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Mohamad, Sharifah Fairuz Syed and Masih, Mansur

INCEIF, Malaysia, INCEIF, Malaysia

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Gold price movements in selected currencies: wavelet approach

Sharifah Fairuz Syed Mohamad¹ and Mansur Masih²

Abstract

Investment in gold has been in demand for the past few years especially in hedging strategies. At the same time, various calls for gold to go back to its historical function even before the coming of Islam have been popular among Islamic scholars due to its characteristic of having intrinsic value as compared to the fiat money enhancing the argument for those supporting gold as a currency. Many studies have been dedicated to the relationships between gold and various commodities and suggesting gold as a hedge against the dollar. This study intends to see the relationship of selected currencies in the price of gold to see the movements and how gold has been performing in different sectors. The wavelet approach is used to show the different movements of paired currencies (US index-US Gold, US Gold-Euro Gold, US Gold-Ringgit Gold, and Euro Gold-Pound Gold) in terms of their gold price in different time horizons (time scales). The findings of the study are of benefit to gold investors especially for diversification and investment purposes.

Key Words: gold, US index, US dollar, Euro, Pound, Ringgit

¹ Sharifah Fairuz Syed Mohamad, pursuing PhD in Islamic finance at INCEIF, Lorong Universiti A, 59100 Kuala Lumpur, Malaysia.

² **Corresponding author**, Professor of Finance and Econometrics, INCEIF, Lorong Universiti A, 59100 Kuala Lumpur, Malaysia. Phone: +60173841464 Email: mansurmasih@inцейf.org

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1. Introduction and Motivation of the Paper

History of gold

During the Gold Standard, gold's price depended upon its purchasing power and whenever there are paper currencies, they were measured against gold. However, the World Wars have resulted in paper currency inflation forcing all countries to abandon the Standard. That was when gold lost its role as currency.

Then came the Bretton-Woods Accord of 1944 which made the US dollar convertible to gold at a fixed rate and establishing it as the world's reserve currency. The fixed rate of US dollar to gold has allowed the United States to inflate the paper currency without recourse. It was then set by decree by Franklin Roosevelt in 1934 that gold was worth \$35 an ounce.

During the Great Depression Era, the US government needed increased spending in order to boost the economy. They did this through creating inflation so people would spend more. To create inflation, the government had to devalue the dollar but devaluing the dollar at the time did not necessarily lead to an increase in spending since gold was still considered as money. Therefore, Roosevelt forcedly declared that it was illegal to own gold in 1933, which made it free for him to print as much paper money as possible.

During the time of 1933, the gold price was fixed at \$20.67 which meant that \$20 gold coin contained 0.9675 ounces of gold. After the declaration was made, citizens were forced to exchange their gold for paper money in dollars at this rate therefore leaving the government with abundance of gold. The next year, Roosevelt announced the gold price at \$35 an ounce which instantaneously devalued the paper dollars.

We can see that the devaluing of the dollars will somehow have certain effects on the gold price and the government had full control over its price; whenever the reserve depletes, the government is able to devalue the dollar and vice versa.

Gold in other currencies work closely with how the currencies move in general. Its price in terms of any other currency is easily calculated by multiplying the dollar gold price by the exchange rate of the currency. An inflated currency will usually affect the gold price to go up; so for example, if there was an inflation of the dollar, which means less buying power, the gold price will go up.

The gold price is always quoted in US Dollars since this currency has become the reserve currency of the world. This reserve currency came about rising from two reasons – one, it was convertible to gold and two, the dollar is in demand to settle international transactions since the United States holds the world's largest economy. In the conference where Tun Dr. Mahathir suggested gold to become a currency, he also urged that gold be used to settle international settlement in the first place.

Now that predictions are pointing to the weakening of the US Dollar, there are questions on whether the Euro could become the next reserve currency to control the economic situation.

The introduction of the euro has made it level up with the dollar especially with the fact that Europe has its advantage of trade surplus as compared to United States' deficit condition. Already in 2007 several countries have started to convert massive amounts of dollars to euro. We will see in the future that if demand for Euros rise further, the need for dollar will definitely decrease. This probably will end up in the massive increase of gold price but the question whether gold could become the worldwide currency is still unanswered.

The emergence of gold to again become one of the important usages in the economic system has been enhanced with the advent of Islamic finance. This is because scholars who oppose the usage of fiat or paper money in today's world are strongly debating that gold should be the currency of the whole system regardless of location. This has been the case even before the coming of Islam, and in today's economic condition, there has been suggestions to go back to gold. One such

suggestion was given by the former prime minister, Tun Dr Mahathir in an International Conference held in Kuala Lumpur. With his understanding of the exploitative nature of the current monetary system, he called for a return to the gold dinar so it would benefit more for the Muslims as it did in the times of the Prophet (pbuh). It is believed that with this system, Muslims could 'extricate themselves from the economic oppression and exploitation' (Hosein, 2007). However, there are scholars who accept the use of paper money as long as it is backed by an asset, preferably gold.

Why is it that gold is so much favored among the Islamic scholars? The answer lies within the characteristic of gold which contains an intrinsic value or has a value in itself if compared to the paper money. The paper money wouldn't have any value if it were not backed by a certain asset since the value that is written on it is obviously not the value of the paper itself. Therefore gold still wins over paper money in its characteristics.

As Muslims, it may be easy to adopt this understanding when we have true faith without demanding any proof from the real economic data to show that gold could actually function well to serve the economy from the Quran and various Hadiths. However, in general, it is hard to persuade people into believing such thing when initially they do not believe the same thing as Muslims do. Therefore this study will try to use some relevant data to see how gold is actually performing and how far it could go from here.

Many previous studies have delved into the movements of gold prices in connection to various other commodities, stock prices, and also to see which macroeconomic variables actually gives bigger impact on gold. Most of them conclude that gold can function as a hedge against the dollar in most cases but none to the knowledge of the author has studied the movement of gold prices in terms of other currencies to see the correlation and volatility through different time frames and frequencies as used here with the wavelet technique.

Therefore this paper tries to show this through the pairing of various currencies in terms of gold price to see which of them tend to lead and lag in different time horizons.

2. Research Objectives

The main research objective of this paper is to see the relationship in terms of lead and lag times of the gold price in two different currencies at a time. This is to test whether it is true that:

- 1) The US dollars in terms of gold price follows the movement of the Dollar Index inversely
- 2) The Malaysian Ringgit follows the US Dollars in terms of gold price
- 3) The Euro follows the US Dollars in terms of gold price
- 4) The Pound follows the Euro in terms of gold price

Computations on volatility and correlation among the pairs will also derive information on whether there are any investment benefits of trading gold in selected currencies.

3. Literature Review

One of the earliest quantitative studies on gold dates back to 1980. Abken investigated the variety of factors that influence gold price movements. He finds that gold differs only by a small gap as compared to other storable commodities. In the case of gold, the relative insignificance of flow supply and demand in relation to the spot price movements, and the liquidity of gold results in making the gold price sensitive to changes in its future prices. (p.12)

It has been a confusion for some when they see that the dollar depreciation causes the gold price to increase; which otherwise means that the other currency appreciates against the Dollar.

Pukthuanthong and Roll (2011) investigated on the confusion that people had regarding the negatively related gold price and the dollar. When the dollar price of gold increases, the Dollar

depreciates against other currencies and therefore seems to suggest that gold prices are associated with an appreciation of other currencies. However it is just the terms that are confusing the public since the dollar price of gold can always be related to the Dollar depreciation and the Euro (or any other currency) price of gold can be related to its own depreciation. It is just a matter of difference of terms depending on which currency we are dealing with.

Levin and Wright (2006) studied both the short and long run determinants of the price of gold. The short-run fluctuations are usually expected from such political and financial issues and also from changes in exchange rates, interest rates, as well as the beta for gold. They also address the inflation hedging properties of gold in the currencies of countries of which consume most gold outside the US. These countries include India, China, Turkey, Saudi Arabia, and Indonesia who were considered rational to purchase gold which served as an inflation hedge.

Capie, Mills, and Wood (2005) also looked into the area of gold as a hedge against the dollar, where they implemented a GARCH analysis using weekly data on gold price and sterling dollar and yen dollar exchange rates. It is found in the study that although gold served as a hedge against fluctuations in the foreign exchange value of the US dollar, it does so up to an extent that depends on political nature and events.

On the issue of Euro and British Pound in terms of currencies, Malik (2004) tested the hourly and daily dummy variable in the conditional variance functions of the two. He suggests that the Euro happens to be more volatile compared to the Pound which is quite contradictory to the findings of Inagaki (2007) which studied the volatility spillover effects between the two currencies. This will be looked into in this paper through pairing these two currencies in terms of gold prices to see which leads and which one lags.

4. . Research Methodology

For our study, we collect the daily returns of currencies in terms of gold prices, totalling 2500 observations. Since the method used only allow for two variables to be tested at a time, we categorized them into sets of two which are:

1. The Dollar index and the dollar price of gold
2. The Dollar price of gold and the Ringgit price of gold
3. The Dollar price of gold and the Euro price of gold
4. The Euro price of gold and the Pound price of gold

Having calculated the return series for all the four models above, a technique called the wavelet analysis is used which separates out each return series into various horizon components. This is done through the discrete wavelet transformation (DWT) on the daily currency series by sampling the series at evenly spaced points in time.

Wavelet Analysis

Almost a decade now, this technique of wavelet analysis has been developing. The two main ones that are being implemented in finance and economic studies are the discrete wavelet transformation and the continuous wavelet transformation (DWT and CWT). The DWT has been used longer before the CWT since various advancements have allowed the transformation to be dealt with in a continuous way. Therefore the CWT is much current than the DWT. However in this study, we only employ the DWT.

Wavelets, as its name indicates are short waves which are similar to the sine and cosine functions that oscillate around zero. However in wavelets, the oscillations fade away around zero and

therefore the function is localized in time. In any analysis, a signal is represented as a linear combination of wavelet functions (Fernandez, 2003).

Wavelets are generally suitable for building-block functions for signals where its features are varied over time and for non-smooth signals (Fernandez, 2003, p.5). An advantage of wavelets in any study including those of economic and finance is that it allows for decomposing one signal into multi-horizon components. Thus we are able to analyze at which frequency levels a particular activity of the data occurs in the time series. The usual scale known as crystals are used as follows: d1, d2, d3, d4, and d5 which represents the days 2-4, 4-8, 8-16, 16-32 and 32-64. In addition, in the continuous wavelet analysis, it allows us to study the co-movement between two time series in time frequency domain by implementing the cross-wavelet tools (Aguiar-Conraria et al., 2008; Rua and Nunes, 2009)

Also in wavelets are the father and mother wavelets. A father wavelet is a component that represents the low frequency or smooth parts of the series, while the mother wavelet represents the high frequency or detailed parts of the series (Masih, Alzahrani, & Al-Titi, 2010). These are shown below, with the left hand side being father wavelet and the right hand side, the mother wavelet.

$$\int \phi(t) dt = 1 \quad \int \psi(t) dt = 0 .$$

In general, the mostly used type of wavelets is the orthogonal ones which include haar, daubelets, and coiflets. In particular, the orthogonal wavelet series approximation to a continuous series is given by

$$f(t) \approx \sum_k s_{J,k} \phi_{J,k}(t) + \sum_k d_{J,k} \psi_{J,k}(t) + \sum_k d_{J-1,k} \psi_{J-1,k}(t) + \dots + \sum_k d_{1,k} \psi_{1,k}(t),$$

where J is the number of multi-resolution components or scales, and k ranges from 1 to the number of coefficients in the corresponding component. The coefficients $s_{J,k}$, $d_{J,k}$, ..., $d_{1,k}$ are the wavelet transform coefficients, whereas the functions $\phi_{j,k}(t)$ and $\psi_{j,k}(t)$ are the approximating wavelet functions. (Fernandez, 2003, p.5)

The discrete feature of wavelet will calculate the coefficients of the approximation in the above equation for a discrete signal f_1, f_2, \dots, f_n . This means that it maps out the vector f to a vector ω of n wavelet coefficients that contain $s_{j,k}$ and $d_{j,k}$ where $j=1, 2, \dots, J$. The $s_{j,k}$ are the smooth coefficients and the $d_{j,k}$ are the detail coefficients, where the smooth coefficients represent the underlying smooth behaviour of the data at say, the scale 2^j , while the detail coefficients are the ones that provides deviations from it. (p5)

5. Results and Interpretations

The results in our analysis are presented in outputs relating to correlation, variance, covariance, and cross-correlation among the variables. Graphical representations of these statistical outputs are also available.

