Do Islamic stocks and commodity markets comove at different investment horizons ? evidence from wavelet time-frequency approach

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Abstract

The financial crisis during the last decade did not only affect the stock markets but also the commodity markets. The behavior and relation of these two markets have changed during and after the financial crisis. Therefore, an understanding of the relationship between commodities and stock markets is crucial, especially during the crisis, when investors are looking for alternative investment opportunities. In this paper, we focus on commodity markets and their relation with Islamic stock markets during the financial crisis. This is one of the first attempts to study this relationship in the important and growing area of Islamic capital markets. The paper applies the recent wavelet analysis to Dow Jones Islamic index and two commodity sector indices (Energy and Precious Metal) and it aims to reveal how they commoved in the period of the Global Financial crisis, which began in the USA as the Subprime mortgage crisis.

Empirical results revealed that Islamic stock market commoved to a certain extent with the commodity indices during the whole period. Also, the wavelet correlation of stock markets and commodities differ significantly when talking about different investment horizons. We observed that stock markets are in general more correlated at different horizons with Energy sector than with Precious Metal. Further, based on wavelet coherence, it is observed that the co-movement between DJ Islamic and Energy Sector is significantly more compared to the co-movement with the Precious Metal commodity sector at different time scales and frequencies.

Keywords: Islamic stocks, commodity markets, wavelets

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1.0 INTRODUCTION

Many financial crises were preceded by bubbles, which were caused by excessive investors' interest in one market sector. The Global financial crisis in the late 2000s was not an exception; it started as a housing bubble. Every crisis is specific in some way, but still they have something in common, it is increased volatility of markets. They also have many different consequences, some of them can be even positive, but mostly every crisis is followed by extreme financial losses, downturn of economic activity, unemployment and many other consequences, that are not generally desired. This is also the reason why it is vital to understand how financial markets commove, how interdependent they are, how contagion is spread out and if their co-movement can be considered causal or not. Most of the research and investigation revolves around stock markets and their historical and potential future development, but recently commodities came to the forefront and they are playing bigger and bigger role. This is also the focus of this paper, to analyze mainly the extent of co-movement between stock markets and commodity markets. Further, during the last couple of decades Islamic Capital market has established itself as a sound and profitable alternative to conventional markets. Islamic capital markets operate on the basis of shariah (Islamic) rules and follow strict guidelines in the screening of the stocks.

There are a few ways how the co-movement can be modeled and studied. The very basic method is correlation coefficient, another more advanced are Vector Autoregressive models, co-integration analysis, family of GARCH models and last but not the least wavelets' time-frequency method. This quite new method became popular in finance lately, because it has something what others are missing. Usually, an analysis of financial data is conducted in the frequency domain or the time domain. Wavelets combine both of them and provide results that seem to be more comprehensive than those acquired by other methods. The paper applies the wavelet correlation and the wavelet coherence to examine time series.

Moreover, analyzing the links between commodity and Islamic capital markets is of particular interest for financial players as raw materials enter many investment portfolios, together with stock classes (Dwyer et al., 2011; Vivian and Wohar, 2012). Furthermore, as documented by Choi and Hammoudeh (2010), commodity traders concurrently look at both stock and commodity

market fluctuations to infer the trend of each market. Comparing the dynamic volatility of raw materials and Islamic equities prices provides useful information about possible substitution strategies between commodity and stock classes. In particular, volatility plays a key role regarding hedging possibilities, and impacts asset allocation across raw materials and their risk-return trade-off.

Building on the observed links between commodity and stock markets, a recent literature has emerged regarding the impact of investors' behavior in explaining the increase in both level and volatility of commodity prices. But, as underlined by Vivian and Wohar (2012), no clear-cut conclusion has been reached so far. However, the relationship between commodities and Islamic stock markets is still an unchartered area and to authors' knowledge there is not much research so far done in this area.

Given the basic idea and methods of the paper, I turn to data, which are Islamic stock market index returns and commodity returns, Dow Jones Islamic (DJI), Energy (EY) and Precious Metal (PM) commodity sector indices in the period starting from 1.1.2007.

The paper begins with the literature review in section 2. Section 3 describes data and methodology. It also provides the basic analysis of data. Empirical results of the application of the wavelet correlation and comments on these results are in section 4, and Section 5 concludes the paper

Given the basic idea and methods of the paper, we turn to data, which are DJ Islamic stock market index returns and sector commodity spot index, namely Energy and Precious Metal sector in the period starting from 1.1.2007.

2.0. Literature Review

Since the early 2000s, commodities have emerged as a popular asset class for many financial institutions. According to a staff report from the U.S. Commodity Futures Trading Commission (CFTC 2008), the total value of various commodity index-related instruments purchased by

institutional investors increased from an estimated $15 billion in 2003 to at least $200 billion in mid-2008. Several observers and policymakers have expressed a strong concern that index investment as a form of financial speculation might have caused unwarranted increases in the cost of energy and food and induced excessive price volatility.

