How Periodic Are the Oil Price Fluctuations?

Posted by Sam Foucher on September 22, 2006 - 11:20am
Topic: Economics/Finance
Tags: oil prices, periodicity transform [list all tags]

The amplitude of the big slide in oil prices from $75 to $61 was a little bit a surprise for everybody. I'm trying to answer the following question: is this big drop significant or simply a consequence of a very volatile market?

There are some cycles in oil price fluctuations. For instance, the seasonal fluctuations in oil demand or even the change of oil contract at the end of each month. On top of that, there is the usual chaos of geopolitical events, Hurricanes, etc.. The objective is to see if we can apply the Periodicity Transform in order to capture eventual cycles and get an idea of future oil market volatility.

I consider the prices from 2002 to end of July 2006 (the data is from the EIA). We fit a straight line in the log domain (Fig. 1). The fit is quite nice with a correlation coefficient equals to 0.97, the slope is 0.2615/year which represents a 30% per year increase in prices.

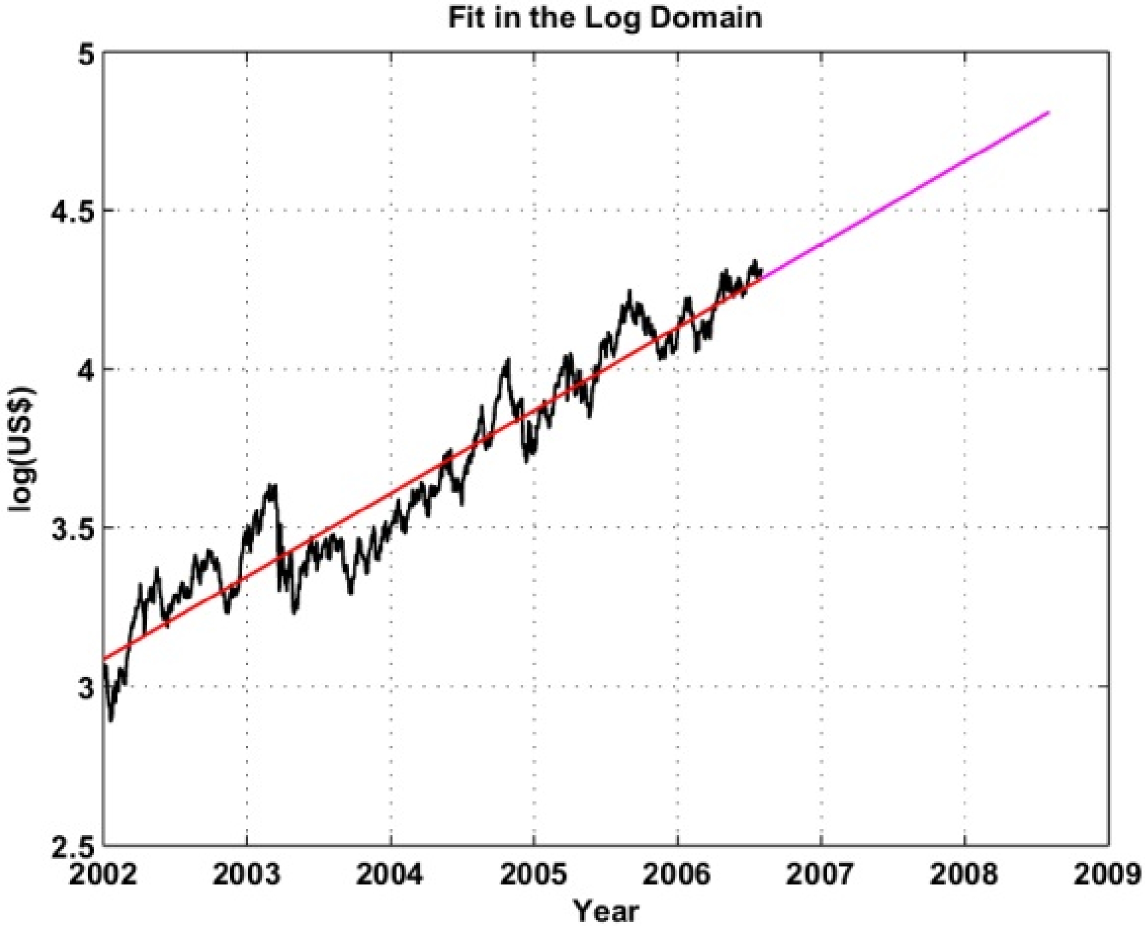
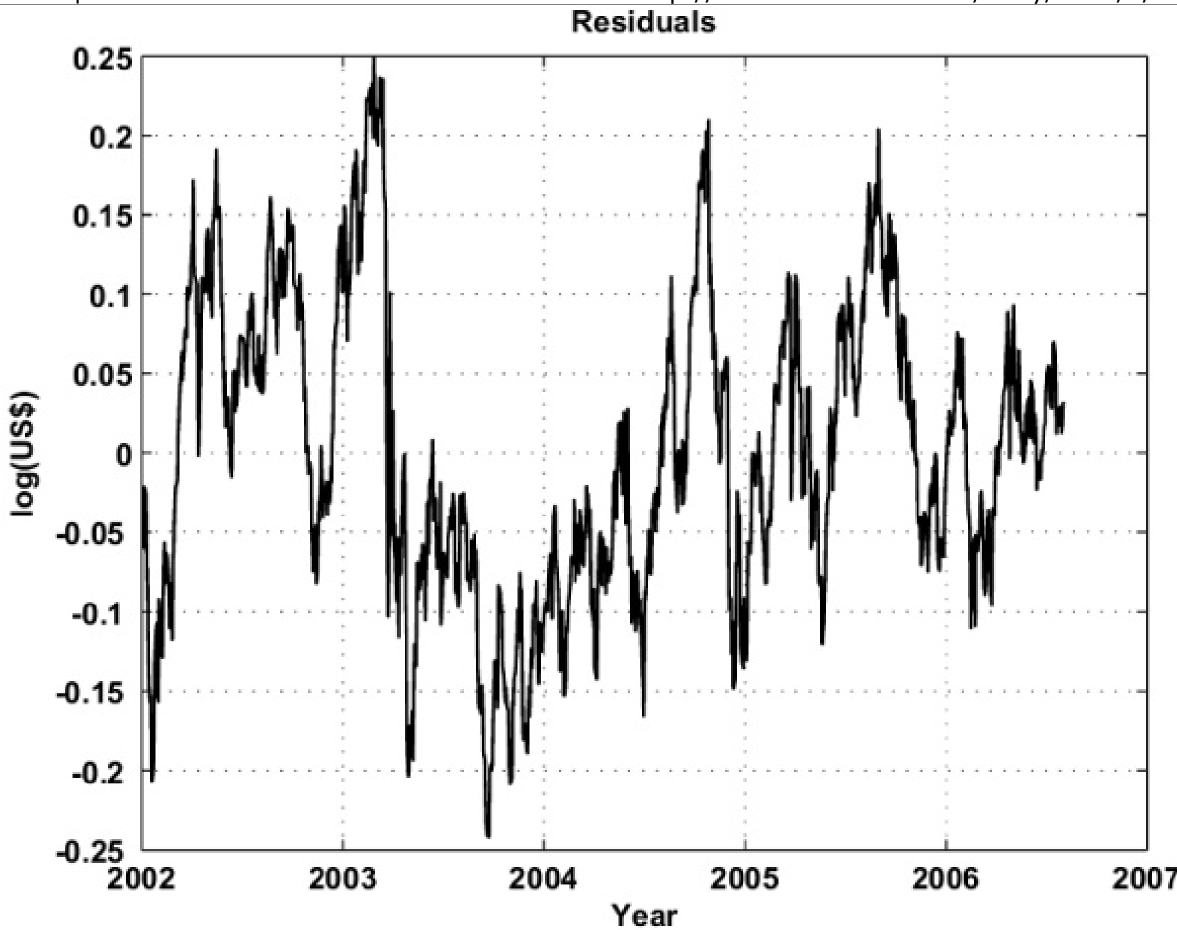


Fig 1.- Linear fit in the log domain. Click to enlarge.