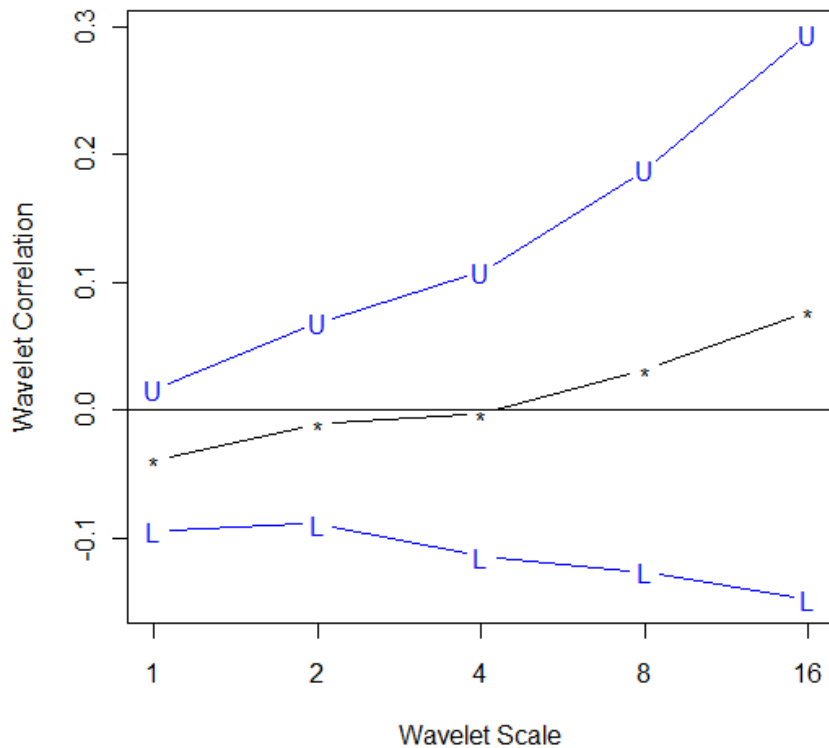
US INDEX AND US GOLD PRICE

The return on US Index turns out to have a negative correlation with the gold price which clicks with intuition since most of the time, when there is an inflation of dollars (US index goes down, as US dollars weakens), gold price will usually go up. This is also consistent with the findings of Toraman, Basarir and Bayramoglu (2011) when they examined the factors determining the gold price which includes US dollar index as one of their variables. They also concluded that the dollar index has an inverse relationship with the gold price. The logic behind this is that whenever the dollar index decreases, it means there is plenty of dollars in the market therefore reducing the purchasing power of this currency with respect to another currency—which implies that the dollar has depreciated. Since gold is priced in terms of US dollar, it makes sense that whenever the dollar depreciates, the gold price appreciates.

This phenomenon is apparent in our output results of correlation since from d_1 to d_3 , the correlation between the US index and the dollar gold is negative. Surprisingly, from d_4 and

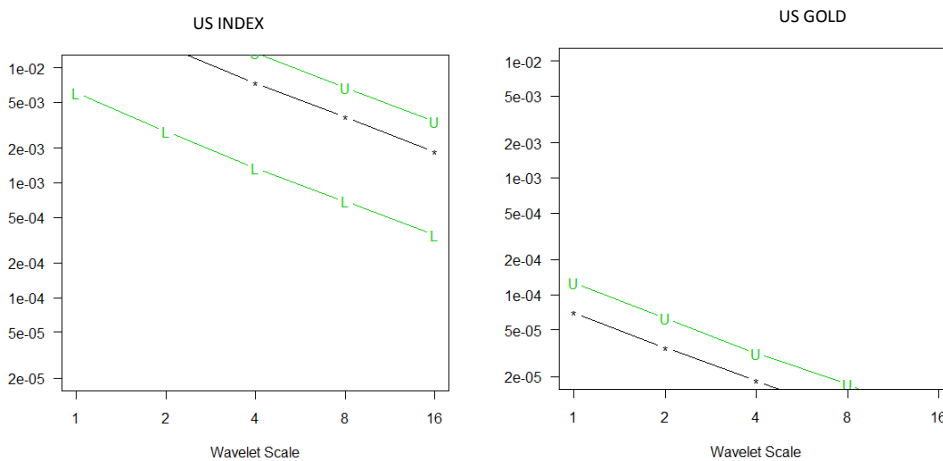
above, the correlation comes to a positive which indicates that the relationship is negative only in the lower scale. From the graphical representation below, it can be seen that the correlation only moves between somewhere just below and above zero with the d4 and d5 showing positive correlation. This may be due to the fact that long run gold price will take into account other factors such as its relation with other commodities like silver, copper, and oil prices. At the same time, demand for gold jewelry will also change its long run correlation with the dollar index. Since our data stretches from 2001 to 2011, the long run refers to the years around 2008 or 2009. This portrays that d4 and d5 which represent the long run, have been affected by the financial crisis therefore reducing the negative correlation between the two subjects.

Figure 1: Wavelet Correlation for US Index and US gold



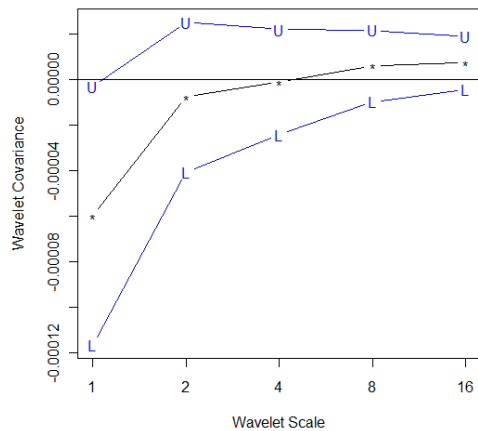
From the individual variances in the figure below, we see quite a different pattern in the US index and US gold.

Figure 2: Comparison of the variances between the US index and US gold



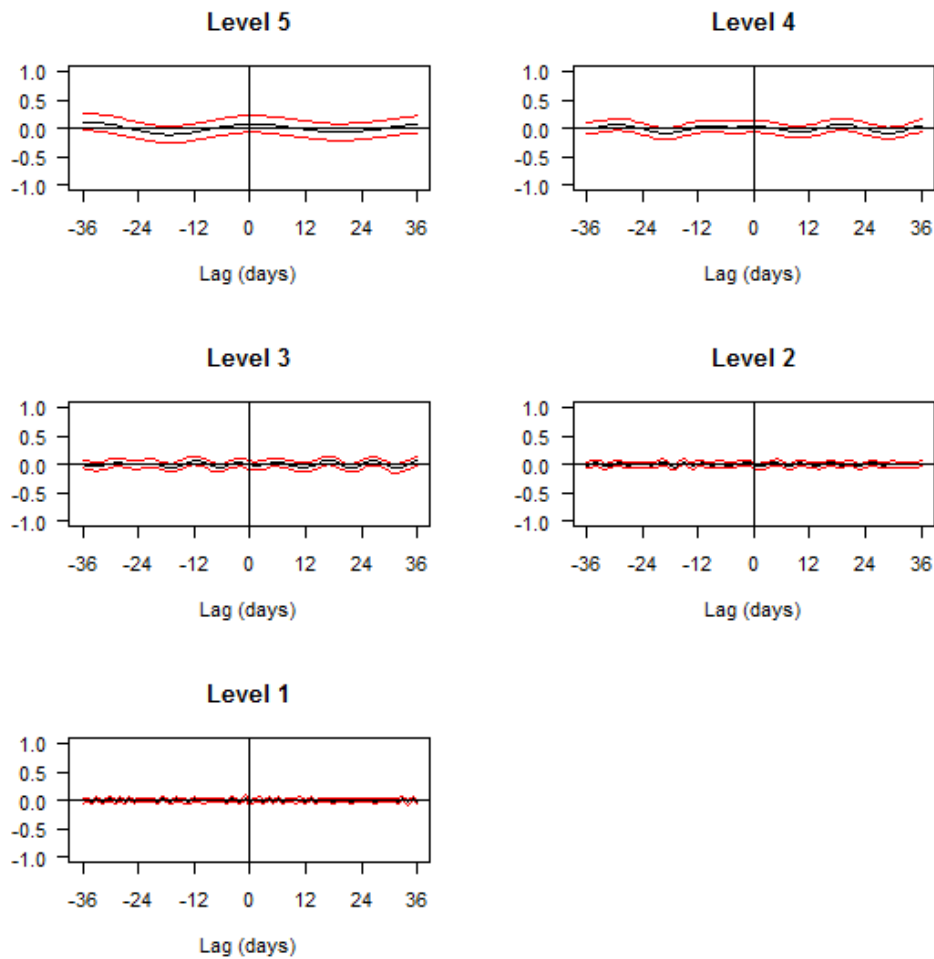
In general, it is obvious to say that the variance of both variables tend to go down in the long run. However, the peculiar result is that the US index has a higher variance compared to the US gold from d1 to d5. This shows that the US index is much more volatile compared to its gold price, which seems to counter our intuition. The logical explanation to this may be the fact that the US index is a measure of the US dollar's value relative to a basket of six currencies: the Euro, British Pound, Canadian dollar, Swedish krona, Swiss franc, and Japanese Yen. Therefore any appreciation or depreciation relative to these currencies will affect the volatility of the dollar. Combing the two movements of the variances, we have the covariance which is presented in the graph below:

Figure 3: Wavelet Covariance between the US Index and US gold



Finally, in the cross correlation output, the findings are quite consistent with the previous findings that in the long run, no clear relationship can be seen since the correlation nears zero. From the graphical output, we cannot say which variable is leading and which is lagging since no apparent feature of such relationship can be seen. Therefore, we cannot confidently conclude that the US index has been impacting the gold price in a positive or negative relationship. It may have been negatively correlated in the earlier parts of the data (short run) which starts from 2001, but later years which form the theoretical element does not show any clear relationship between the two. This again, may be the case when there are a lot going on in the market, in relation to other possible factors, which eliminates the cross correlation that may have occurred between the US index and US gold.

Figure 4: Cross Correlation between the US Index and US gold

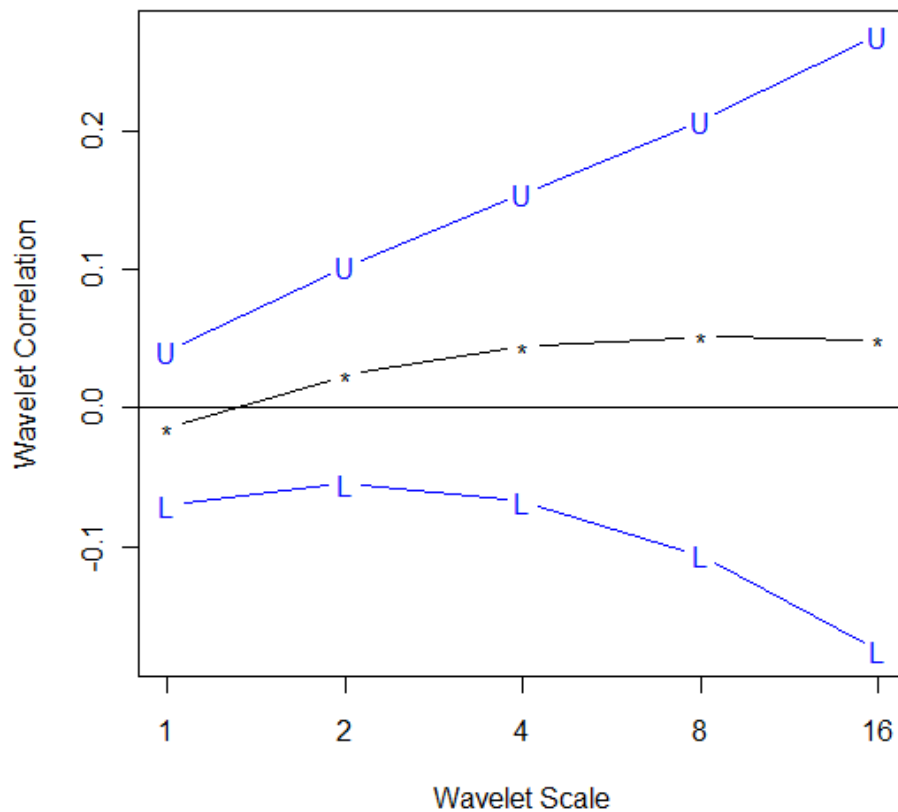


US GOLD AND EURO GOLD

Next we come to analyze the price of gold in two different major currencies; the US dollar and the Euro.

The correlation between these two major currencies in terms of gold price has been on the low, which actually averages to about zero. This means that the two gold prices do not really have any relationship. This is due to the fact that both the Euro and US dollar move in their own direction being the major currencies of the world.

