Should Shariah-compliant investors include commodities in their portfolios? New evidence

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ABSTRACT

This paper investigates the links between price returns for seven commodities and Shariah-compliant equities (developed and emerging markets) over the period from January 1996 to April 2013. Employing the dynamic conditional correlation (DCC) M-GARCH methodology, we show that the correlations between commodity and stock markets evolve over time and are highly volatile, particularly during the financial crisis, which has played a key role, emphasizing the increased integration between commodity and stock markets, and underlining the financialization of commodity markets. However, in the last couple of years the correlation between commodities and equities seems to be decaying. Hence, Islamic investors hopefully could gain from the diversification benefits by the inclusion of commodities into their portfolios.

Keywords: financialization of commodities, shariah-compliant equities, MGARCH – DCC technique

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1. INTRODUCTION

Investors looking for the optimal way to play in the markets have found that holding a diversified portfolio is the efficient way of allocating assets. Diversification is realized by combining assets that are not perfectly correlated. The lower the correlation between assets, the greater the reduction in risk that can be derived. Diversification spreads risks while granting exposure to various corners of the market that behave quite differently depending on the current environment.

Many institutional managers have accepted commodities as a profitable alternative asset class, implying that they possess similar investment attributes, distinguishing them from other asset classes. Typically, commodities have the following characteristics (*Büyüksahin et al., 2010; Daskalaki & Skiadopoulos, 2011; Belousova & Dorfleitner, 2012*):

- *First*, commodities offer an effective hedge against both expected and unexpected inflation. Commodities are real assets that have an intrinsic value and tend to move in parallel to inflation.
- *Second*, commodity prices are determined by the current state of the economy and vary with the business cycle. Thus, periods of strong expansion coincide with rising commodity prices due to the increased demand and to the inflation-hedging properties of commodities.
- *Third*, commodities have little or no correlation with other assets. The idea of a well-diversified portfolio is to have low correlation in order to spread risks, and with some commodities exhibiting almost zero correlation to other assets, there is no question that they have a place in the portfolio.

These attributes of commodities encourage investors to choose them as a refuge during periods of stress in traditional asset markets, especially if macroeconomic shocks tend to work on commodity and stock prices in opposite directions, as well as because of diversification benefits.

There are several options for inclusion of commodities into portfolios, among which are:

(a) *Shares of commodity producers*. Although stocks are comparatively less volatile, the drawback of this investment is that returns are affected by factors other than the commodity price. Firstly, the performance of a single company is not dependent on the price movements of commodities only, but also on such factors as cost of capital, wage rates and exploration costs. Secondly, earnings are more related to the state of the economy and the management decisions than the commodity price.

(b) *Futures contracts* (directly or through ETFs and ETNs). The advantage of such commodity investment is the possibility to bet on rising (long position) as well as falling (short position) commodity prices depending on the investor's market expectation. The disadvantage is the high risk because of the high short-term volatility of the commodity prices (*Demidova-Menzel & Heidom, 2007*).

(c) *Commodity indices*. Commodity index investment is passive, fully-collateralized, long-only investment by an institution or individual and is similar in principle to a stock index portfolio. Its fundamental contribution to investment management is in providing an effective diversification tool *(Stoll & Whaley, 2009)*.

(d) *Commodity in kind*. Physical commodities are costly to buy and sell as well as store (the issue of transaction costs). After accounting for trading and storage costs, the expected returns from commodity investments could be so low that they outweigh the diversification benefits.

However, current trends in commodities markets brought the skepticism on the diversification benefits of commodities. Since the last decade, we are witnessing integration of commodity markets with equity and debt markets by rising nominal commodity prices. According to *Roache & Rossi (2010)*, recent commodity price volatility has overlapped with an increasing participation in commodity markets by financial

investors rather than commercial traders, who are mainly seeking to enhance investment returns and/or achieve greater portfolio diversification.