The residuals are Gaussian distributed with a standard deviation equals to 0.095:



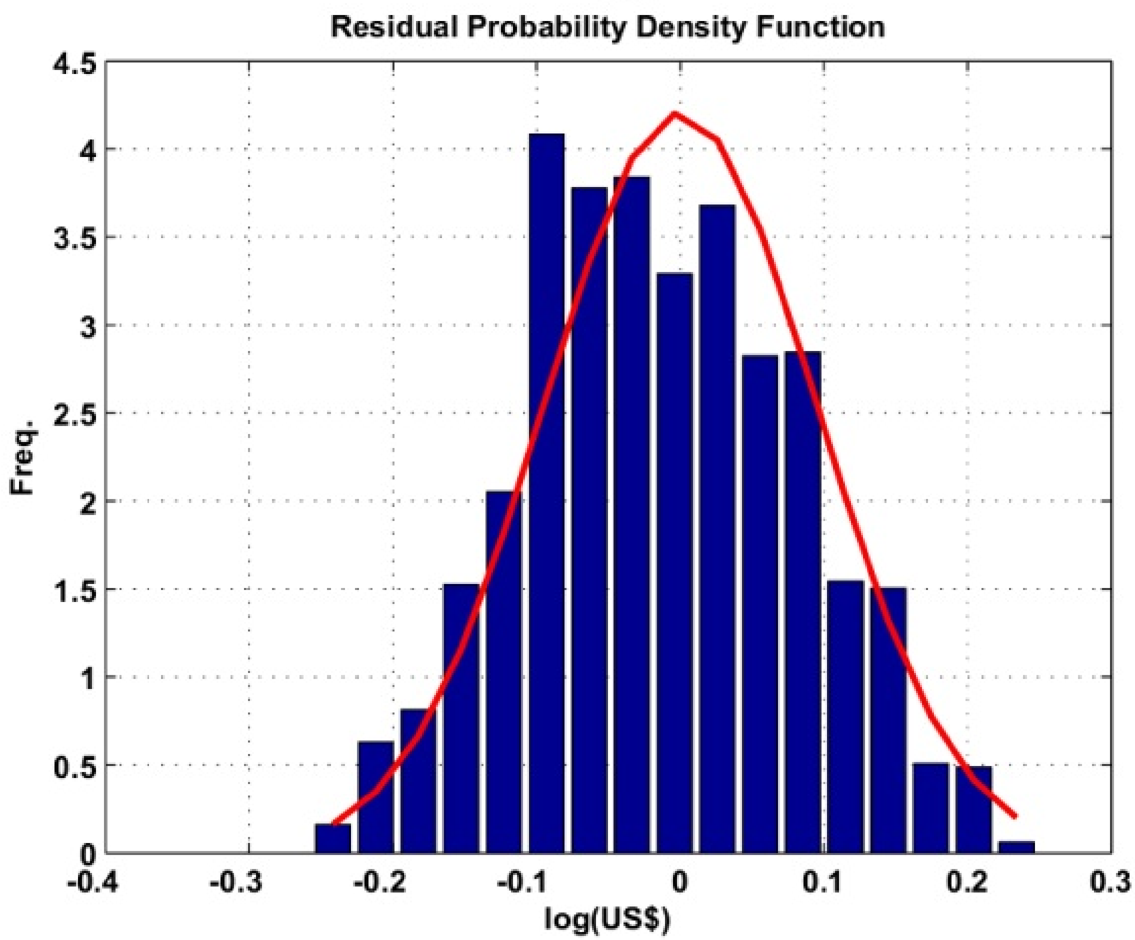


Fig 2. - Residuals of the fit shown on Fig. 1 and corresponding pdf (the red line is the Gaussian

model). Click to enlarge.

If we apply an exponential transform to go back to the normal price domain, we get a nice exponential trend (Fig. 3). The dotted lines are the 95% confidence interval derived from the above gaussian model for the residuals. Note that even if the residuals can be modeled as a gaussian additive noise, once the exponential transform is applied the noise becomes multiplicative and non gaussian (that's why the confidence interval becomes wider with time).