As documented in the introduction, commodity markets share several characteristics with stock markets and financial assets. So far the literature has analyzed this phenomenon mainly by focusing on conventional stock markets, and looking at the co-movements between conventional stock and oil markets. Most of this literature offers substantial evidence on the impact of oil on stock prices, putting forward a negative relationship between oil price and stock market returns. For instance, Jones and Kaul (1996), using a standard cash-flow dividend valuation model, find a significant negative impact of oil price shocks on US and Canadian quarterly stock prices in the postwar period. Several models, relying on some variants of Vector Autoregressive analysis (VAR), highlight similar findings. Park and Ratti (2008), performing a multivariate VAR analysis, find statistically significant impact of oil prices shocks on real stock returns for US and 13 European countries over the period from January 1986 to December 2005.

The substantial increase in commodity prices over the past decade has been supported by a number of fundamental drivers. One of the most significant has been the shift in the composition of global growth over this period, as emerging market economies – particularly China – have come to prominence as the engines of world growth. Since these emerging market economies are generally at a relatively commodity-intensive stage of development, there has been a corresponding shift in global demand towards commodities as these countries industrialize and expand their infrastructure.

Keeping in view the lack of literature, especially on Islamic stock indices, this study explores the relationship between different commodities spot indices and Islamic stock indices, using wavelet analysis at different frequencies and time scales.

3.0. Data and Methodology

Throughout this paper, we are going to use one set of data. We are going to analyze three time series, more precisely DJ Islamic stock indices and two commodities spot indices (Energy EY and Precious Metal PM). Data was collected form Data Stream. To derive the objective of this study, a multi-step empirical analysis will be employed. Firstly, a simple descriptive examination of the data is conducted.

3.1. Wavelet Analysis

For each commodity and stock market, we collect daily return series for each index in the sample as well as for the market index. Daily stock and commodity index returns are calculated from stock price (P) as follows,

$$r_{it} = \ln\left(\frac{P_{it}}{P_{it-1}}\right) for\ stock\ and\ commodity, i\ at\ day\ t$$

After calculating the return series for every index, we use wavelet analysis to be able to separate out each return series into its constituent multiresolution (multi-horizon) components. To do that we apply Maximum Overlap discrete wavelet transformation (MODWT) on daily return series by sampling the return series at evenly-spaced points in time. We transform the return series from time domain into scale (interval) domain in order to understand the frequency at which the activity in the time series occurs. In our study, we sample the daily return series at different scale crystals (j) as follows: d1 (2–4 days), d2 (4–8 days) days, d3 (8–16 days), d4 (16–32 days), d5 (32–64 days), and s5 (>64 days).

We use non-decimated orthogonal Maximum Overlap Discrete Wavelet Transform (MODWT) with *symmlet 8* as a wavelet function to obtain a multi-scale decomposition of the return series. The Maximum Overlap Discrete Wavelet Transform (MODWT) will be used with the advantage on the flexibility of the length of data (not requiring the integral power of two) as well as time invariant property. The wavelet family *symmlet 8* is chosen to get the least asymmetry property which is more appropriate for financial series. The transformed return series r (t) is represented as a linear combination of wavelet functions as follows:

$$r\,(t) \approx \sum_k s_{j,k}\,\boldsymbol{\phi}_{j,k}(t) + \sum_k d_{j,k}\,\boldsymbol{\psi}_{j,k}(t) + \sum_k d_{j,k}\,\boldsymbol{\psi}_{j,k}(t) + \cdots \sum_k d_{1,k}\,\boldsymbol{\psi}_{1,k}(t)$$

where:

j is the number of scale crystals (intervals or frequencies)

k is the number of coefficients in the specified component

$\phi_{j,k(t)}$and $\psi_{j,k(t)}$ are the father and mother orthogonal wavelet pair that are given respectively by

$$\phi_{j,k}(t) = 2^{-j/2}\phi\left(\frac{t-2^j k}{2^j}\right) for\ j = 1\ to\ j$$

$$\phi_{j,k}(t) = 2^{-j/2}\phi\left(\frac{t-2^j k}{2^j}\right) for\ j = j\ to\ 1$$

Father wavelets represent the low-frequency (smooth) parts of the series, whereas mother wavelets represent the high-frequency (detailed) parts of the series. $s_{j,k}$ and $d_{j,k}$ are wavelet coefficients that are approximated by the following integrals:

$$s_{j,k} \approx \int \phi_{j,k}(t) f(t) dt$$

$$d_{j,k} \approx \int \phi_{j,k}(t) f(t) dt$$

$s_{J,k}$ are called the 'smooth' coefficients that represent the underlying smooth behavior of the series, while $d_{j,k}$ are called the 'detail' coefficients that represent the scale deviations from the smooth process. These coefficients are measures of the contribution of the corresponding wavelet function to the total series. After we decompose the return series into *j* crystals, the crystals *dj* are recomposed into a time domain. The entire return series is replicated in multi-resolution decomposition as follows:

$$\widehat{r^J} = D_1 + \ldots\ldots D_j + S_j$$

where *Dj* is the recomposed series in the time domain from the crystal *dj* and S_J is the recomposition of the residue. The reconstituted return series $\hat{r}_J$ contain the separate components of the original series at each frequency *j. Dj* represent the contribution of frequency j to the original series.

