration Data

The empirical density plot of the time duration data against normal distribution is below.

Parameters for Normal density are obtained using Maximum Likelihood Estimation (MLE). Parameters of the time duration data in figure 10 is : $\mu = 13.19291$ and $\sigma = 12.99212$.

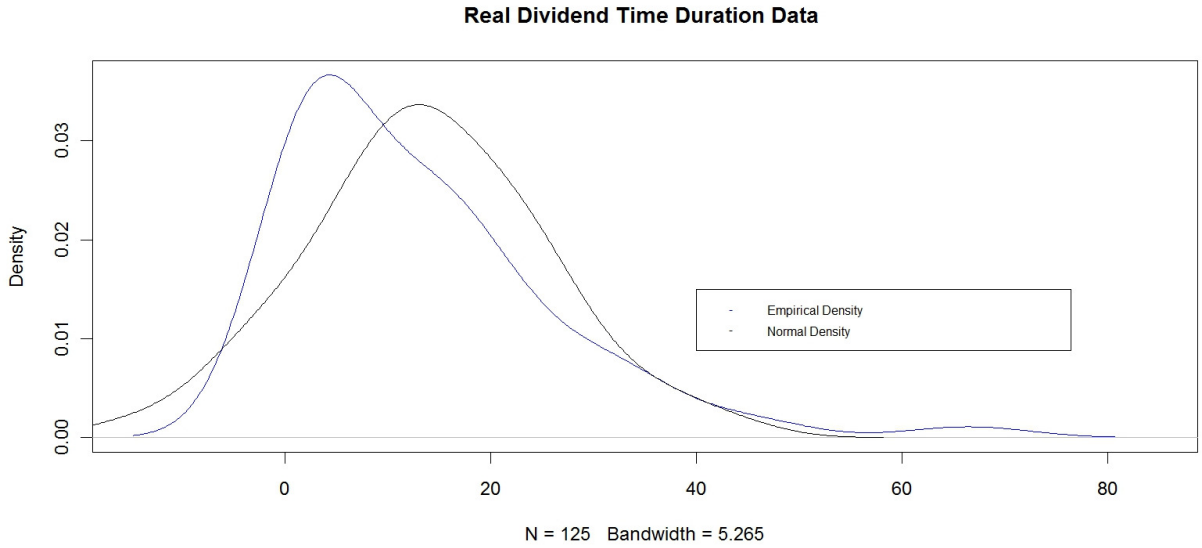

Figure 11: Density Plot

The Normal density plot in black has a slightly different shape. This is because of the high standard deviation against the mean. The plot above suggests that the time plot is not normal. In order to confirm our results we look at the Q-Q plot of the series as well as test for normality using Shapiro–Wilk test.

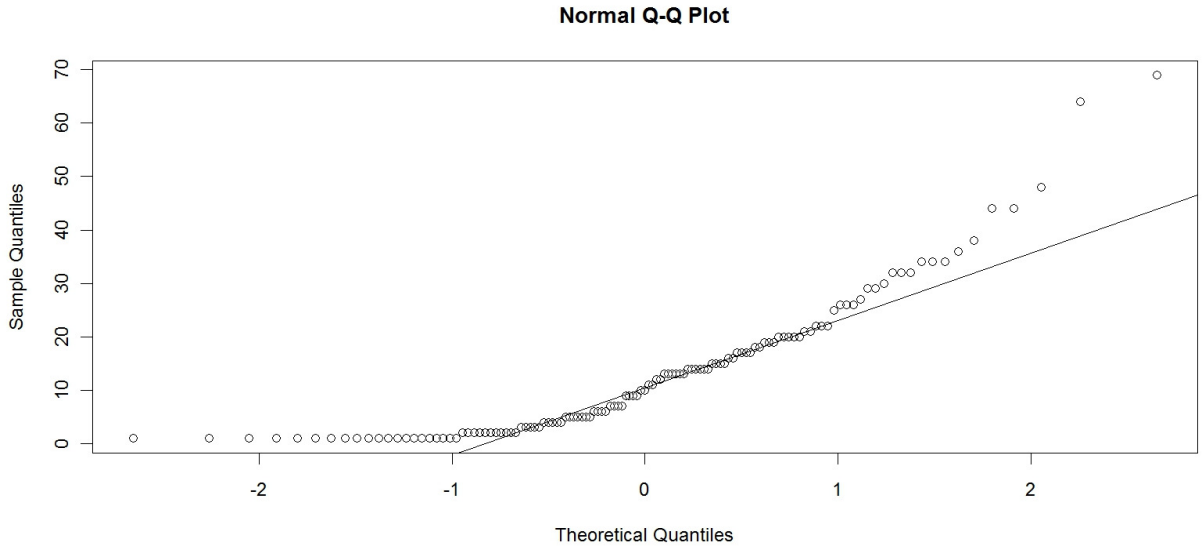

Figure 12: Q-Q Plot

We see that the data points towards both the tails are extremely away from the straight line at 45

degrees. Thus confirming non-normality. Shapiro–Wilk test has the following output.

Test Statistics : W = 0.8383 and p-value = 2.189e – 10.