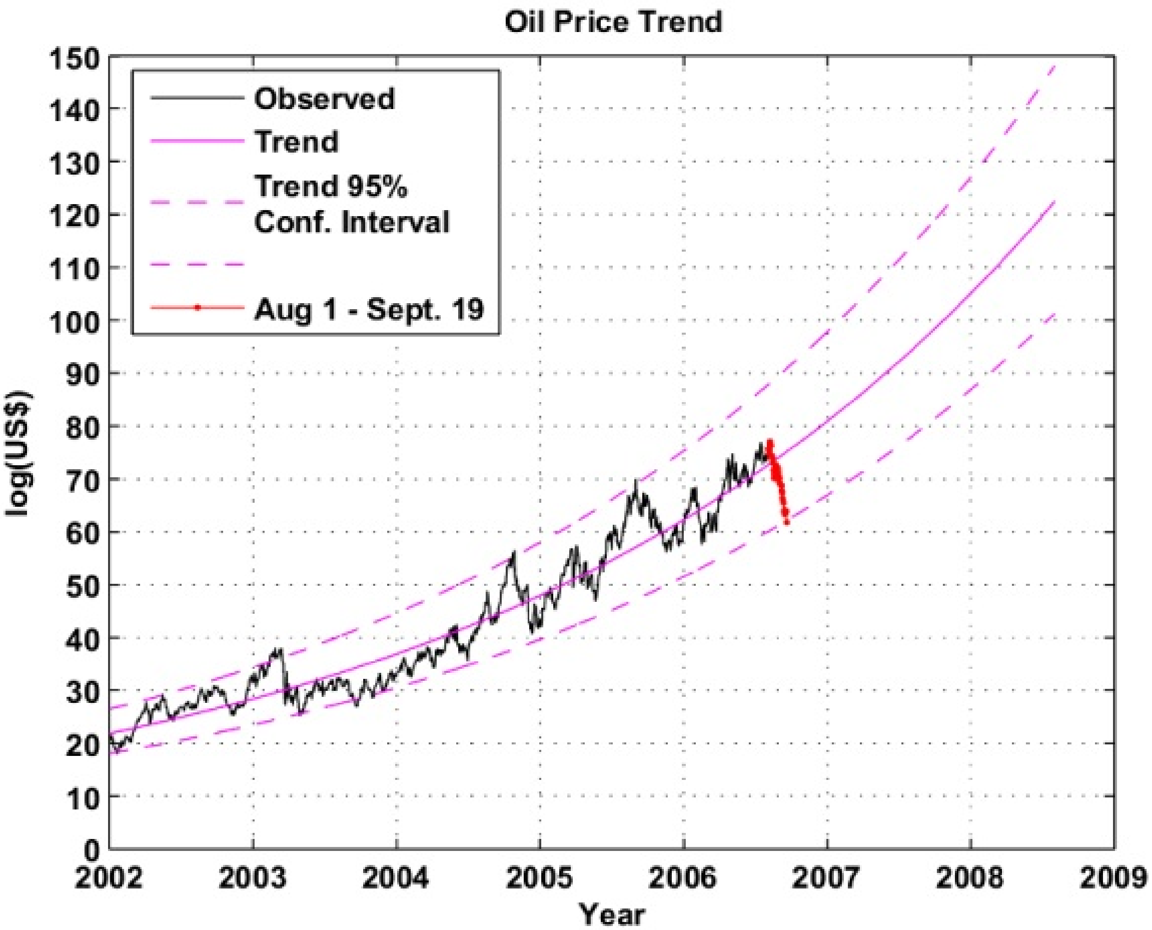


Fig 3. - Exponential trend and 95% confidence interval. The red points are the recent drop from Aug 1 to Sept 19. Click to enlarge.