4.0. EMPHERICAL RESULTS

4.1. Descriptive Statistics

The descriptive statistics for the daily returns of the 2 commodity spot price indices and DJ Islamic stock index, in my study provides interesting insights into the volatility of the returns, as represented by the standard deviations.

Table 2: Descriptive Statistics

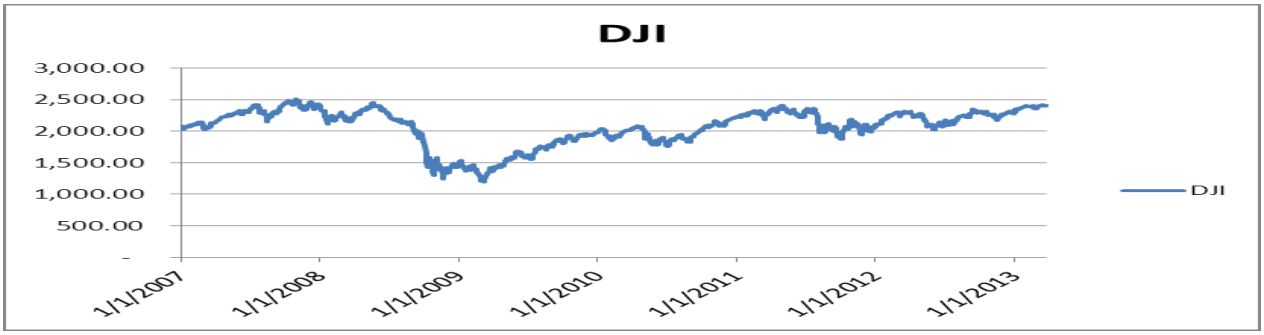
	DJI	CM	EY
Mean	**6.96E-05**	**0.000374**	**0.000284**
Std. Dev.	**0.011086**	**0.011149**	**0.020113**
Skewness	**-0.294426**	**-0.238584**	**-0.166490**
Kurtosis	**10.36142**	**5.398383**	**5.293964**

The energy commodities (EY) seem to differ from Precious Metal (PM) commodities in terms of volatility: the standard deviation (0.02) is much higher than the Precious Metal and even the DJ Islamic stock index. Together with high volatility, the group of energy and metal sector exhibits low returns on average, leading to the lowest benefit-risk trade off compared to the DJ Islamic. However, DJ Islamic stock index is highly volatile as it has a significantly higher kurtosis value (10.36).

From the following graph, we can see an interesting pattern of DJ Islamic index. First there is a huge fall in year 2008, which was caused by the Subprime mortgage crisis in the USA. Afterward

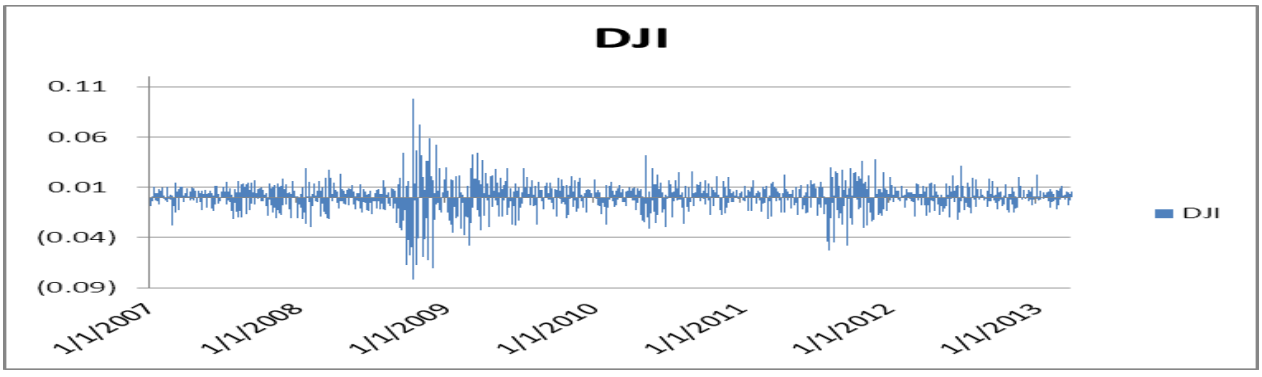
there was rise in index till 2011 and then there was a slight decline due to the US Debt Ceiling and European Debt crises.