Since the p-value is well below any significance level we would like to select, we reject the Null Hypothesis of Shapiro-Wilk test of Normally distributed data. Thus we conclude that time taken by the Real Prices ratios to cross over its mean is not normally distributed.

4. Real Earnings

Here we analyze monthly series of Real Dividends rates from January, 1871 to July, 2010. 14 months Real Earnings ratio is plotted below.

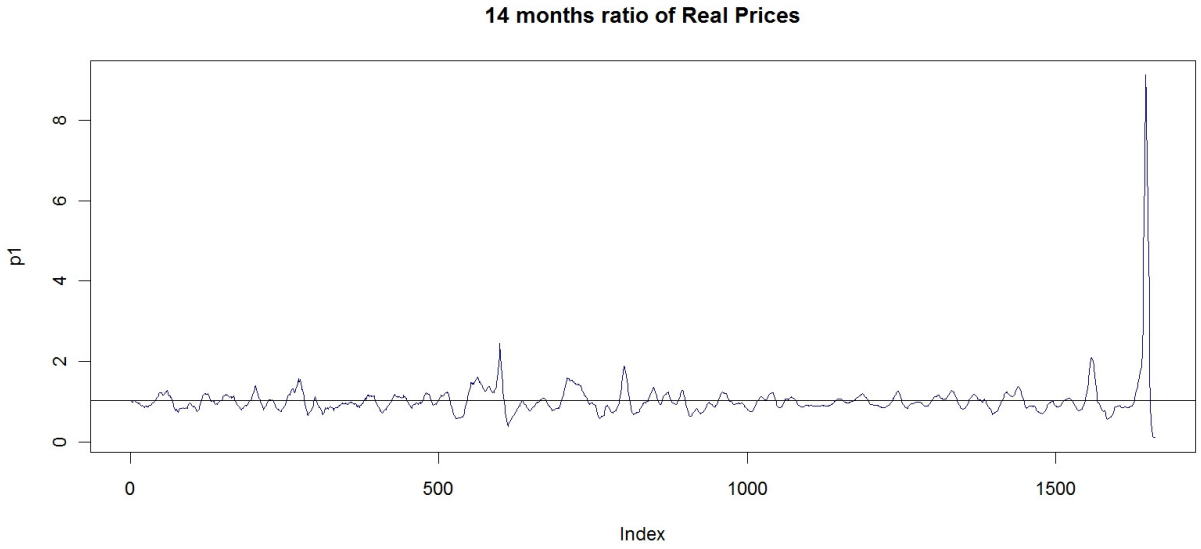

Figure 13: 14 months ratio of Real Earnings

Above we see that the 14 months ratio of real prices continuously reverts back to its mean of 0.9938736 (horizontal black line). The number of months taken by the interest rates ratio series to cross the mean value of 1.000029 each time is plotted below, with values in ascending order.

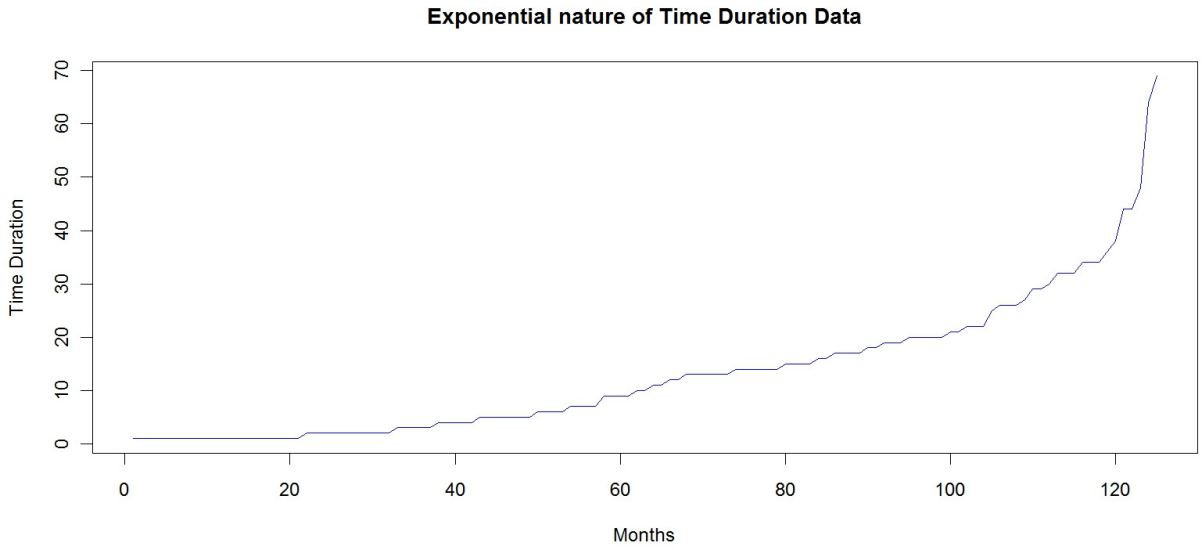

Figure 14: Exponential Nature of Time Duration Data

The empirical density plot of the time duration data of Real Earnings in months against Normal density is plotted below. Parameters for Normal density are obtained using Maximum Likelihood Estimation (MLE). Parameters of the series in figure 14 is : $\mu = 24.29563$ and $\sigma = 15.73603$.