Figure 5: Correlation between the US gold and Euro gold

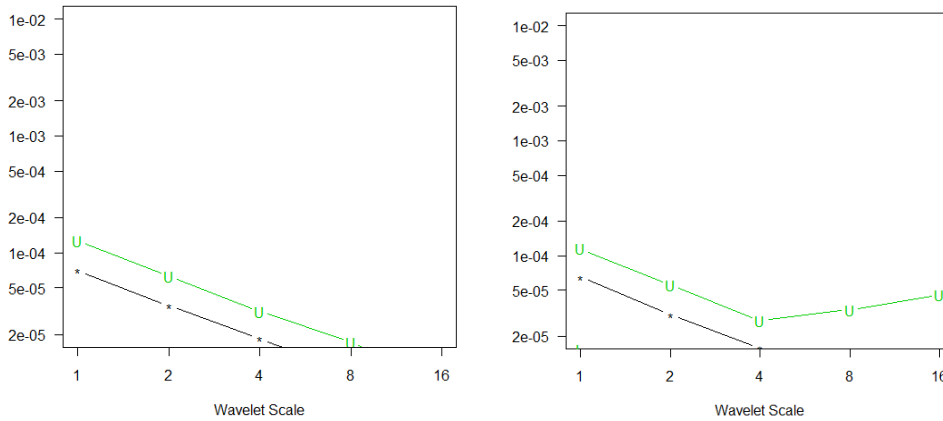


In explaining the early part of the period (negative correlation), it might have been affected by the September 11 occurrence which since the US dollar had depreciated giving way to the gold price in Euro to increase and thus the negative relationship. On that exact date, the gold price experienced a spike of 5 percent increase within a trading day which is very unusual to happen, since the price differences are normally only between ten and twenty times smaller compared to the one that happened on the tragic day.

In terms of the variances, both US gold and Euro gold show significantly lower volatility compared to the US index in the previous part. As mentioned before, the independence of these two currencies make them experience low volatility over the study period. The euro seems to start gaining strength to be at par with the US dollar. With its strength almost similar to the dollar, it became the other viable alternative reserve currency. And since it has a trade surplus, it may just work out to be the worldwide currency in the near future. With this event happening,

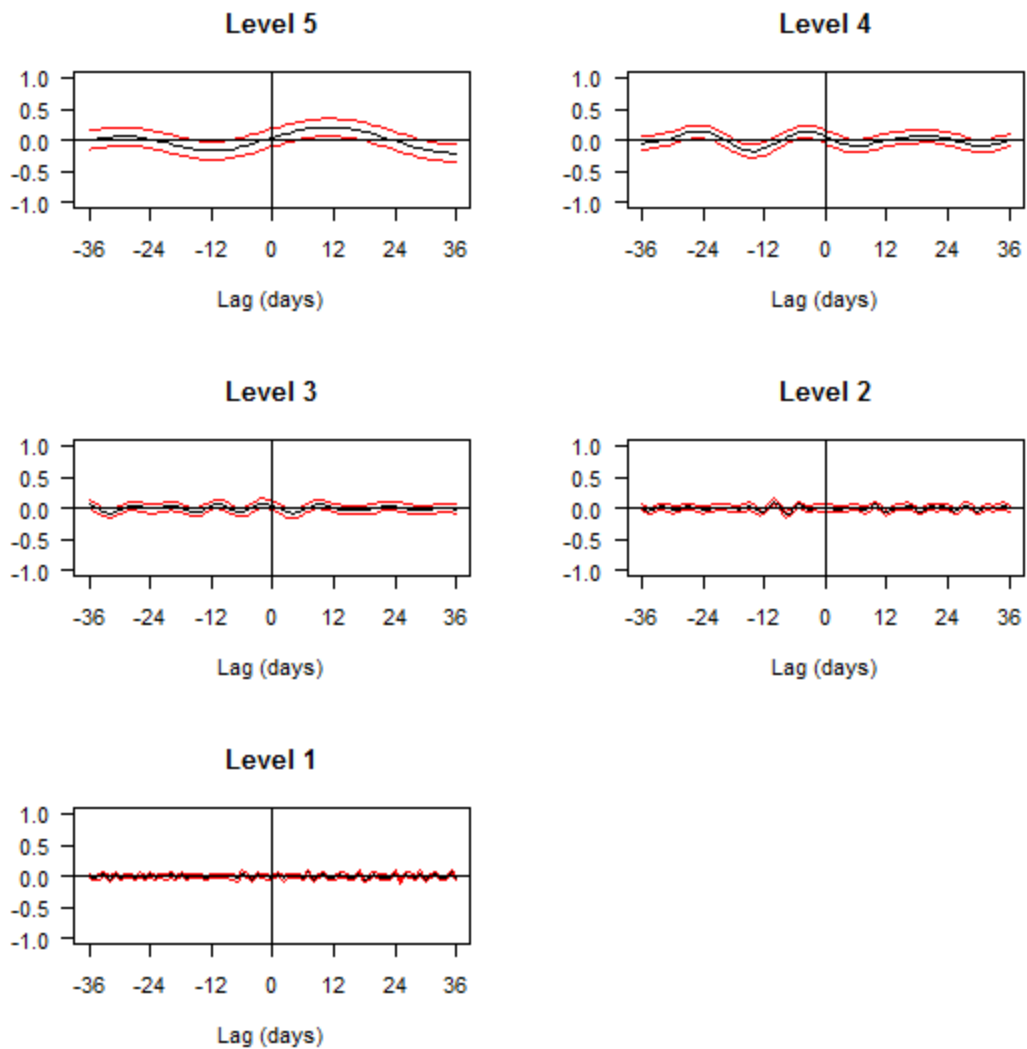
the dollar will certainly lose its value and therefore the need for it will also decrease. There have been speculations that the dollar will fall and a financial crisis may happen again. IF this were to happen, the Euro gold price will shoot up.

Figure 6: Comparison of the variances between US gold and Euro gold



In the case of cross-correlation, we are not able to decipher which variable leads and which one lags in the short run. However, in the long run, we see some different movements of the waves especially starting from the Level 4 component of the cross-correlation graph. We are able to conclude that the US gold does in some respect have tiny affects on the Euro gold with a lag of around 12 days in a negative correlation. That means, in the long run, if the US gold price goes down, 12 days later, the Euro gold price will go up. However, in the longer run at level 5 in the graph, we see a balance of the former leading the latter in a negative relationship, and the latter leading the former in a positive relationship. This again correlates with our earlier findings that both the US and Euro gold tend to move independently.

Figure 7: Cross-Correlation between the US Gold and Euro Gold

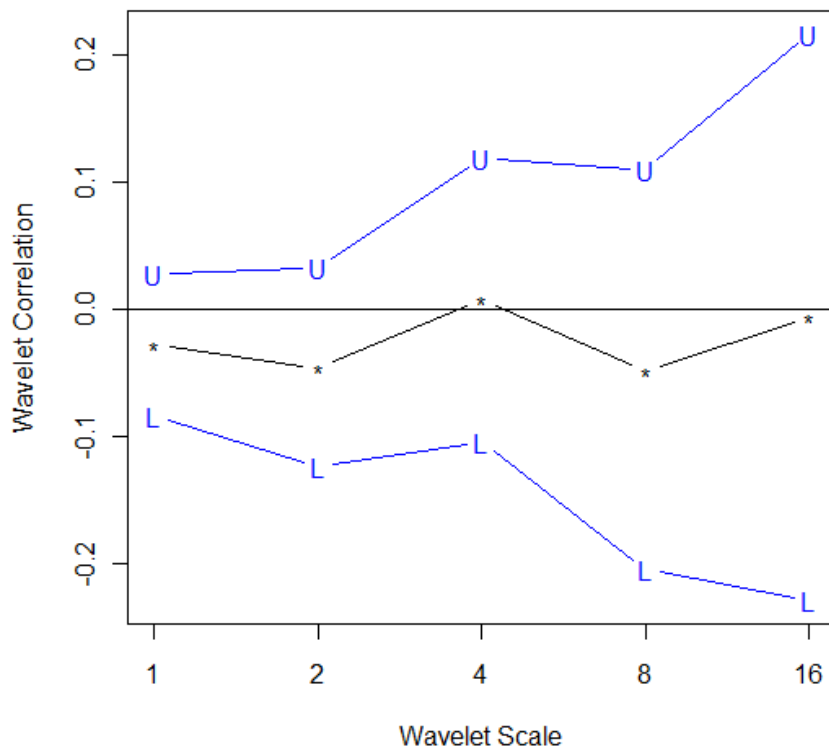


US GOLD AND the RINGGIT GOLD

For almost all the scales (d1, d2, d4, and d5), the correlation among the two currencies in gold price are negative. This indicates that whenever the gold price in US dollars increase, the gold price in Ringgit will fall along these scales. The d3 scale show a near to zero correlation which falls probably in the 2005 period where the Ringgit was de-pegged from the US dollars, causing the US dollars to depreciate. With the depreciation of the dollars, the gold price in US dollars went up to more than US\$500 an ounce and the appreciating Ringgit could buy more of gold at the time therefore reducing the negative relationship.

With the majority of scales having negative correlation among these two currencies in gold price, there is a possible hedging strategy or diversification opportunities that we can benefit from. This is because with a negative correlation, when one component is on the increase, the other will decrease unlike a positive correlation which will make investors worse off if investing in two portfolios of the like. Therefore, Malaysian investors could benefit from investing in gold with the predictions of weakening US dollars in the near future. This is exactly what banks in Malaysia are starting to do: gold investment accounts. They attract Malaysian citizens to buy gold from the bank for investment purposes.

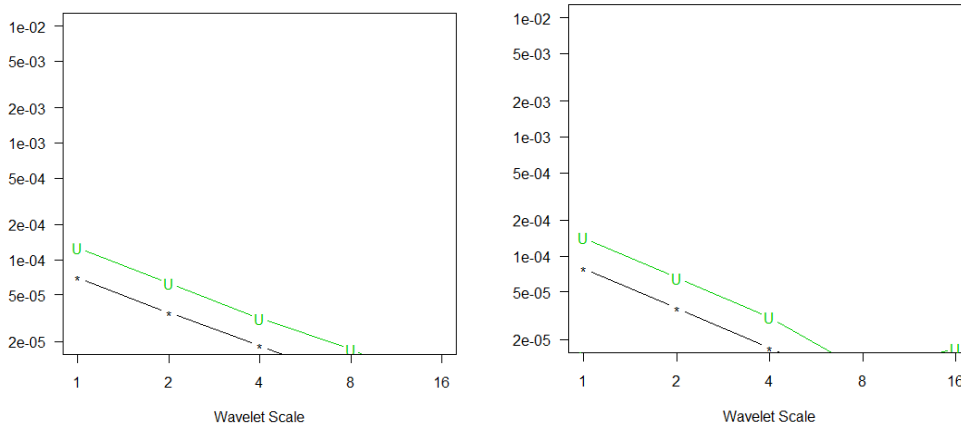
Figure 8: Correlation between the US gold and Ringgit gold



The variances also did not differ much as in the case of US gold and Euro gold. During the earlier periods, maybe ranging from 2001 to 2005, this can be explained by the fact that the Ringgit was pegged at 3.8 USD therefore not having any impact on volatility. However after

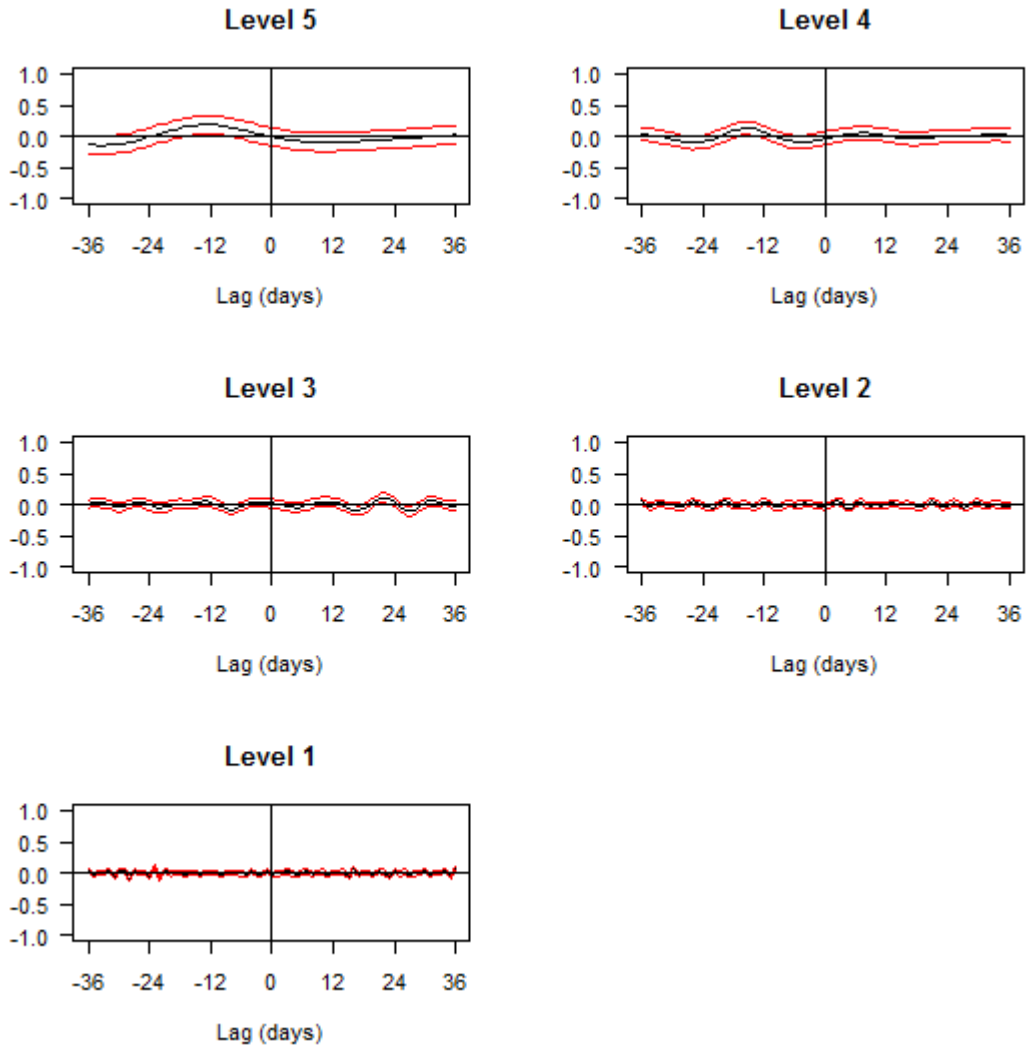
2005, when the Ringgit was no longer pegged to the US dollar, the currency did fluctuate bit by bit and this has caused the gold price in Ringgit to also fluctuate.