1.1 DJ Islamic Stock Market Index



When we take a look at returns of DJ Islamic stock market indices in Figure 1.2, we can conclude that it became very volatile in the second half of 2008. There was no exception, the crisis was obviously global. In addition, there is a recent increase of volatility in the second half of 2011 and the possible explanation can be a tension on financial markets caused by the EU sovereign debt and US debt ceiling crisis.

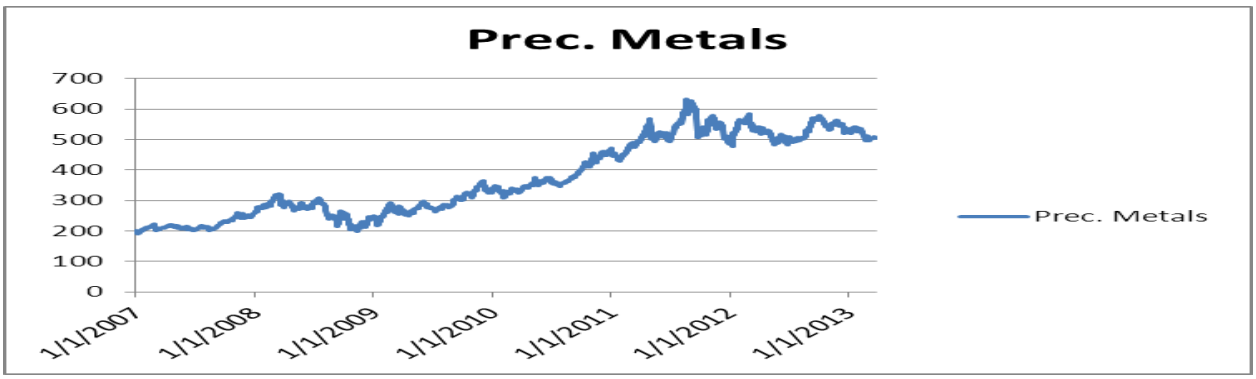
1.2: Returns of DJ Islamic stock market



In our analysis we focus on Energy EY and Precious Metal (ML) commodity indices. We can see in Figure 1.3 big differences in the price development, there is an obvious increase in the Precious

Metal index, which includes Gold. It can be said that Gold served as a safe haven for investors during the economic turmoil. The price index increased by three times in the examined period. On the other hand Energy (EY) commodities that represent a necessary part of the economy and include Crude Oil and Heating Oil; went through a huge decrease in 2008 .The reason of such drop in the prices can be probably explained by a lower industry production during the crisis and correspondingly lower demand for fuels.

1.3: Precious Metal Price Index



1.4: Energy Price Index

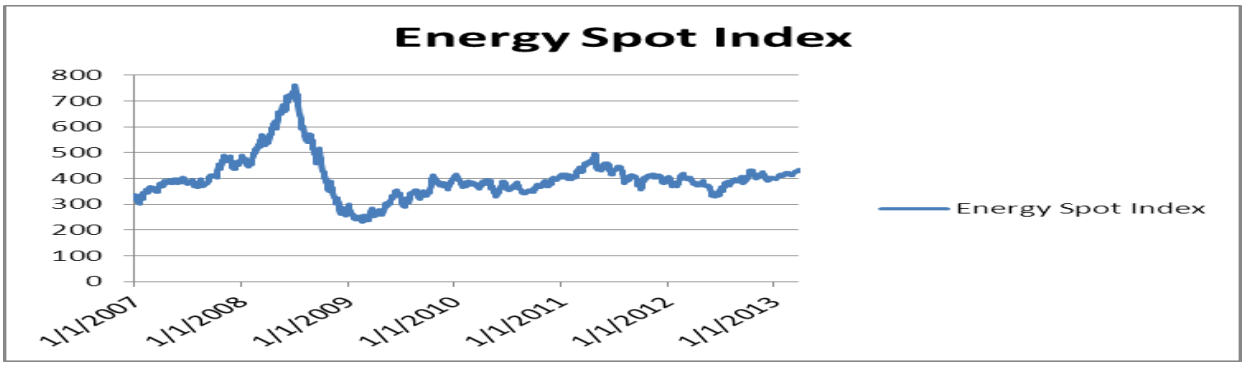
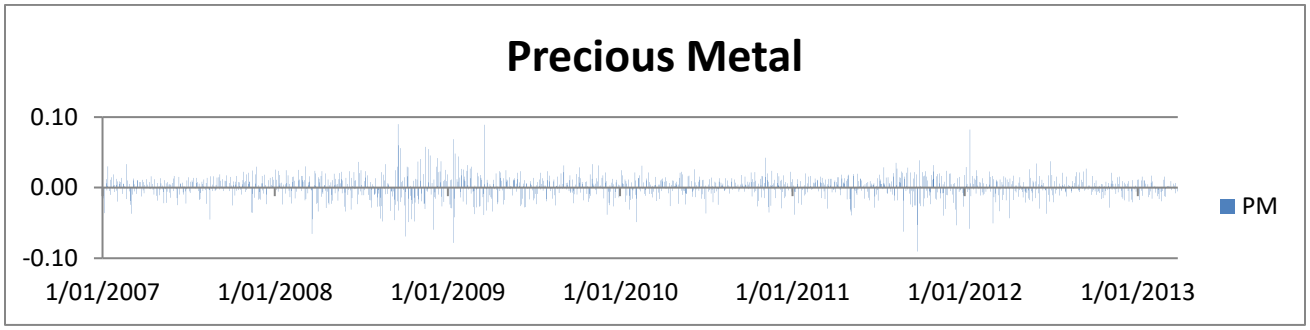
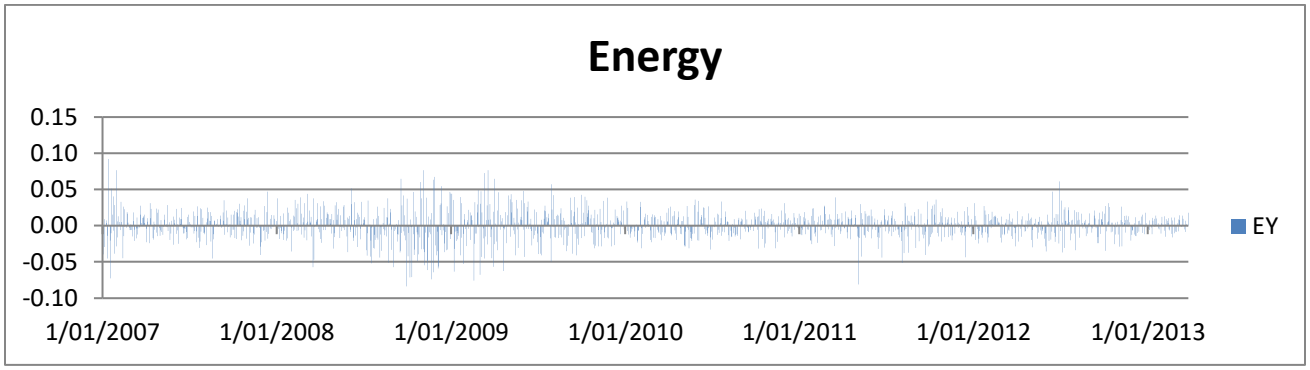