Various factors are claimed to have contributed to that, such as increase of demand for commodities from India and China and slow supply response, instability of USD and Euro, growth of biofuel production, surge of crude oil prices and presence of speculators in the markets (*Silvennoinen & Thorp, 2013; Nazlioglu et al, 2013; Daskalaki & Skiadopoulos, 2011; Tang & Xiong, 2010).*

Financial investors significantly increased their investments in commodity futures markets in 2008 *(Girardi, 2012),* influencing the formation of futures prices, which are considered as the benchmark for spot prices. In particular, financial actors had been buying large amounts of futures contracts between 2004 and 2008, putting a huge upwards pressure on prices of commodities. Then they temporarily exited those markets between the late 2008 and early 2009, selling the contracts they held and causing the fall in prices. They started being bullish again from mid-2009, triggering the new price peak of 2010-2011.

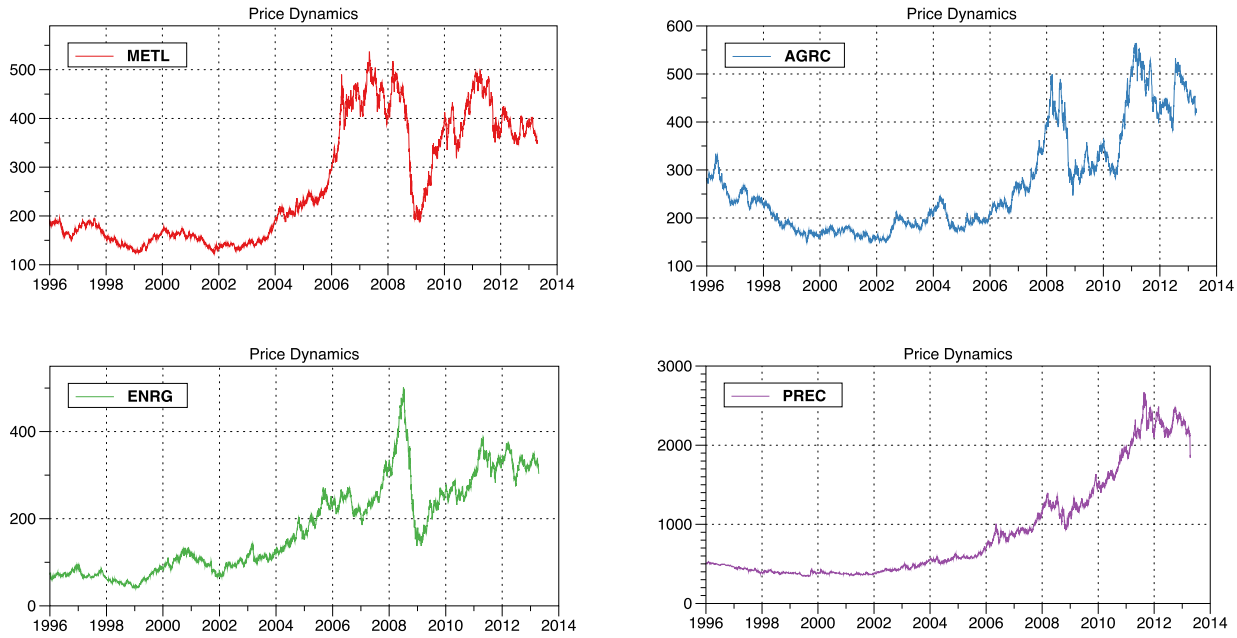

Figure 1: Price dynamics of metals, agricultural and energy commodities, and precious metals

These activities of speculators increased the volatility of commodity prices, possibly inducing higher correlation with equity markets. Increasing correlation across equity and commodity returns, particularly during the crisis, would discourage investors from choosing commodities as a refuge during periods of stress in traditional asset markets.

Hence, the issue is that if commodity and Shariah-compliant equity markets become more integrated, systematic shocks may increasingly dominate commodity returns, raising correlation with equities and generating more time-variation in correlation and volatility, hence abolishing diversification benefits for Islamic portfolio managers.

2. LITERATURE REVIEW

There is a vast literature on the issue of financialization of commodities and its impact on integration between the commodities and other asset classes. Applying regression analysis on daily non-public data for individual trader positions in seventeen U.S. commodity futures markets, *Büyüksahin & Robe (2010)* found that the recent increase in the correlation between equity indices and commodities is due to the presence of hedge funds that are active in both equity and commodity futures markets.