Figure 9: Comparison of Variances between US gold and Ringgit gold



Finally, the cross-correlation among the US gold and the Ringgit gold is shown in figure 10:

Figure 10: Cross-Correlation between US gold and Ringgit gold



What can be concluded from this graphical representation is that in the long run (even starting from the short run –level 2) the US gold has an impact as a leader towards the Ringgit gold price in both positive and negative ways. In general, the US gold price will be followed by the Malaysian Ringgit's gold price in a lag of around ten days as depicted in the level 5 diagram. From this finding, investors could benefit by investing in gold in terms of the Ringgit after seeing that the US gold price has gone down after ten days.

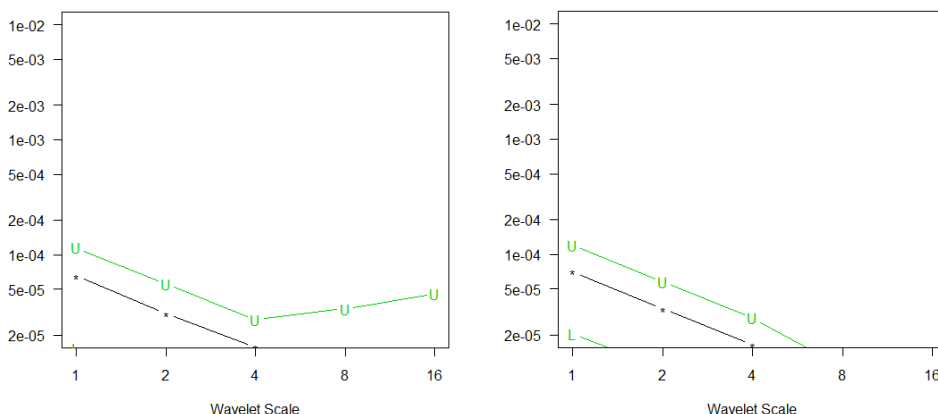
EURO GOLD and POUND GOLD

We come to our last combination of gold price which is put in terms of Euro and Pound. The intuition is that these currencies work well in moving together considering that both are of European origin and one of the major currencies.

The correlation between the Euro gold and Pound gold, as shown in Figure 11, shows very significant results. As already predicted, there is a high correlation among the gold price in terms of these two currencies. The correlation ranges from 0.88 to 0.91 which is considerably high enough to show that they actually move together. However, the highest correlation occurs in the d1 scale which is in the lower scale where no financial crisis has hit. Towards the end of the scale, in d5, the correlation weakens may be due to the fact that the Bank of England had to raise its interest rates to take care of inflationary expectations towards 2011 while the Euro faces the Greek debt crisis. With these pressures, it is not impossible that the correlation between the two strong currencies may have dropped.

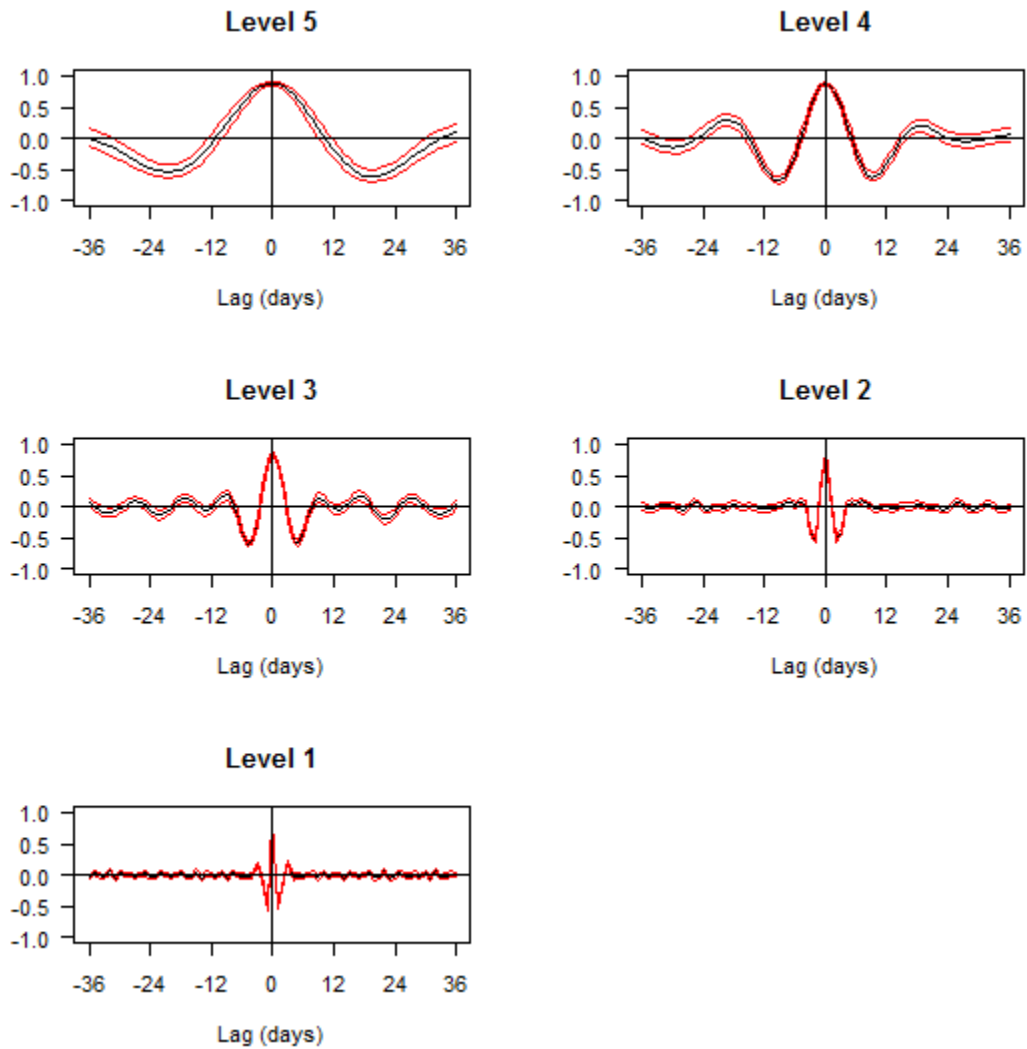
Looking at the variances individually, the Pound has almost similar digits as the Euro. Here, we cannot say which one affects the other since the volatility is quite the same. However, from previous studies, it has been shown that the Euro somehow causes the Pound to fluctuate the same way. In terms of volatility, Malik (2004) estimated the hourly and daily dummy variables in the conditional variance functions of the two European currencies which end up suggesting that the Euro seems more volatile when compared to the British Pound. However in this study, if the numbers are scrutinized in the variance table, we see that the Euro gold's variance is slightly lower than that of Pound's variance. This may have occurred as a result from different study periods, or more likely since this data has to do with the gold price instead of just plain currency. At the same time, the effect of the US dollar on both currencies will have different effects on their gold prices; different from the effects on just the currencies itself.

Figure 11: Comparison of Variances between Euro gold and Pound gold



Finally, we interpret the finding from the cross-correlation among these two currencies' gold prices. The graph certainly supports our earlier correlation study since over the long run, it does show that the Euro gold somehow affects the Pound gold as a leader with 0-1 day of lags. Therefore, it is quite immediate that the Pound gold price will follow after the Euro gold price. This has some relation to a previous study that found a Granger effect of the Euro on the Pound. In this study, the residual cross-correlation approach was used and empirical results had shown there exists a strong simultaneous interaction between the Pound and the Euro and that the Euro Granger-causes the British pound in both mean and variance. These findings are quite similar to ours, except that it did not involve the price of gold. Even though the Pound is considered one of the major European currencies, the fluctuations in other smaller European currencies will certainly be affected by the euro; thus it is concluded that the Euro has more influential power in the region. At the same time, the fact that there has been developments in the European economic and financial integration, the international linkages between the Pound and the Euro has also been strong (Inagaki, 2007).

Figure 12: Cross-Correlation between Euro gold and Pound gold



6. Policy Implications and Limitations

Policy Implications

This study has considerably shown that the gold price in different currencies will differ in fluctuations and correlation at different time intervals or scales. Whether gold is a possible

investment tool today is seen in the US gold-Ringgit gold relationship. Malaysian banks could do well in encouraging customers to buy gold as investments for the future.

The question whether gold can go back to its old function as currency is still unanswerable in this context since there is still a long way to go for people to own and trade gold if there is still not much demand for it, especially in countries like Malaysia who just started to delve into the gold investment book.

Limitations of the paper

This study only involved selected currencies, one that especially focuses to see the effects on Malaysian gold prices, and also that of Euro and Pound. In future research, other currencies could be looked into to see which the ones that can create diversification benefits. Another limitation is that this study only uses the discrete technique of wavelet and certainly would appreciate future research implementing the use of continuous wavelet transformation.

7. Conclusions

We have shown through the wavelet approach that gold in terms of different currencies move differently in different time horizons. From the correlations in this study, we have found negative relationships between the US Index and US gold price, between the US gold price and Malaysian Ringgit gold price and between the US and Euro gold price. Whereas only between the Euro and Pound gold price, we see a positive correlation that shows these currencies move together, which adheres to intuition. From these findings we can conclude that we cannot generalize that the US index will always influence the US gold price to move up and down, although at some point in time, they do actually look like one is the follower and one is the leader. And from the US-Ringgit relationship in terms of gold prices, we conclude that there are possible diversification strategies to benefit from which is indicated from the negative or low correlation. While for the stronger currencies, there is also room for the Euro to become the next reserve currency if it is true, as the speculators are seeing the down-going of US dollars and at the same time, its price in gold has been moving quite consistently with the US and Pound prices.

In terms of Islamic financial perspective, it can be said from this limited research that gold does have a bright future seeing that it allows for diversification of assets and minimizing risk with the right combination of currencies as for example the US and Ringgit prices of gold. At the same time, if demand for gold were to increase in the next years or so, there will be enhancement on the trading of gold in different currencies and thus could become a currency itself and possibly take over the fiat money era.