Figure 1.5, depicting commodity returns, indicates that there was also a higher volatility, which began in the second half of 2008; they also suggest that Precious Metal (PM) commodity was affected first as compare to the Energy (EY) commodity index.

1.5: Return of Precious Metal Commodity Index



1.6: Return of Energy Commodity Index



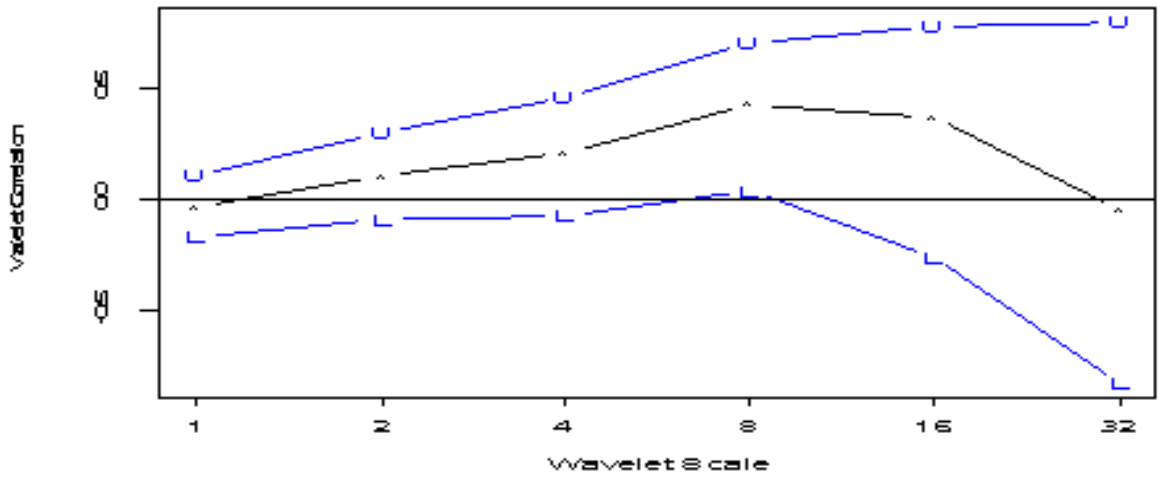
4.2. The Wavelet Correlation of Stock and Commodity Markets

Our empirical analysis follows the approach of Gencay et al. (2002) and we use filter denoted by LA(8), which has a length L = 8, this filter is commonly used in literature as can be found in Percival & Walden (2000). In our figures x-axis represents different scales a y-axis represents levels of the correlation between examined time series. Wavelet scales, based on the length of the time series, are ranging from the scale 1 to the scale 6 and are associated to changes of 1-2, 2-4, 4-8, 8-16, 16-32, 32-64 days, respectively. Symbol "U" represents upper bound and "L" represents lower bound of the estimate, for the approximate 95% confidence interval. Our results were acquired by using R 3.0 and package Waveslim.