Similarly, *Basak & Pavlova (2013)* by employing tractable multi-asset general equilibrium model brought to the light that the presence of institutional investors positively affects on commodity prices, and even more on futures prices and their dynamics. Moreover, the presence of institutions is found to be leading to an increase in the cross-commodity and equity-commodity correlations, and in particular stronger impact on index commodity futures. Likewise, with the aim to analyze empirically whether variations in the make-up of trading activity help explain the co-movements of energy and equity returns, *Büyükşahin & Robe (2011)* constructed a daily dataset of all large trader positions in U.S. equity and three U.S. energy futures markets from 2000 to 2010 based on non-public, trader-level information from the U.S. Commodity Futures Trading Commission (CFTC), and, by applying MGARCH-DCC method, discovered that along with fundamental factors that drive asset returns, the overall size of speculative activity of

hedge funds in energy futures markets has explanatory power for the variations in the correlation between the returns on investable energy-futures and equity indices over time.

According to *Silvennoinen & Thorp (2013)*, who used double smooth transition conditional correlation (DSTCC–GARCH) models to estimate sudden and gradual changes in correlation between stocks, bonds and commodity futures returns, in 1990s most correlations were near zero, however since the early 2000s the integration emerged and reached peaks during the 2008 global crisis, implying that diversification benefits to investors across equity, bond and stock markets significantly reduced.

The study of *Li et al. (2011)* used the GARCH-DCC model to estimate time-varying return correlations between commodity futures and equities exploring 45 equity indices. 70% of them demonstrated an upward long-run trend in their correlations with the commodity futures market throughout the 2000s, and 95% had their correlation trends surged sharply during the 2008 economic turmoil. When volatilities of those equity markets increased, the conditional correlations of 39 equity markets with the commodity futures market were found moving towards or above their long-run trends.

In contrast, *Öztek & Öcal (2013)* after applying Smooth Transition Conditional Correlation method (STCC-GARCH) to analyze time varying correlations among agricultural commodity, precious metals and S&P500 indices rationalized that the high correlation between the assets was observed only because of high volatility during the financial crisis, however in calm periods the correlation comes down to normal levels.

A considerable body of research exists on cross-market correlation dynamics between the equity and commodity markets, as mentioned above. The current study is a humble attempt to analyze the time-varying relationship between the Shariah-compliant equities and commodities and find out whether international Shariah-compliant portfolios are affected by the "financialization of commodities" and the global financial crisis, and whether Islamic investors could retain the opportunity to reap diversification benefits by incorporation of commodities into their equity portfolios.

3. DATA AND METHODOLOGY

Data: The study uses log returns to daily spot price indices for seven types of commodities and Shariah-compliant equities (developed and emerging markets) from January 1996 to April 2013, including wheat and corn, soybeans and livestock, gold, silver and crude oil. As the proxies for Shariah-compliant equities from developed and emerging markets, the Dow Jones Islamic World indices are used. The following table shows the list of variables used in this study:

Code	Description	Period	DataStream
ISLD	Dow Jones Islamic World: Developed Markets- PRICE INDEX		DJIWDD$
ISLE	Dow Jones Islamic World: Emerging Markets - PRICE INDEX		DJIWEM$
GOLD	S&P GSCI Gold Spot - PRICE INDEX	From	GSGCSPT
SLVR	S&P GSCI Silver Spot - PRICE INDEX	02/01/1996 to	GSSISPT
CORN	S&P GSCI Corn Spot - PRICE INDEX	17/04/2013	GSCNSPT
WHET	S&P GSCI All Wheat Spot - PRICE INDEX		SGWTSPT
SOYB	S&P GSCI Soybeans Spot - PRICE INDEX	(4512 obs.)	GSSOSPT
OILP	S&P GSCI Crude Oil Spot - PRICE INDEX		GSCLSPT
LVST	S&P GSCI Livestock Spot - PRICE INDEX		GSLVSPT

Table 1: Data description

The data source is DataStream. The starting point of 01/01/1996 for the variables is based on the date of inception of Dow Jones Islamic Market.