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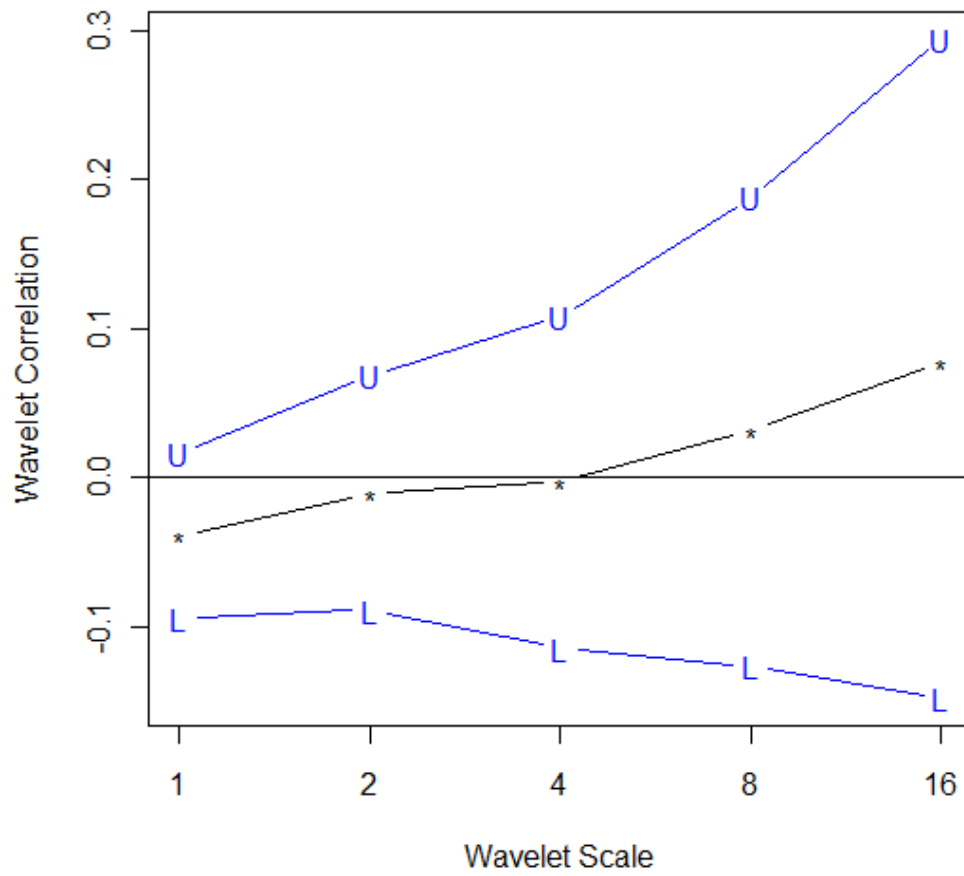
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<http://www.silverbearcafe.com/private/gold101.html>

APPENDICES

US INDEX – DOLLAR GOLD

	wavecor	lower	upper
d1	-0.039121210	-0.07528977	-0.002849851
d2	-0.010619526	-0.06192612	0.040743045
d3	-0.003453125	-0.07621000	0.069340330
d4	0.031248816	-0.07222234	0.134054512
d5	0.076702279	-0.07100789	0.221120647
s5	0.042906966	-0.16902090	0.251042624



Wavelet Variance US INDEX

Variance of A1

wavevar lower upper

d1 0.033379453 0.0060191571 0.060739748

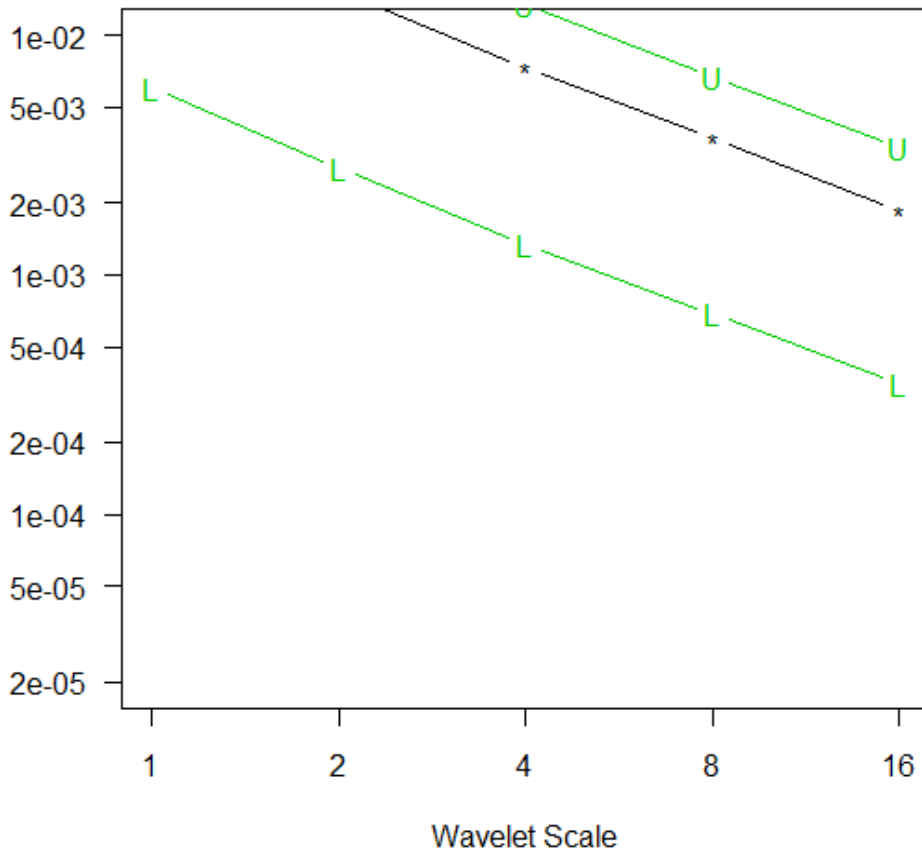
d2 0.015347857 0.0027718814 0.027923832

d3 0.007374995 0.0013382930 0.013411697

d4 0.003717646 0.0006871201 0.006748173

d5 0.001865634 0.0003495957 0.003381673

s5 0.001976669 0.0003578250 0.003595513



Variance of B1/ DOLLAR GOLD

wavevar lower upper

d1 7.036500e-05 1.385318e-05 1.268768e-04

d2 3.521641e-05 7.240945e-06 6.319188e-05

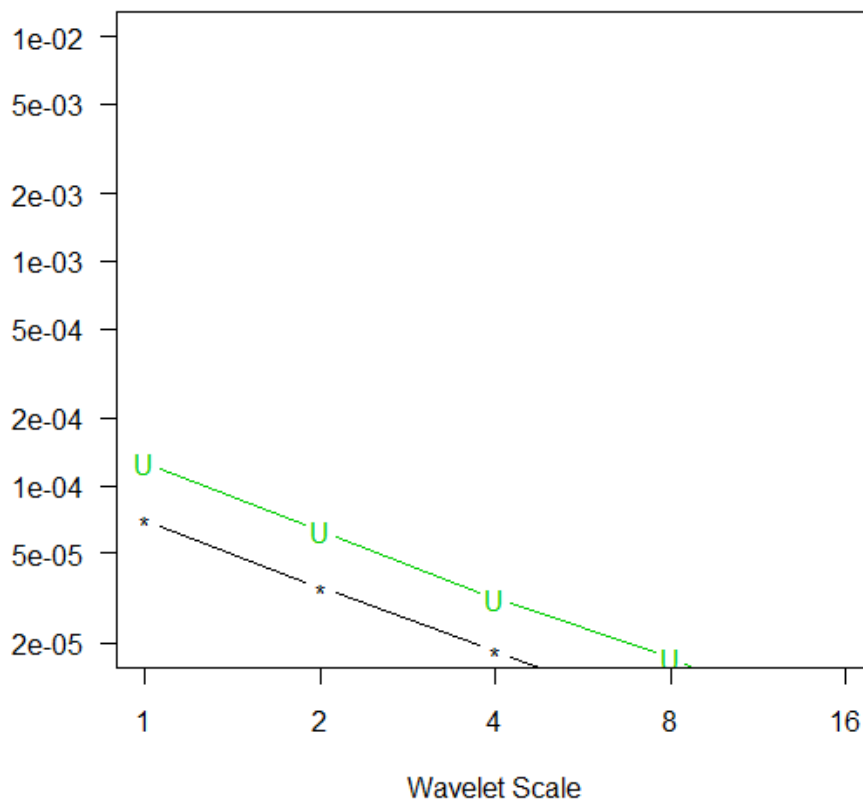
d3 1.845023e-05 5.467636e-06 3.143282e-05

d4 9.464091e-06 1.734358e-06 1.719382e-05

d5 4.762061e-06 2.049917e-06 7.474204e-06

s5 3.981862e-06 1.065388e-06 6.898335e-06

GRAPH FOR VARIANCE B1



COVARIANCE

wavecov lower upper

d1 -5.995567e-05 -1.167842e-04 -3.127158e-06

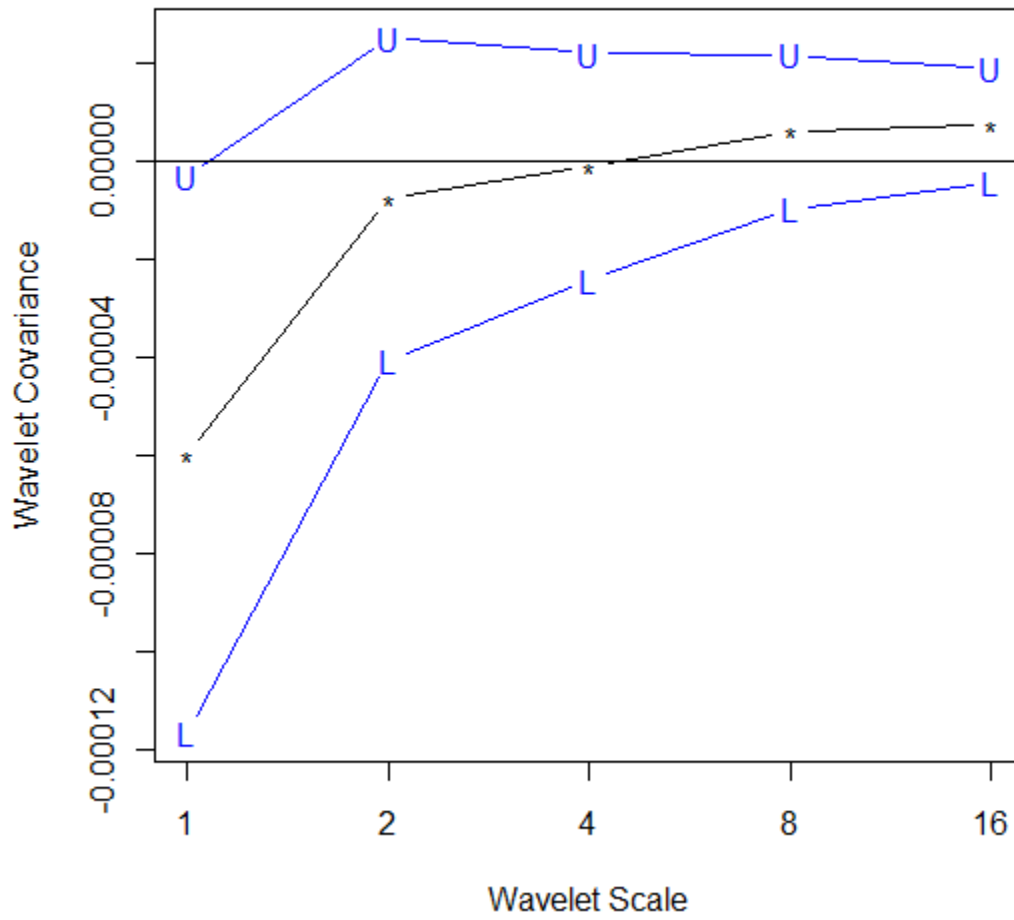
d2 -7.807312e-06 -4.077460e-05 2.515997e-05

d3 -1.273779e-06 -2.437983e-05 2.183227e-05

d4 5.861477e-06 -9.831443e-06 2.155440e-05

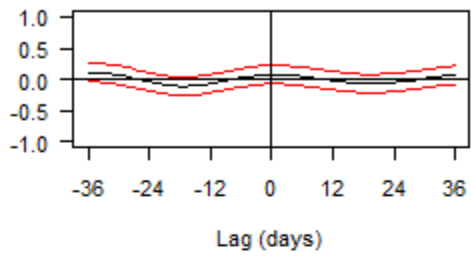
d5 7.229679e-06 -4.403755e-06 1.886311e-05

s5 3.806605e-06 -1.093681e-05 1.855002e-05

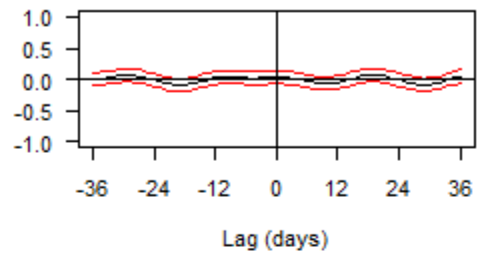


CROSS CORRELATION

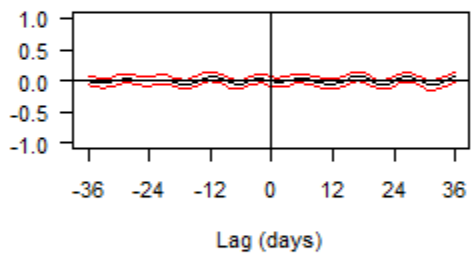
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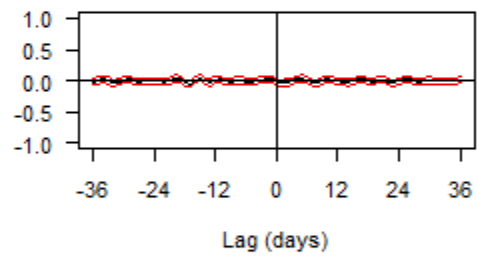
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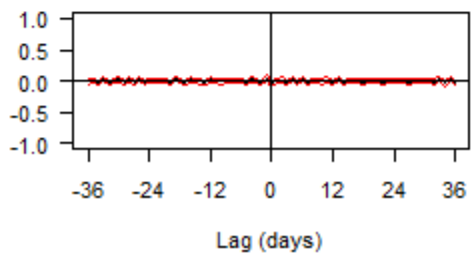
Level 3