We begin our analysis with correlations of the two commodities and DJ Islamic index. Correlations of DJ Islamic and Precious Metal (ML) index is most of the time very close to 0 and less than 0.4, but with respect to confidence intervals, which seem to be very wide, we can only say that in general correlation is very low, especially on scales 1,2,3 (i.e., high frequencies). On

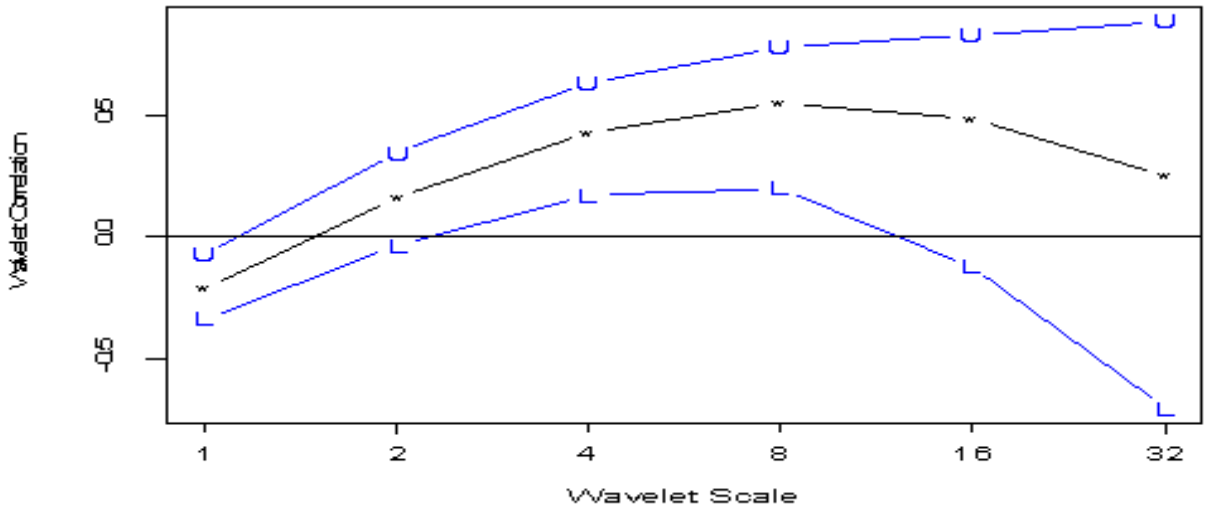
scale 1, the correlation is -0.03. However, at scale 4 the correlation is the highest at 0.37. After scale 4, the correlation tends to decline again.

Figure 1.7: The wavelet correlation DJ Islamic and Precious Metal



The correlation of DJ Islamic and Energy index is increasing on the daily basis. The correlation start at negative 0.2 at level 1 and then just before level2, the correlation is zero. After level 2, the correlation increases till level 4(0.55), and again it declines in level 5 and 6.

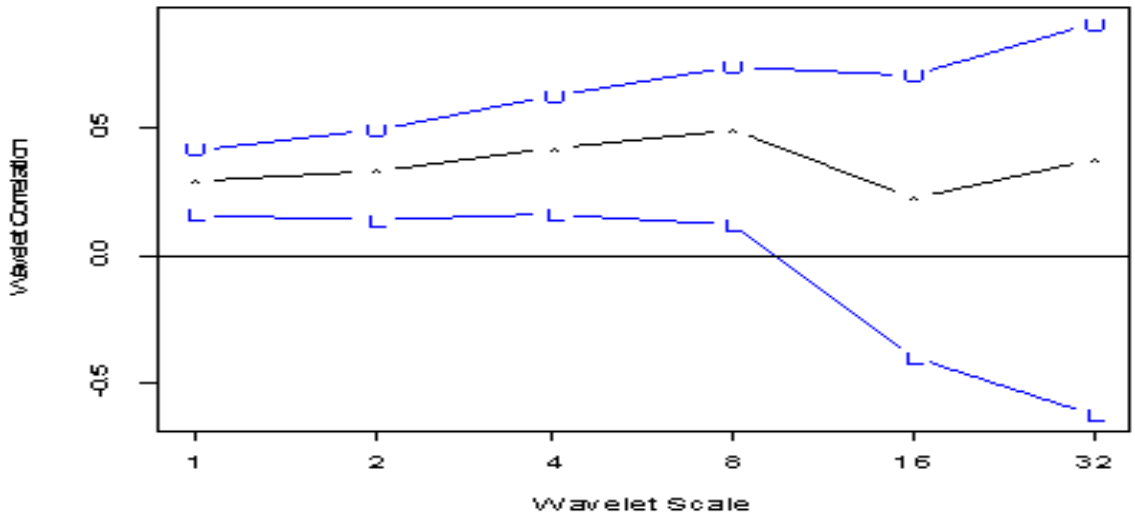
Figure 1.8: The wavelet correlation DJ Islamic and Energy



The figure 1.9 shows the daily correlation between the Energy (EY) and Precious Metal (commodity) indices. The correlation between the two indices is positive for all the scales. At

level 1, the correlation is 0.29 and it increases till the level 4 at 0.50. However, after level 4, the correlation decreases again and reaches 0.23 at level 5. Interestingly, the correlation again rises after level 5.