The reason for choosing Dow Jones is that its Shariah screening methodology is considered to be as the most stringent compared to other index providers. For the equities to be accepted as Shariah-compliant a company must pass through the following screening criteria:

1. The qualitative screening approach - any involvement in such activities as sale and production of alcoholic beverages; broadcasting and entertainment; conventional financial services; gambling; hotels; insurance; media agencies (except newspapers); pork-related products; restaurants and bars, tobacco; weapons and defense.

2. The quantitative screening approach - all of the following must be less than 33%:

- The total debt divided by trailing a 24-month average market capitalization process;

- Taking the sum of a company's cash and interest-bearing securities to be divided by the trailing 24-month average market capitalization;
- Accounts receivables divided by the trailing 24-month average market capitalization.

Methodology: To investigate the integration between commodities and Shariah-compliant equities, we employ dynamic conditional correlation (DCC) GARCH model introduced by Engle (2002), which allows us to assess the time-varying volatility and correlation between assets.

Assuming r_t as the vector composed of two return series, $r_t = (r_{1t,} r_{2t})'$ and denoting by *A(L)* the lag polynomial, we have:

$$\boldsymbol{A(L)r_t = \mu + e_t} \quad \textbf{(1)}$$

where e_t is error-term vector.

The DCC model is based on the hypothesis that the conditional returns are normally distributed with zero mean and conditional covariance matrix $H_t = E[r_t r_t^{'} \mid I_{t-1}]$. The covariance matrix is expressed as follows:

$$\boldsymbol{H_t = D_t R_t D_t} \quad \textbf{(2)}$$

where $D_t = diag[\sqrt{h_{1t}}, \sqrt{h_{2t}}]$ is a diagonal matrix of time-varying standard deviations issued from the estimation of univariate GARCH(1,1) process:

$$\boldsymbol{h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1}} \quad \textbf{(3)}$$

and R_t is the conditional correlation matrix of the standardized returns ε_t, with $\varepsilon_t = D_t^{-1} r_t$:

$$\boldsymbol{R_t = \begin{bmatrix} 1 & q_{12t} \\ q_{21t} & 1 \end{bmatrix}} \quad \textbf{(4)}$$

The matrix R_t is decomposed into:

$$\boldsymbol{R_t = Q_t^{*-1} Q_t Q_t^{*-1}} \quad \textbf{(5)}$$

where Q_t is the positive definite matrix containing the conditional variance-covariances of ε_t, and Q_t^{*-1} is the inverted diagonal matrix with the square root of the diagonal elements of Q_t:

$$\boldsymbol{Q_t^{*-1} = \begin{bmatrix} 1/\sqrt{q_{11t}} & 0 \\ 0 & 1/\sqrt{q_{22t}} \end{bmatrix}} \quad \textbf{(6)}$$

The DCC(1,1) model is then given by:

$$\boldsymbol{Q_t = \omega + \alpha \varepsilon_{t-1} \varepsilon_{t-1}^{'} + \beta Q_{t-1}} \quad \textbf{(7)}$$

where $\omega = (1 - \alpha - \beta)\bar{Q}$. Following Engle (2002), $\bar{Q}$ is treated as the second moment of ε_t, and is proxied by the sample moment of the estimated returns in large systems.

However, according to Aielli (2011), the equality $\bar{Q} = E[\varepsilon_t \varepsilon_t^{'}]$ does not hold in the general case, and the interpretation of $\bar{Q}$ as well as its estimation are not straightforward.

The dynamic conditional correlations are finally given by:

$$\boldsymbol{\rho_{12t} = \frac{q_{12t}}{\sqrt{q_{11t} q_{22t}}}} \quad \textbf{(8)}$$

According to Engle (2002), the estimation of this model is done using a two-step maximum likelihood estimation method, the likelihood function being given by:

$$\boldsymbol{L = -\frac{1}{2} \sum_{t=1}^{T} (2 \log(2\pi) + 2 \log|R_t| + \varepsilon_t^{'} R_t^{-1} \varepsilon_t)} \quad \textbf{(9)}$$