Level 2

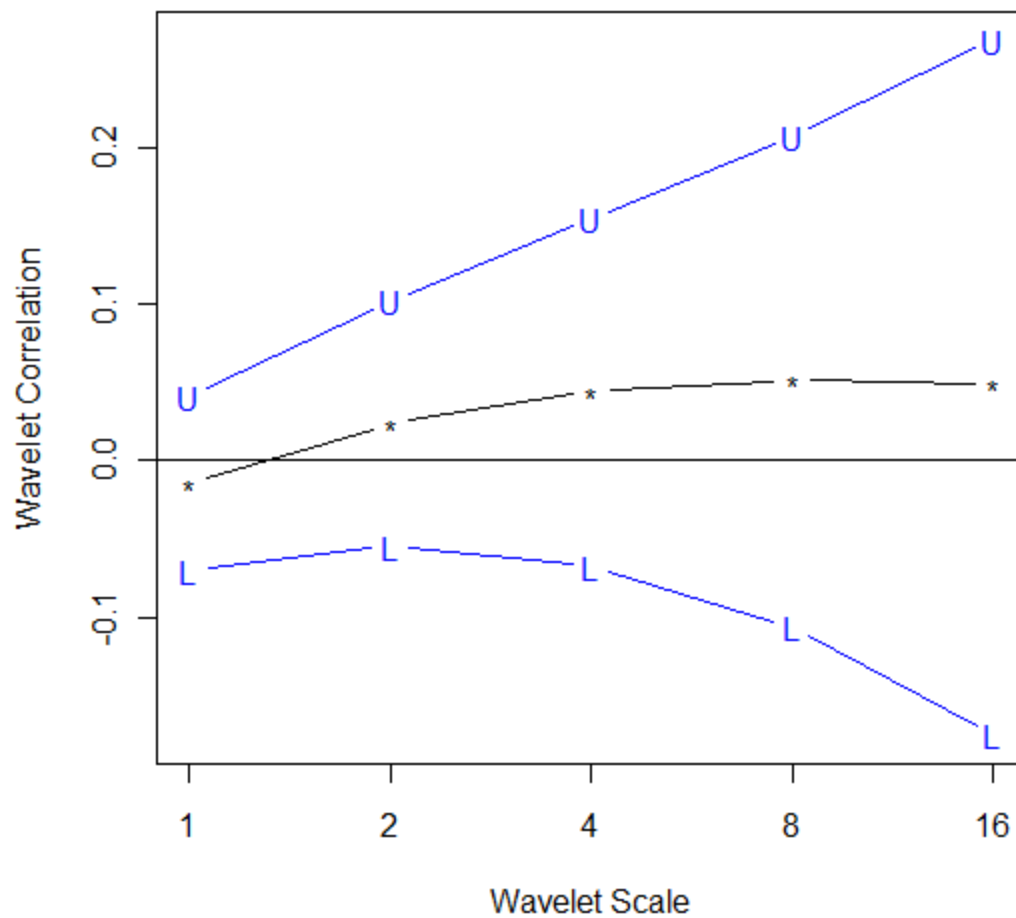


Level 1



US DOLLAR GOLD PRICE AND EURO GOLD PRICE

	wavecor	lower	upper
d1	-0.01445073	-0.06984064	0.04102802
d2	0.02354043	-0.05498710	0.10177854
d3	0.04398919	-0.06737862	0.15427433
d4	0.05145620	-0.10654607	0.20692380
d5	0.04899386	-0.17544976	0.26859621
s5	0.24428068	-0.07718541	0.51973899

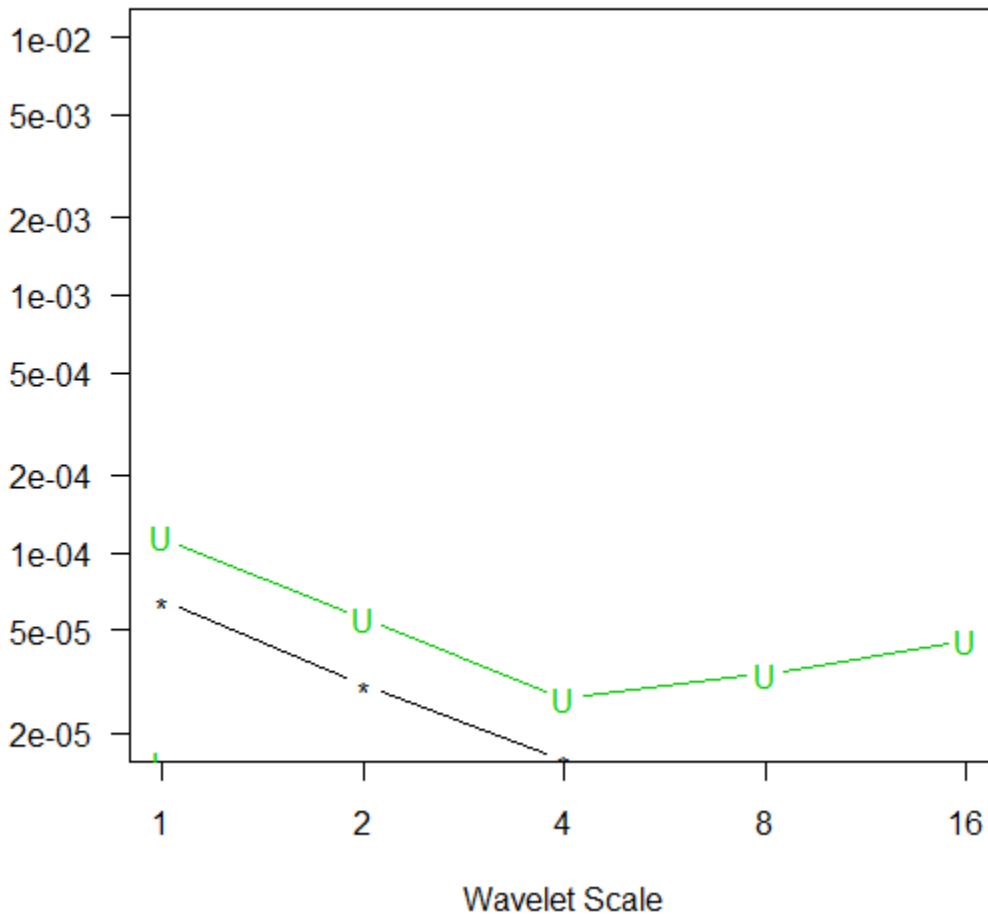


Variance of D1/EURO

wavevar	lower	upper
d1	6.508548e-05	1.147192e-04
d2	3.069104e-05	5.579479e-05
d3	1.568445e-05	2.719484e-05
d4	7.517084e-06	3.388406e-05

d5 3.860030e-06 -3.835573e-05 4.607579e-05

s5 4.012845e-06 3.535948e-06 4.489742e-06



COVARIANCE

wavecov lower upper

d1 -9.752922e-07 -3.419225e-06 1.468641e-06

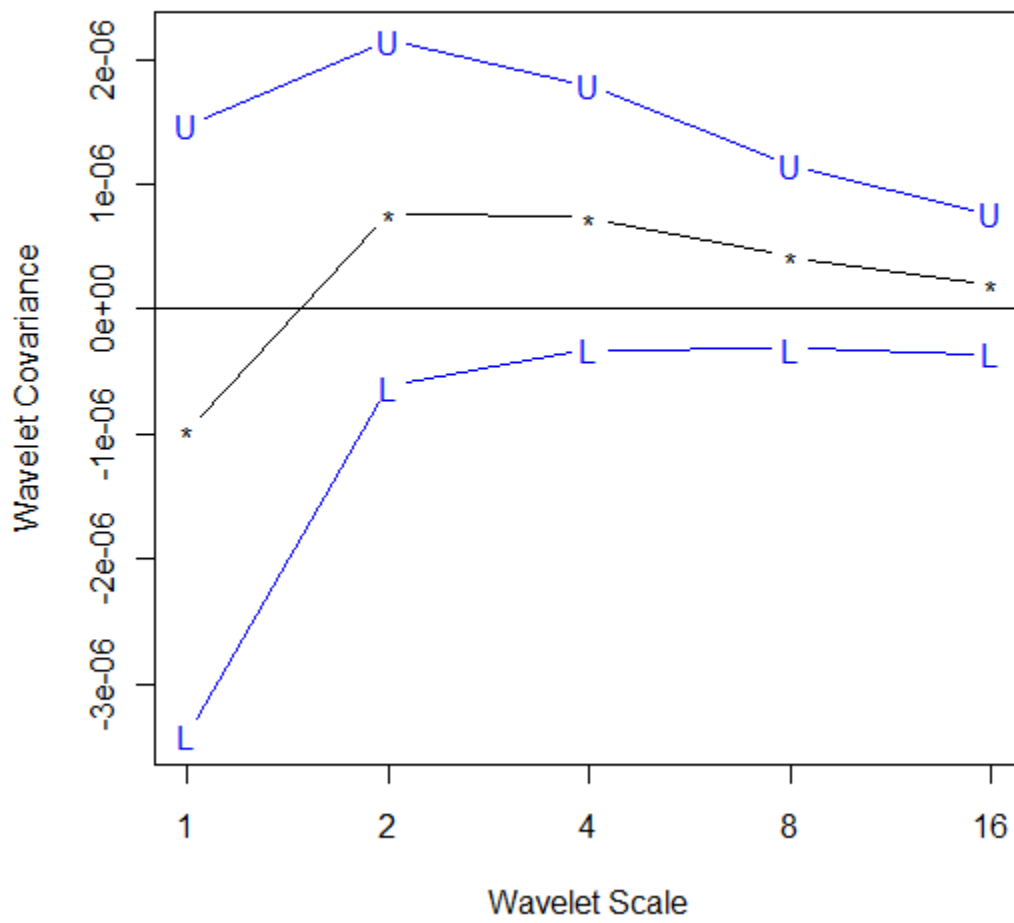
d2 7.676051e-07 -6.184738e-07 2.153684e-06

d3 7.339192e-07 -3.247746e-07 1.792613e-06

d4 4.199050e-07 -3.173475e-07 1.157158e-06

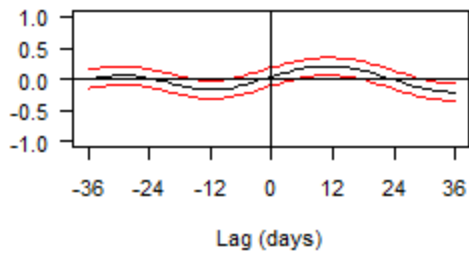
d5 2.029067e-07 -3.580668e-07 7.638803e-07

s5 9.432360e-07 1.501019e-07 1.736370e-06

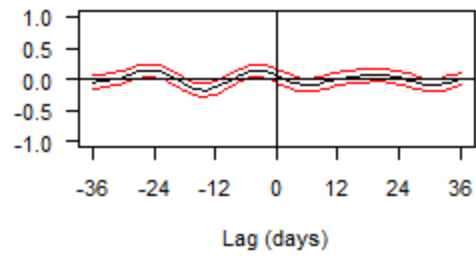


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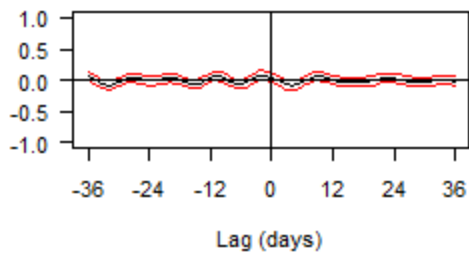
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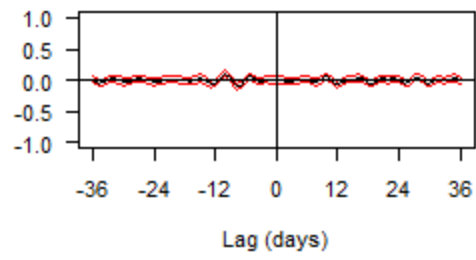
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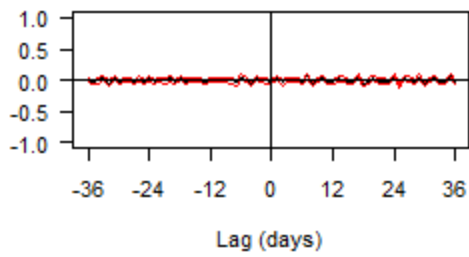
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Level 2