The Periodicity Transform is quite a new tool proposed by William A. Sethares and Tom Staley in 1999:

> Periodicity Transforms decompose a data sequence into a sum of simple periodic sequences by projecting onto a set of periodic subspaces, leaving residuals whose periodicities have been removed. As the name suggests, this decomposition is accomplished directly in terms of periodic sequences and not in terms of frequency or scale, as do the Fourier and Wavelet Transforms. In consequence, the representation is linear-in-period, rather than linear-in-frequency or linear-in-scale. Unlike most transforms, the set of basis vectors is not specified a priori, rather, the Periodicity Transform finds its own "best" set of basis elements. Technically, the collection of all periodic subspaces forms a frame, a more-than-complete spanning set. The Periodicity Transforms specify ways of sensibly handling the redundancy by exploiting some of the general properties of the periodic subspaces.

Applied on the residuals, we get 29 basis elements. I show the four most important periodic basis elements in terms of energy contribution:

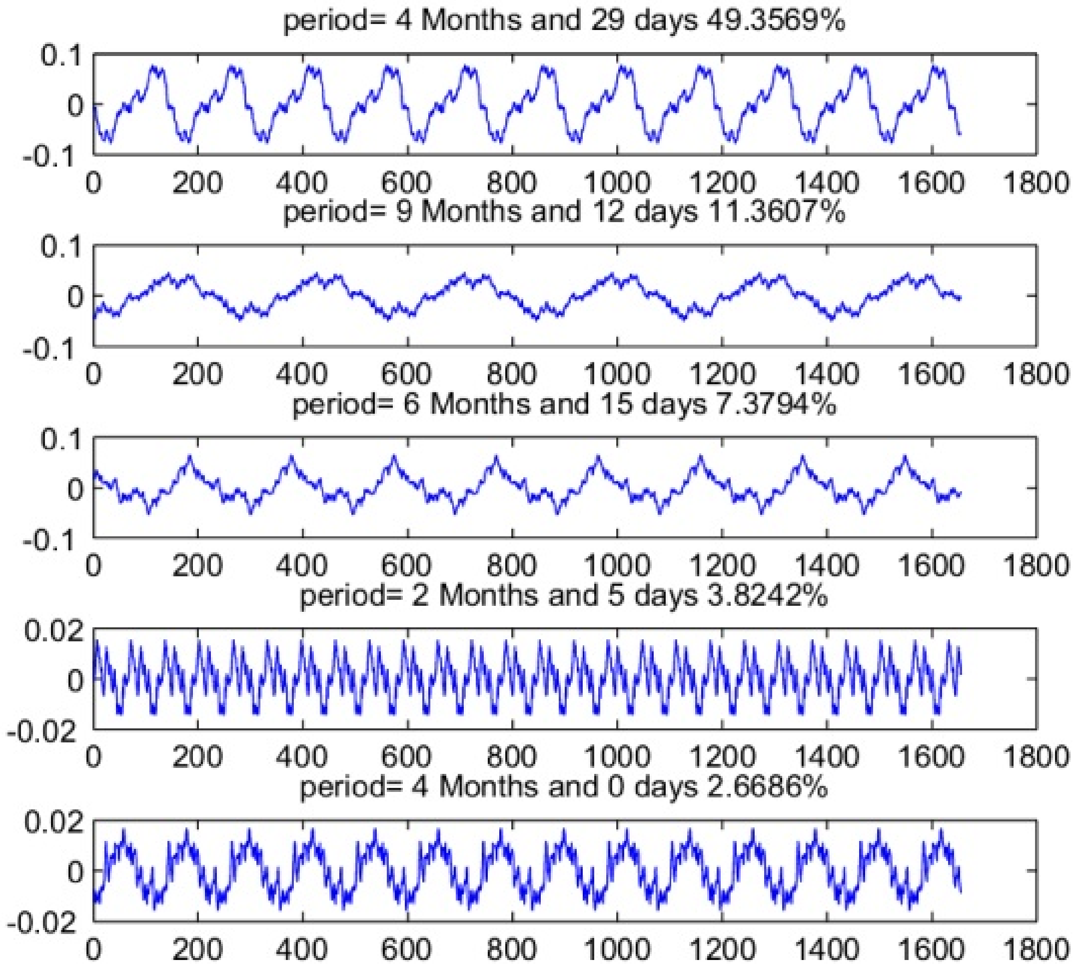


Fig 4. The 4 top basis elements out of 29. Click to enlarge.