4. EMPIRICAL RESULTS

4.1 Preliminary results:

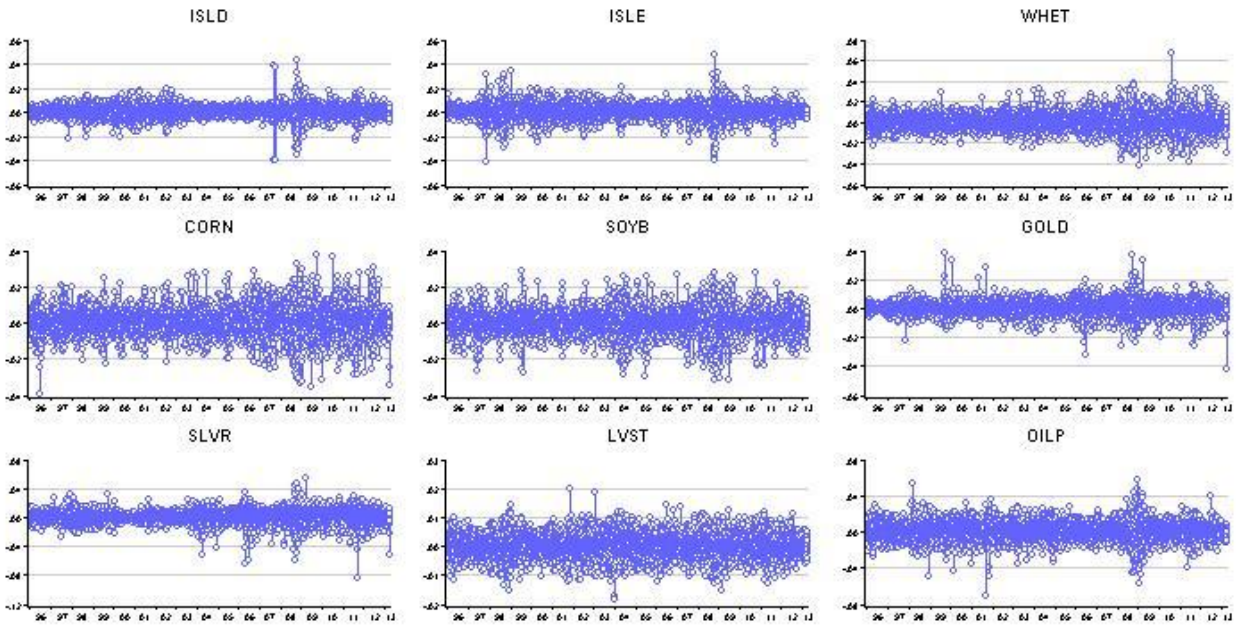

Figure 1: Log returns on assets

The Figure 1 shows dynamics of log returns on equities and commodities. Generally, most of these assets indicate higher volatility on the second half of 2000s. Stocks of developed markets appear to be relatively more stable than those of emerging markets, and the variation of returns is greater in the period of financial crisis.

Statistics	ISLD	ISLE	WHET	CORN	SOYB	GOLD	SLVR	LVST	OILP
Mean	0.00010	0.00007	0.00003	0.00005	0.00006	0.00012	0.00014	0.00005	0.00014
Std. Dev.	0.00486	0.00595	0.00802	0.00743	0.00665	0.00474	0.00835	0.00388	0.00960
C.V.	49.55	85.75	268.29	139.96	111.94	38.88	57.99	79.43	66.68
Return/Risk	0.020	0.012	0.004	0.007	0.009	0.026	0.017	0.013	0.015
Skewness	-0.322	-0.346	0.173	-0.005	-0.209	-0.106	-0.921	-0.066	-0.247
Kurtosis	12.070	8.266	6.110	5.256	5.216	10.472	11.263	3.937	6.308
Jarque-Bera	15544.7	5302.9	1841.4	956.6	955.7	10505.2	13473.7	168.2	2103.2
Probability	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Observations	4512	4512	4512	4512	4512	4512	4512	4512	4512

Table 2: Descriptive statistics

The table 2 above provides some descriptive statistics of the returns series, defined as $r_t = \ln(P_t/P_{t-1})$, where P_t denotes the price index at time t. The highest volatilities are displayed by crude oil, silver, wheat, and corn returns. Agricultural commodities seem to differ from other groups in terms of return-risk: the mean per standard deviation of wheat, corn and

soybeans is lower than that obtained from other commodities and equities. Gold, Shariah-compliant equities from developed markets, silver and oil appear to be most profitable. The fat tail property of return series is apparent from the excess kurtosis of all assets, hence indicating that observing extreme values is more likely. However, all asset returns, except for wheat, are skewed to the left implying tendency towards large negative returns. The Jarque-Bera test indicates that all the return series are not normally distributed evidenced by the significance of the results at 1% level.