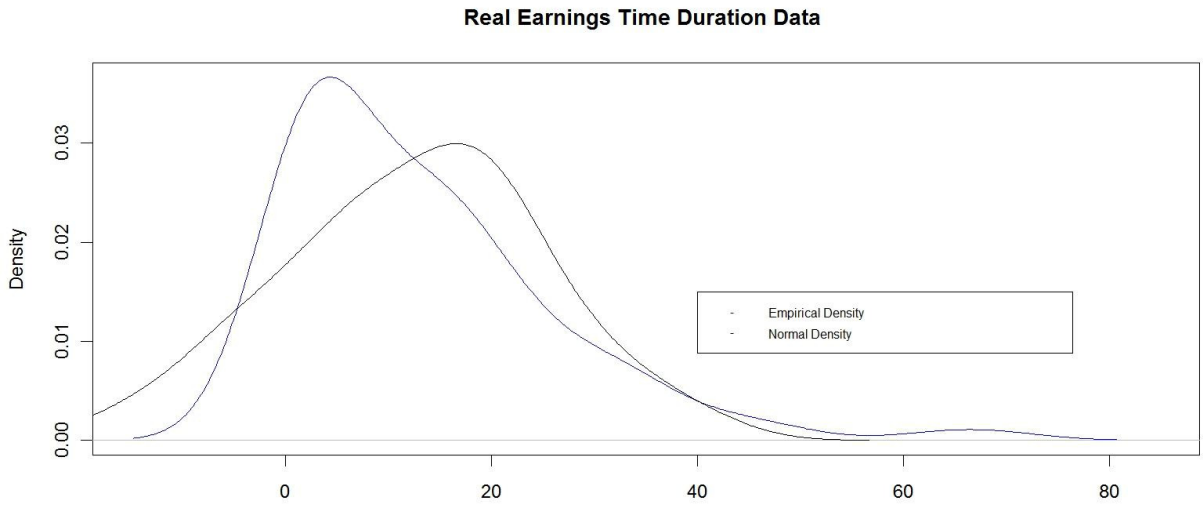

Figure 15: Density Plot

The Normal density plot in black has a slightly different shape. This is because of the high standard deviation against the mean. The plot above definitely suggests that the time plot is not normal. In order to confirm our results we look at the Q-Q plot of the time duration data as well
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as test for normality using Shapiro–Wilk test.

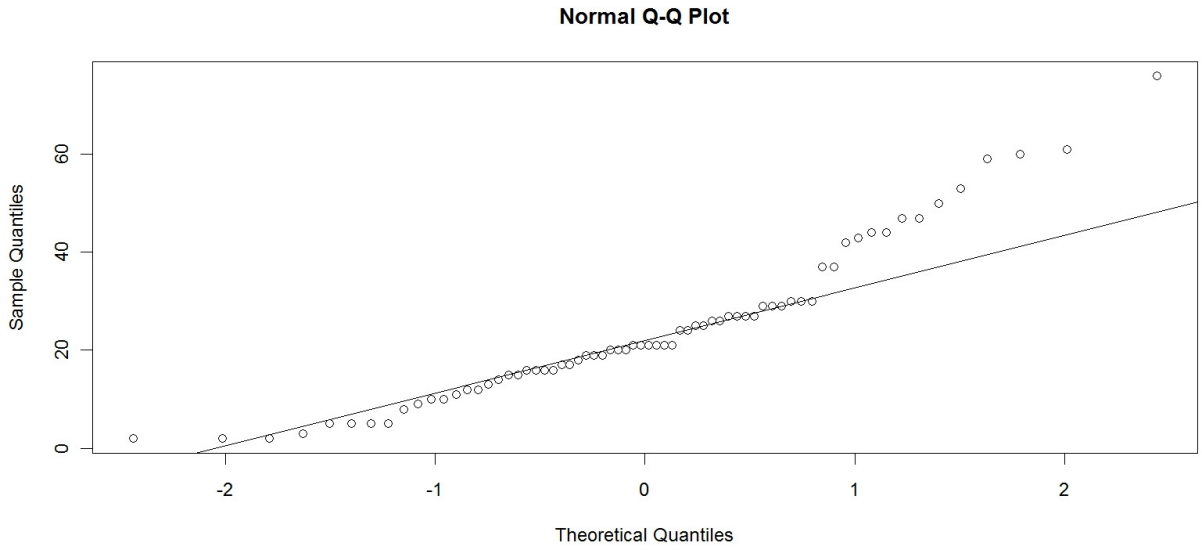

Figure 16: Q-Q Plot

We see that the data points towards both the tails are extremely away from the straight line at 45 degrees. Thus confirming non-normality. Shapiro–Wilk test has the following output.

Test Statistics : W = 0.921and p-value = 0.0003606.

Since the p-value is well below any significance level we would like to select, we reject the Null hypothesis of Shapiro-Wilk test of Normally distributed data. Thus we conclude that time duration data of Real Earnings ratios is not normally distributed.

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