Figure 1.9: The wavelet correlation Energy and Precious Metal



We can observe that the wavelet correlation of examined time series differs at different scales. As a result of that the wavelet correlation has a potential to become a very useful tool especially in the portfolio analysis, since it shows differences in the correlation between scales, it can serve both short term horizon and long term horizon investors. We also observed that stock markets are in general more correlated with Energy sector than with Precious metal.

5.3 Wavelet Coherence Analysis

The wavelet coherence is a very efficient tool how we can study when and at what scales examined time series commove. Our results are acquired by using Matlab package, which was written by Grinsted et al. (2004). Following figures depict the wavelet coherence into a contour plot. The time domain is represented by x-axis and the frequency by y-axis. In addition, the frequency is represented by the period, i.e. the higher frequency the lower the period. The interpretation of our figures is based on the color of regions, blue color means that there is low or even no comovement. On the other hand, red regions with a thick black outline mean that

there is a significant comovement between time series. As a result of this we can obtain very detailed results based on the time domain and the frequency domain at the same time. Another thing that helps us to interpret results are so called phase arrows, which show the relative phasing of time series at given scale. If arrows are pointing to the right that means that time series are in phase, opposite direction means anti-phase. If they are pointing down then the first variable is leading the second one and if they are pointing up then the second variable is leading the first one.

We focus on the comovement between DJ Islamic and commodity Indices. This part of analysis should reveal how interdependent stock markets and commodity markets are. We can observe how specific the two commodities sectors behaved in the crisis, whether they commoved with Islamic stock market or not.

The wavelet coherence revealed very interesting patterns. We observe that Precious Metal (PM) sector commoved with the DJ Islamic index in different periods and only on certain frequencies, there are a couple significant regions. The first one is in the mid of 2007 around 16 day period that represents low frequency and secondly; there is a significant region at very low frequencies in 2010. More significant comovement is in the case of Energy (EY) sector, in the second half 2009 there was a strong comovement on 12-32 day period. In 2010 we observed a comovement at quite low frequencies and last one in 2011 at almost all frequencies. From the figures below it can be seen that the comovement between DJ Islamic and Energy Sector is more as compare to the comovement with the Precious Metal commodity sector.