4.2 Empirical results:

Parameter	Estimate 1	Prob	Parameter	Estimate 2	Prob	Value	
lambda1_ISLD	0.93300	[.000]	lambda2_ISLD	0.05900	[.000]	0.99200	<1
lambda1_ISLE	0.92140	[.000]	lambda2_ISLE	0.06800	[.000]	0.98940	<1
lambda1_GOLD	0.94300	[.000]	lambda2_GOLD	0.04310	[.000]	0.98610	<1
lambda1_SLVR	0.95200	[.000]	lambda2_SLVR	0.03900	[.000]	0.99100	<1
lambda1_CORN	0.92590	[.000]	lambda2_CORN	0.05470	[.000]	0.98060	<1
lambda1_WHET	0.95080	[.000]	lambda2_WHET	0.03620	[.000]	0.98700	<1
lambda1_SOYB	0.93840	[.000]	lambda2_SOYB	0.04620	[.000]	0.98460	<1
lambda1_OILP	0.95410	[.000]	lambda2_OILP	0.03880	[.000]	0.99290	<1
lambda1_LVST	0.94970	[.000]	lambda2_LVST	0.03370	[.000]	0.98340	<1
Maximized Log-Likelihood = 157025.3							

Table 3: Multivariate GARCH with underlying multivariate t-distribution

According to the Table 3 above, all volatility parameters are statistically highly significant at 1% level showing tendency of volatility towards gradual sliding down (i.e. no persistence). Hence, after experiencing a shock in the market, the high riskiness of asset returns gradually decays. Moreover, summing up of both lambdas for each assets results in less than unity, implying that the volatility due to shocks is not permanent (i.e. not IGARCH).

Matrix	ISLD	ISLE	GOLD	SLVR	CORN	WHET	SOYB	OILP	LVST
ISLD	0.00487	0.53733	0.10332	0.21037	0.15800	0.16338	0.17933	0.25665	0.11608
ISLE	0.53733	0.00597	0.14265	0.23796	0.13324	0.12382	0.17116	0.20687	0.09275
GOLD	0.10332	0.14265	0.00476	0.73249	0.17715	0.15522	0.18335	0.23511	0.05332
SLVR	0.21037	0.23796	0.73249	0.00837	0.22078	0.19433	0.23372	0.25897	0.08807
CORN	0.15800	0.13324	0.17715	0.22078	0.00745	0.62912	0.64629	0.22121	0.09986
WHET	0.16338	0.12382	0.15522	0.19433	0.62912	0.00804	0.48777	0.21081	0.10051
SOYB	0.17933	0.17116	0.18335	0.23372	0.64629	0.48777	0.00667	0.22614	0.11202
OILP	0.25665	0.20687	0.23511	0.25897	0.22121	0.21081	0.22614	0.00961	0.12771
LVST	0.11608	0.09275	0.05332	0.08807	0.09986	0.10051	0.11202	0.12771	0.00389

Table 4: Estimated Unconditional Volatility and Correlations Matrix

The on-diagonal elements on Table 4 represent unconditional volatilities of asset returns. The highest values we can observe in crude oil (OILP), wheat (WHET), silver (SLVR) and corn (CORN) returns, respectively, which implies that returns on these assets are less stable compared to the assets with the lowest estimates, such as livestock (LVST), gold (GOLD), Islamic developed (ISLD) and emerging (ISLE) market equities, respectively.