We can reuse the periodicity basis in order to estimate future fluctuations of the residuals:

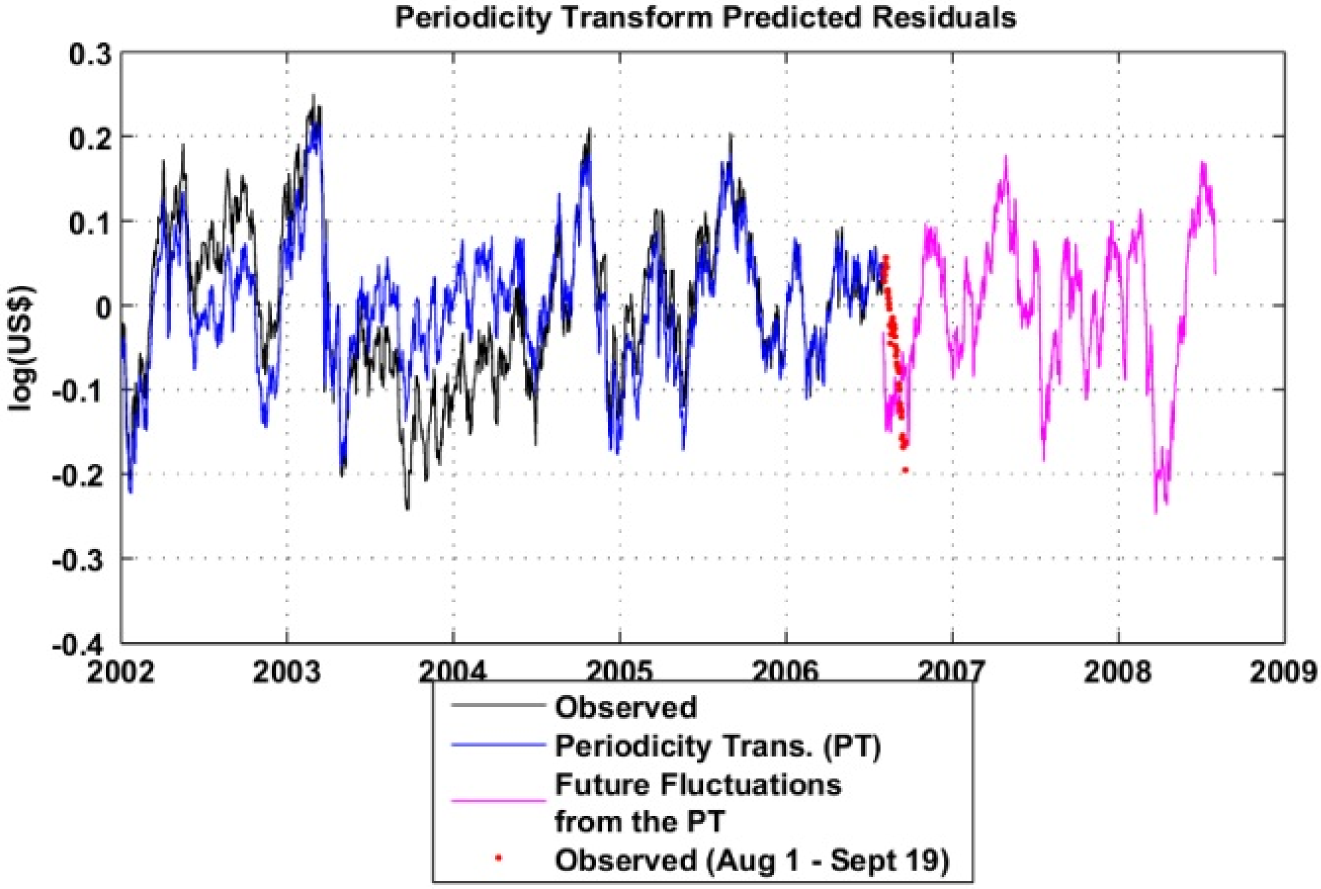


Fig 5.- Modelisation of the residuals by the Periodcity Transform. Click to enlarge.