Figure 1.10: Comovement of DJ Islamic and Precious Metal Sector

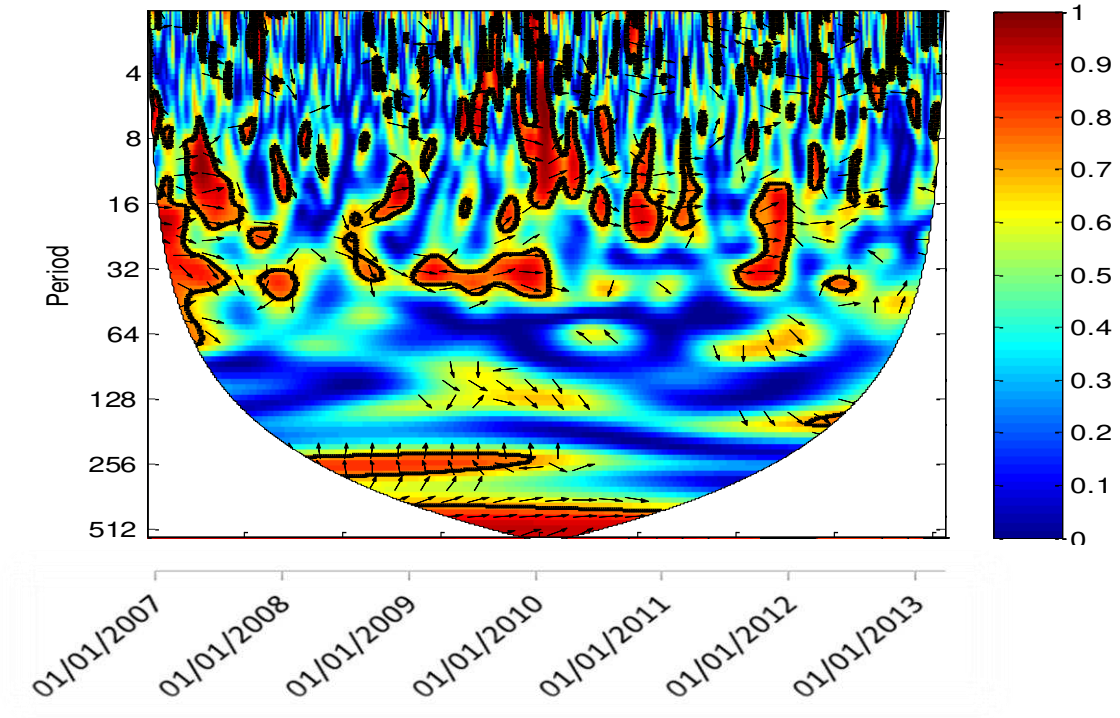
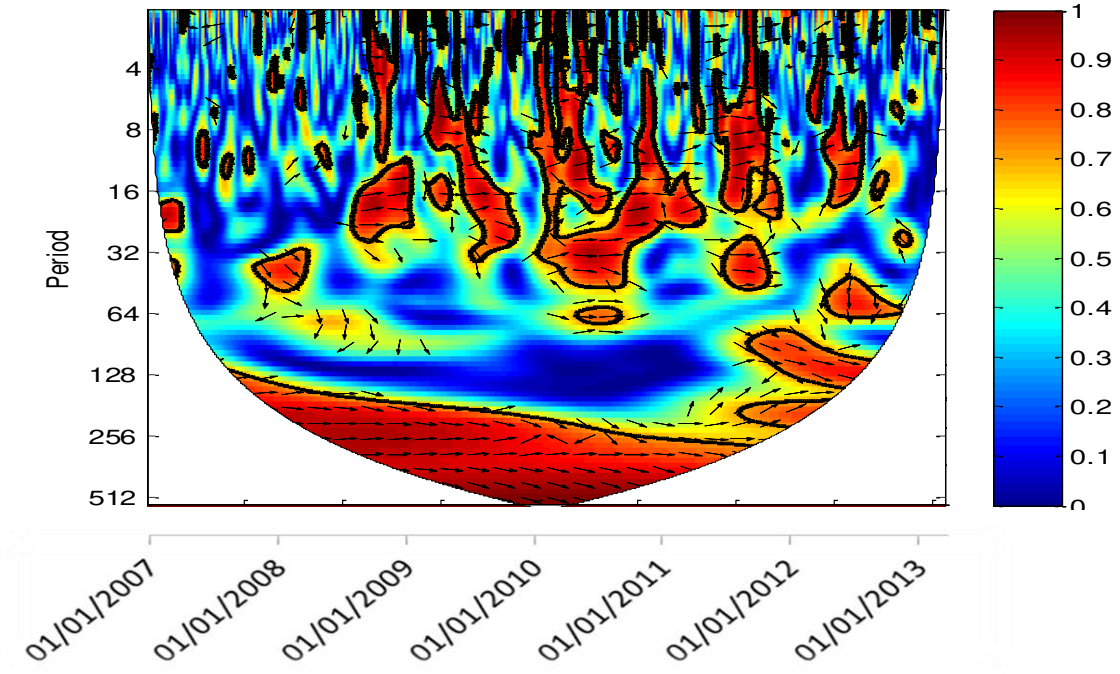


Figure 1.11: Comovement of DJ Islamic and Energy Sector



Conclusion

The paper revolves around the topic of wavelets and their application to Islamic stock markets and commodity markets in the time of the Global financial crisis. We analyze relations of Islamic stock market indices: DJI Islamic and two sector commodities: Energy and Precious Metal. First part describes the theoretical background and the motivation why wavelets can be such a useful tool in the analysis of time series. The analysis is conducted on dataset of daily returns, which includes days from 1.1.2007 until 29.3.2013.

We can observe that the wavelet correlation of examined time series differs at different scales. As a result of that the wavelet correlation has a potential to become a very useful tool especially in the portfolio analysis, since it shows differences in the correlation between scales, it can serve both short term horizon and long term horizon investors. We also observed that stock markets are in general more correlated with Energy sector than with Precious metal. This indicates that the wavelet correlation confirmed something what is generally known; Gold is a safe haven for investors during the crisis.

Then we analyzed the wavelet coherence of examined time series, which is an excellent tool that allows us to see their comovement in both frequency and the time domain at the same time. The wavelet coherence revealed very interesting patterns. We observed that Precious Metal (PM) sector commoved with the DJ Islamic index in different periods and only on certain frequencies, there are a couple significant regions. The first one is in the mid of 2007 around 16 day period that represents low frequency and secondly; there is a significant region at very low frequencies in 2010. More significant comovement is in the case of Energy (EY) sector, in the second half 2009 there was a strong comovement on 12-32 day period. In 2010 we observed a comovement at quite low frequencies and last one in 2011 at almost all frequencies. From the analysis, it can be seen that the comovement between DJ Islamic and Energy Sector is more compared to the comovement with the Precious Metal commodity sector at different investment horizons.

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