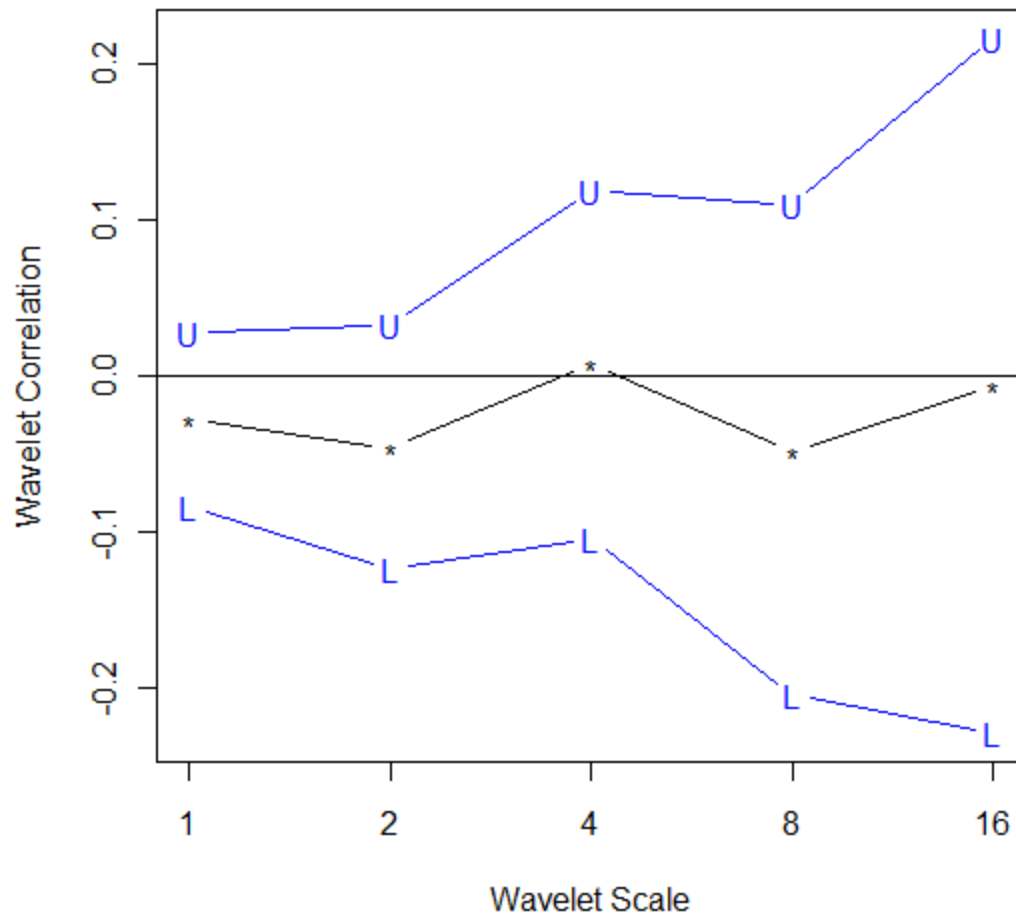


Level 1



DOLLAR-MYR

	wavecor	lower	upper
d1	-0.028088822	-0.08340480	0.02739972
d2	-0.045687374	-0.12367026	0.03285636
d3	0.007631780	-0.10349462	0.11857000
d4	-0.048217840	-0.20381429	0.10975452
d5	-0.006277546	-0.22848912	0.21655573
s5	0.237825365	-0.08399446	0.51471896



VARIANCE OF F1/MYR

wavevar lower upper

d1 7.839185e-05 1.437966e-05 1.424040e-04

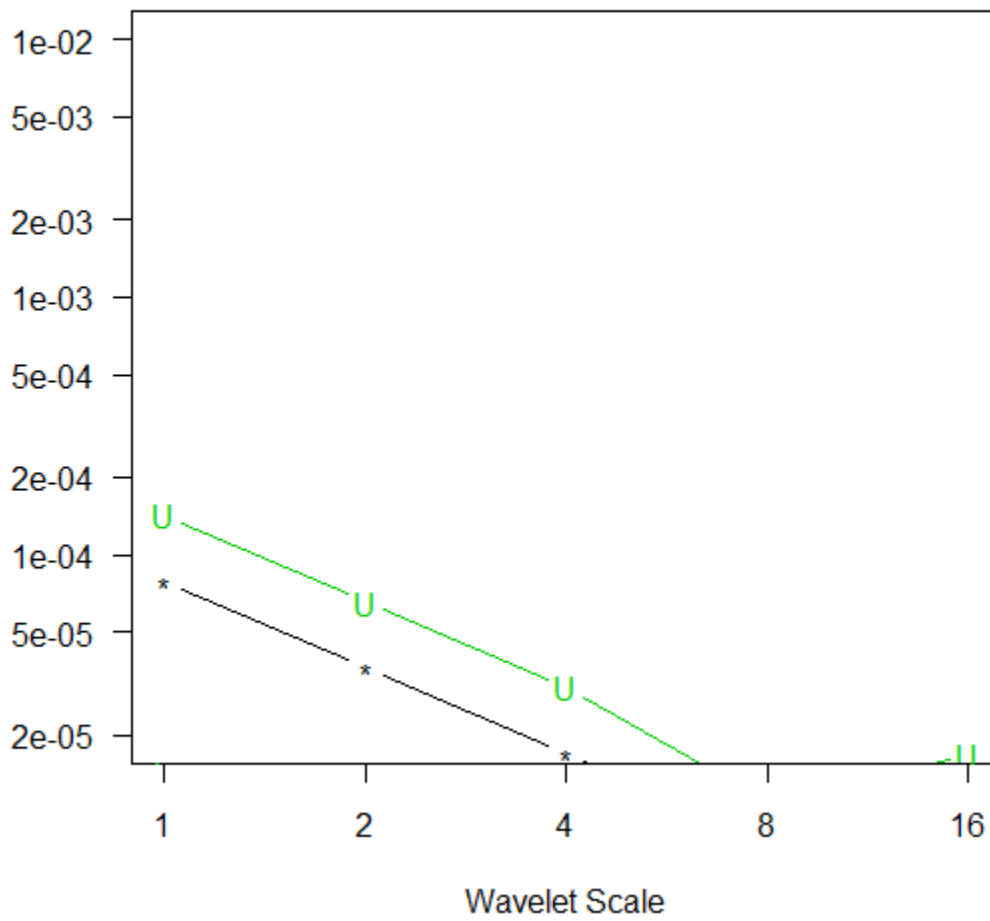
d2 3.662363e-05 7.608857e-06 6.563840e-05

d3 1.688743e-05 3.167753e-06 3.060710e-05

d4 8.576468e-06 6.058216e-06 1.109472e-05

d5 4.288710e-06 -8.074432e-06 1.665185e-05

s5 3.876542e-06 1.879627e-06 5.873457e-06



COVARIANCE

wavecov lower upper

d1 -2.080520e-06 -4.738249e-06 5.772086e-07

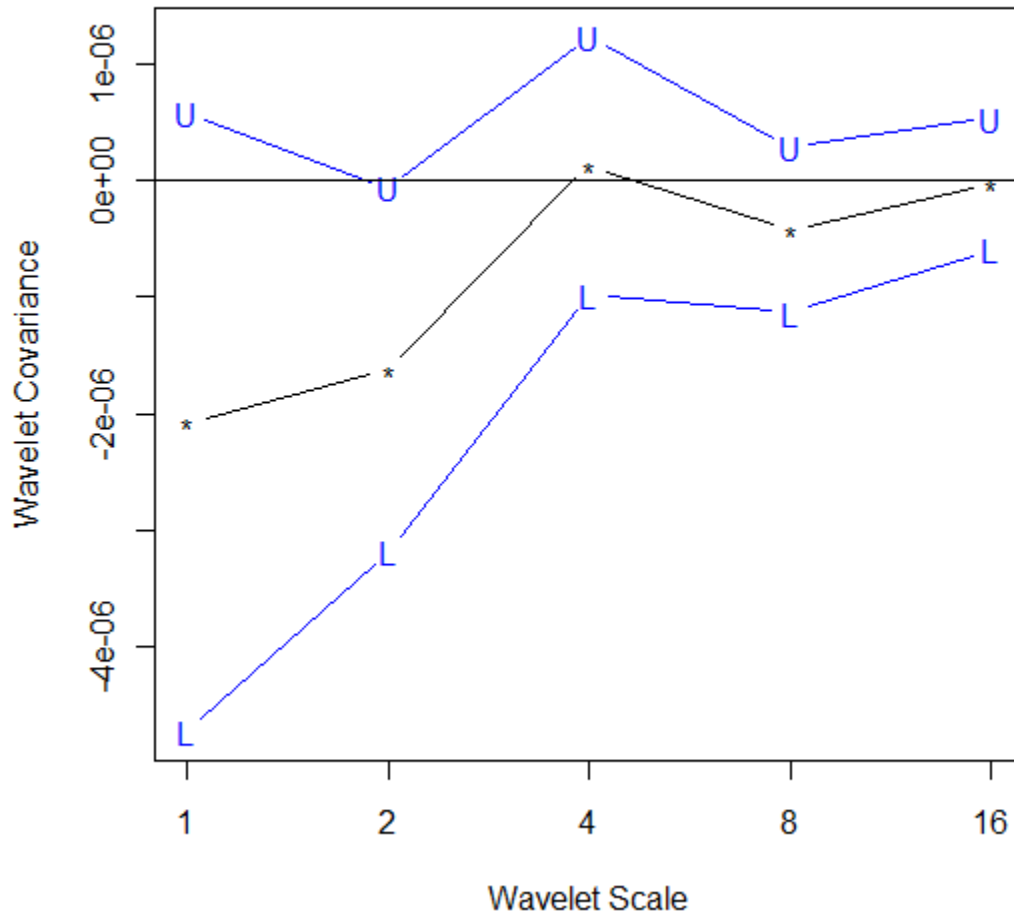
d2 -1.627401e-06 -3.193096e-06 -6.170490e-08

d3 1.321220e-07 -9.767930e-07 1.241037e-06

d4 -4.202915e-07 -1.134155e-06 2.935721e-07

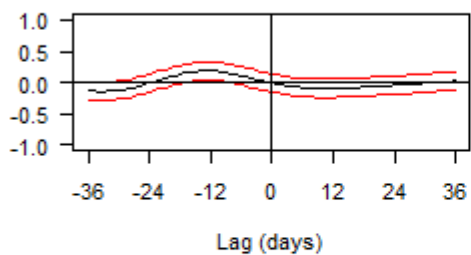
d5 -2.740392e-08 -5.916695e-07 5.368617e-07

s5 9.025796e-07 1.152769e-07 1.689882e-06

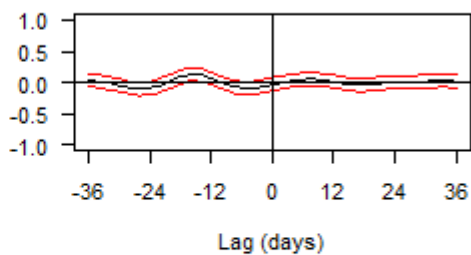


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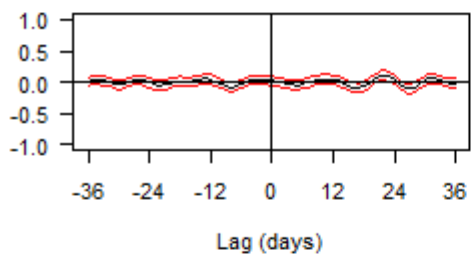
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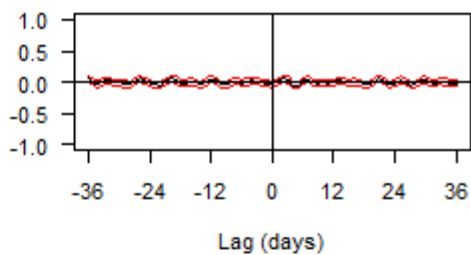
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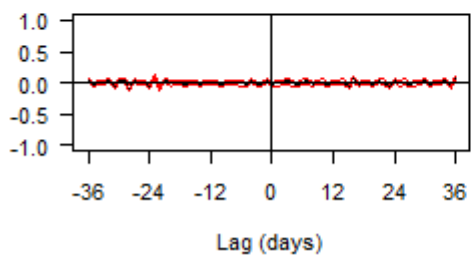
Level 3