Back in the price domain, we get the following prediction:

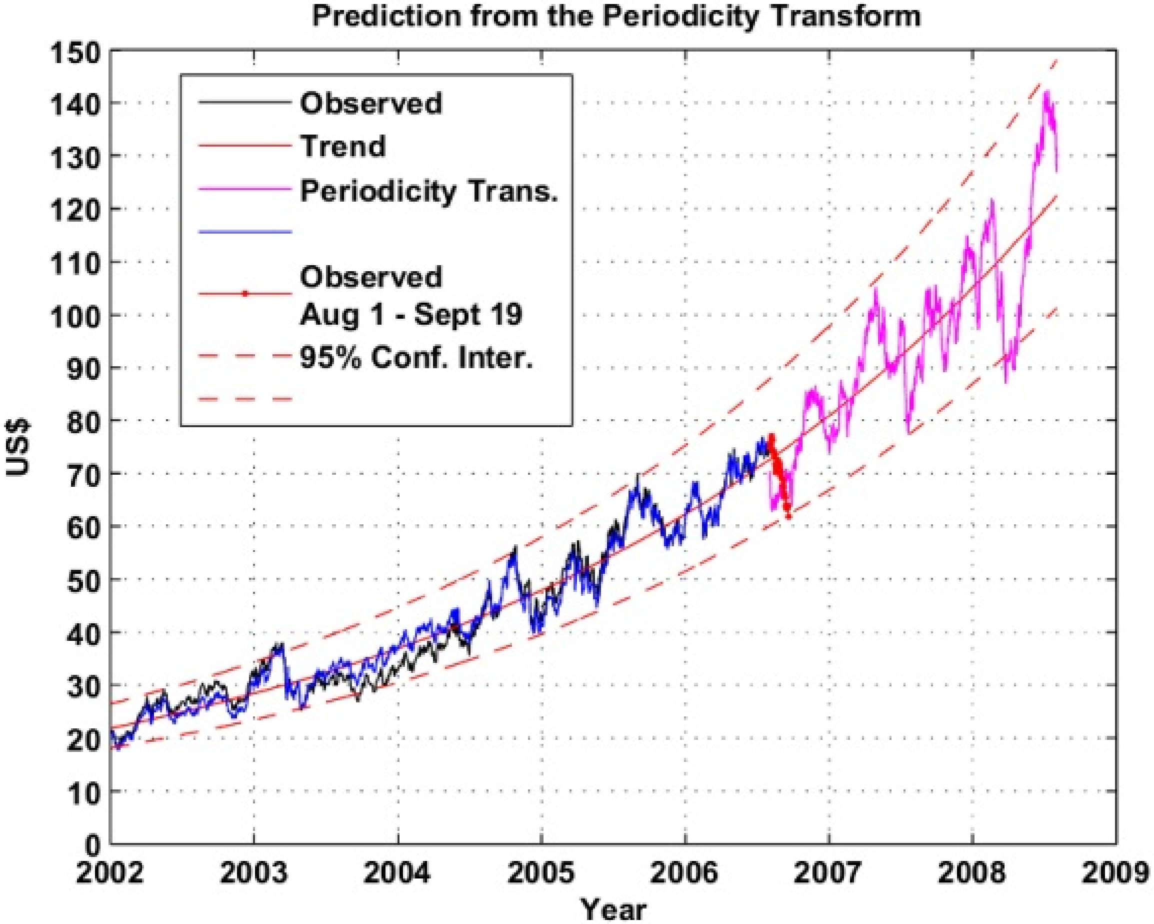


Fig 6.- Periodicity Transform Extrapolation. Click to enlarge.

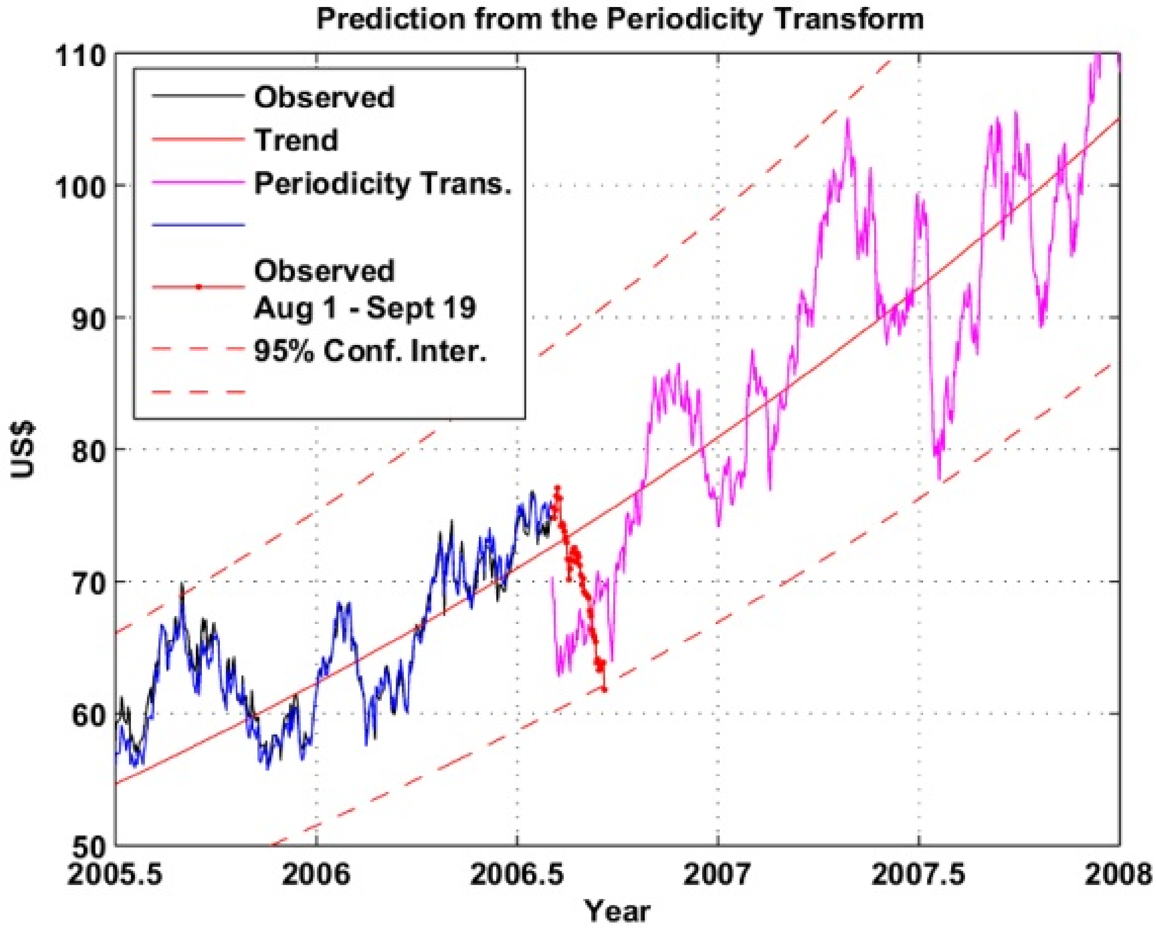


Fig 7.- Zoom in on Fig. 6.

A few comments:

- The recent drop in oil prices is still within the confidence interval of the exponential trend observed since 2002.
- There is about a 2% probability that prices could drop below $61. It seems that $60 is the actual lower support line for the oil prices right now.
- The periodicity transform gives us a rough idea of what future volatility could look like.
- The PT basis elements are hard to interpret in terms of known price cycles.
- The predictive power of the Periodicity Transform is probably limited because of the chaotic nature of price fluctuations. The PT seems to have predicted the recent big drop in prices and is predicting a big rise at the end of the year.
- Of course, this is a very simple approach that is assuming that the exponential trend observed since 2002 will stay a valid model for the coming years.