Level 2



Level 1



EURO-POUND-CORRELATION

wavecor lower upper

d1 0.9103210 0.9003173 0.9193633

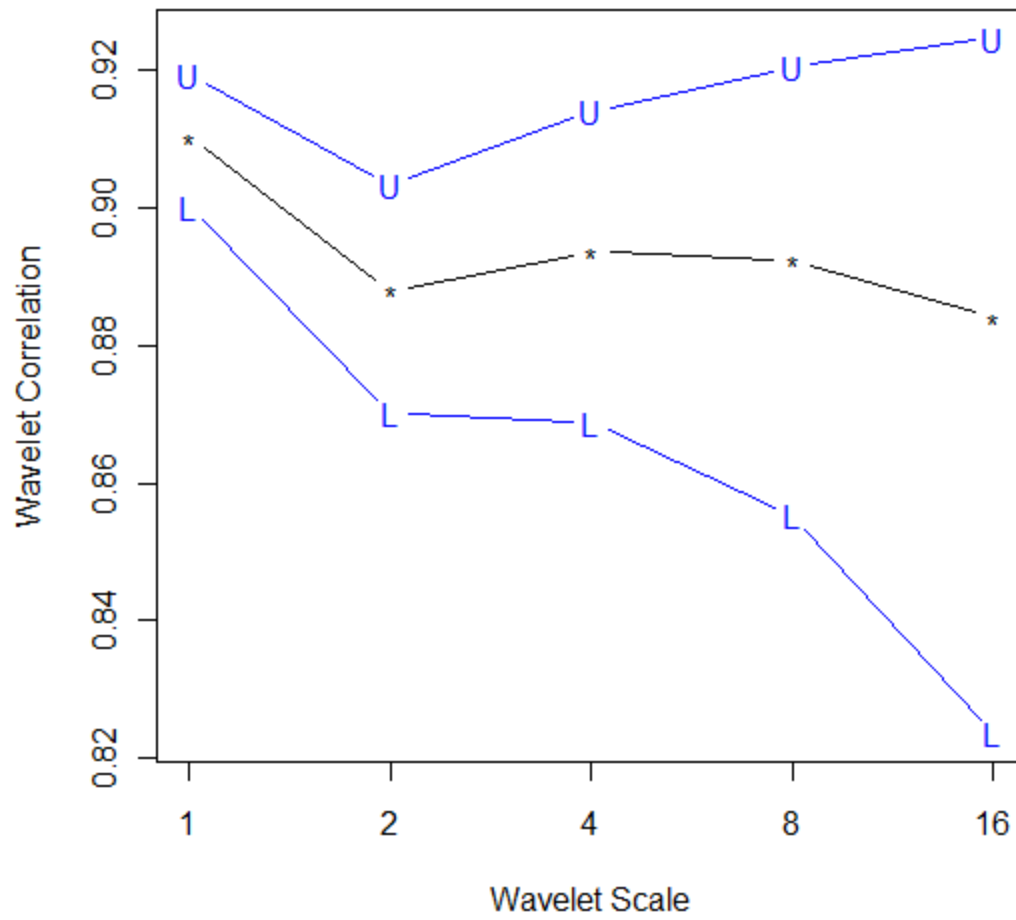
d2 0.8879970 0.8701716 0.9035013

d3 0.8937053 0.8688918 0.9140386

d4 0.8924538 0.8552546 0.9205025

d5 0.8841270 0.8236445 0.9247227

s5 0.9135614 0.8402381 0.9540726

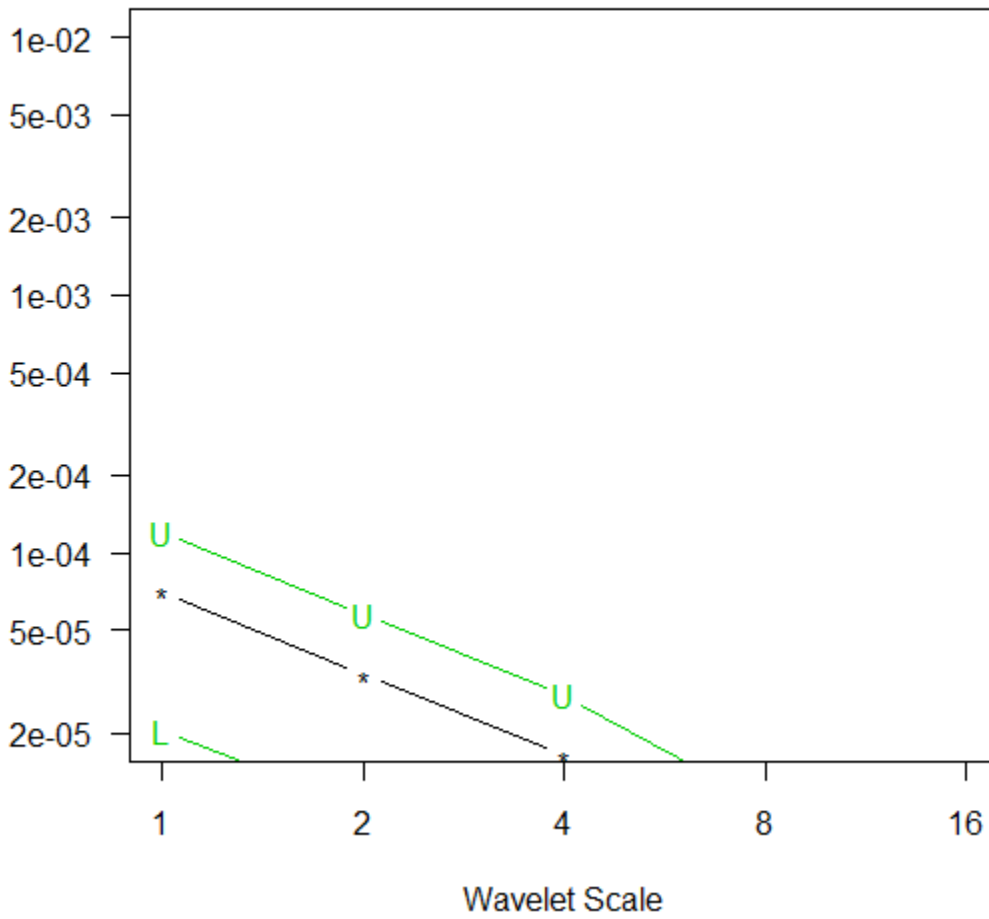


VARIANCE H1/PS

	wavevar	lower	upper
d1	7.018503e-05	2.051235e-05	1.198577e-04
d2	3.364543e-05	1.012153e-05	5.716932e-05
d3	1.647060e-05	4.992680e-06	2.794851e-05
d4	8.236608e-06	5.901452e-06	1.057176e-05

d5 3.798252e-06 -3.200672e-06 1.079718e-05

s5 4.420674e-06 2.101967e-06 6.739382e-06



COVARIANCE

wavecov lower upper

d1 6.152602e-05 5.805749e-05 6.499456e-05

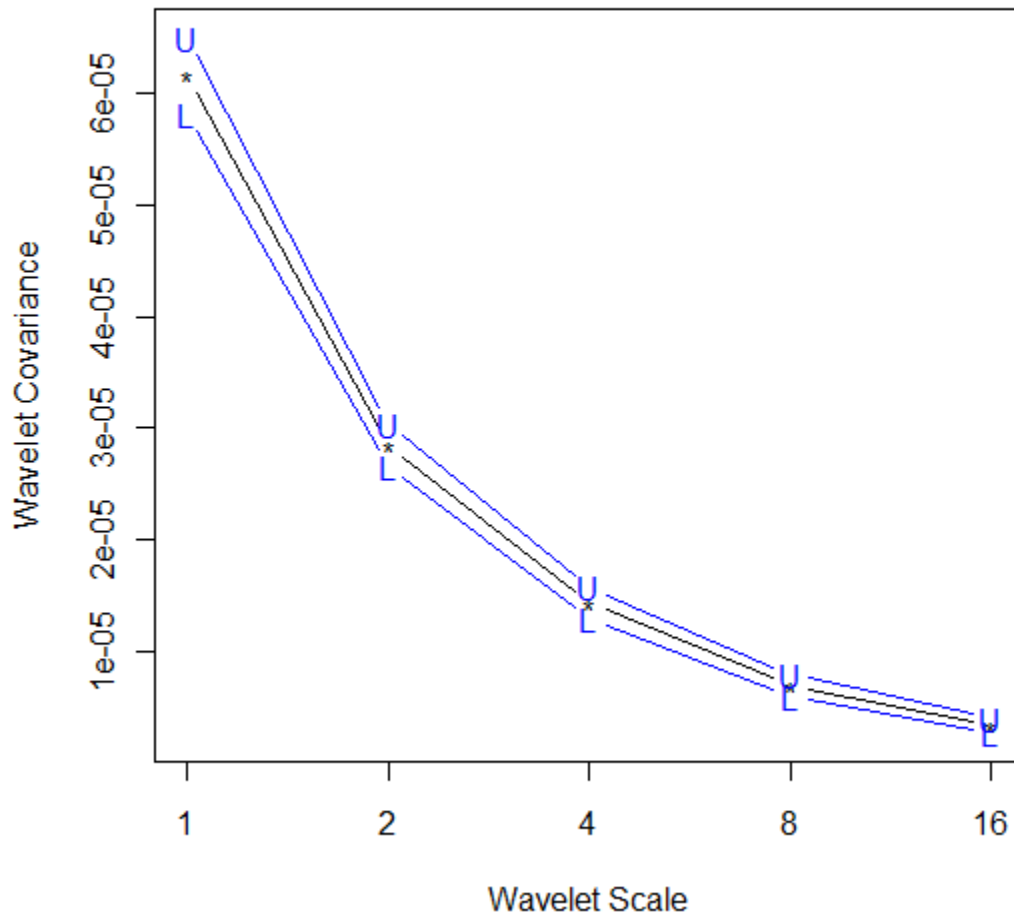
d2 2.853516e-05 2.664616e-05 3.042417e-05

d3 1.436427e-05 1.296943e-05 1.575912e-05

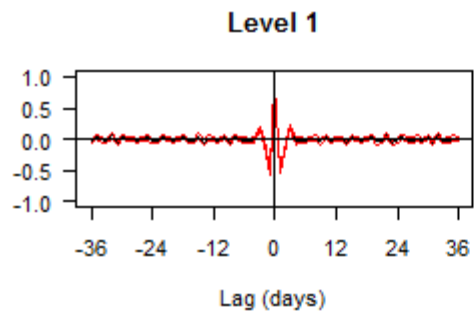
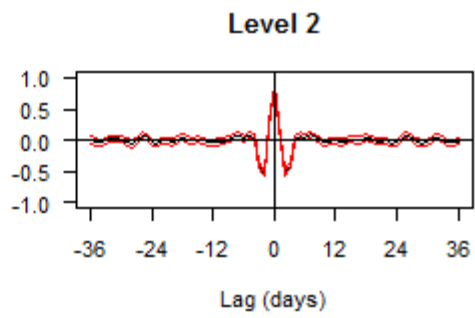
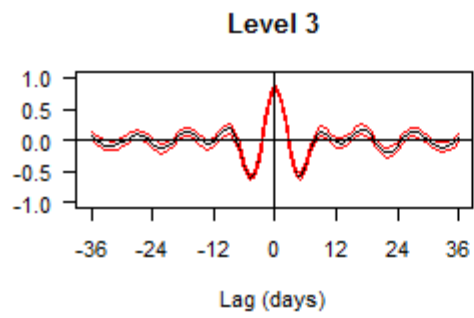
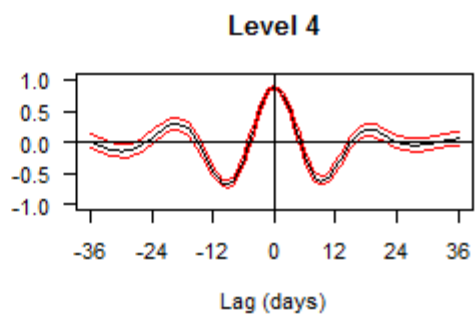
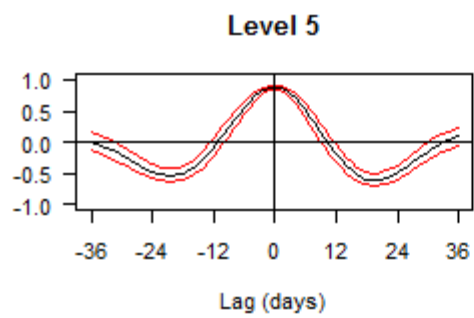
d4 7.022385e-06 6.064169e-06 7.980601e-06

d5 3.385337e-06 2.721691e-06 4.048982e-06

s5 3.847762e-06 2.846608e-06 4.848915e-06



CROSS CORRELATION



C