The off-diagonal values, which represent unconditional correlations between assets, suggest that crude oil and silver returns are the most positively correlated with the Shariah-compliant equities of developed markets (OILP=0.26 and SLVR=0.21). The similar case is with the returns of emerging market equities (OILP=0.21 and SLVR=0.24). Perhaps, the most attractive commodities to gain diversification benefits in portfolios, due to their lowest correlations with Islamic equities, are the gold and livestock for equities from developed markets, and livestock, gold, corn, and wheat – for stocks of emerging markets. The summary of unconditional correlations of commodities with the Shariah-compliant equities can be presented by the following table:

Range	ISLD	ISLE
0.00-0.10	xxx	LVST
0.10-0.15	GOLD, LVST	GOLD, CORN, WHET
0.15-0.20	CORN, WHET, SOYB	SOYB
0.20-0.25	SLVR	SLVR, OILP
0.25-0.30	OILP	xxx

Table 5: Summary of unconditional correlations between assets

Figures in ***Appendix C*** report conditional volatilities of returns on each commodity and Dow Jones Islamic Market equities (global developed and emerging markets). Variation of returns on equities of both markets demonstrate almost identical behavior, especially after year 2001. During the 1998-1999, probably due to the Asian crisis, the volatility of returns on emerging market equities is relatively stronger, while effect of recent global financial turmoil seems to have greater impact on developed market equity returns.

The amplitude of variation of gold returns is relatively more stable compared to silver. Traditionally, gold is used as a "safe haven" or "commodity-money" during the periods of uncertainty about the future stability of purchasing power of fiat money. Since the

demand for silver is more price-elastic than demand for gold, the changes in expectations of investors or economic conditions result in greater magnitude of movement of the former. The inferences that could be drawn from here is that buying the silver during the downdrafts and selling it when the market recovers would possibly give better returns than gold.

The figures further demonstrate that the behavior of returns on agricultural commodities tend to move close to each other, and, since the year 2004, the volatility of returns on commodities intensified, probably due to "financialization of commodities", increased participation of financial investors in commodity markets influencing the formation of futures prices. According to *Girardi (2012),* in the period between 2004-2008, the financial actors had been acquiring large amounts of futures contracts, thus putting a huge upwards pressure on prices of commodities. Later, between the late 2008 and early 2009, they temporarily withdrew from those markets by liquidating the contracts they held and causing the fall in prices. Again, form mid-2009, they started being bullish again, triggering the new price peak of 2010–2013. On the other hand, the volatility of returns on crude oil significantly amplified in the period of global turmoil, between 3rd quarter of 2008 and mid of 2009, and by the year 2013 it seems to be slowly diminishing.

Prior to the late 2000s, the dominant view among the investors was that commodities showed low, and sometimes negative, correlation with equities *(Silvennoinen & Thorp, 2013)*. The sample of conditional correlations reported in Figures in ***Appendix D*** support this statement showing that correlation between commodities and equities, on average, *did not exceed* the threshold of 0.25:

(a) Equities vs precious metals (gold and silver): Developed markets – until 2006Q1, Emerging markets – until 2005Q3.
(b) Equities vs food commodities (wheat, corn, soybeans and livestock): Developed markets – until 2009Q1, Emerging markets – until 2008Q3.
(c) Equities vs oil: Both markets – until 2008Q3.

However, the maximum threshold of 0.40 had been crossed by:

(a) Equities vs precious metals (gold and silver): Developed markets – in the period from 2010Q1 to 2010Q3. Emerging markets only (silver) – from 2010Q1 to 2010Q2.

(b) Equities vs food commodities (wheat, corn, soybeans and livestock): not observed in both markets.

(c) Equities vs crude oil: Developed markets – 2009Q1 to 2013Q1, except in 2011Q1 when correlation was in between 0.25-0.40 range. Emerging markets – from 2010Q1 to 2012Q3, except the period of 2011Q1-2011Q3 when the correlation fluctuated in the range of 0.22-0.4; however, after 2012Q3 the correlation of emerging market Islamic equities with crude oil loosened up to 0.25.

These results indicate that correlations between commodity and equity markets are time-varying and highly volatile. The oil appears to be the most related asset to the equities of both developed and emerging markets. Theoretically, the fundamental value of any asset is derived based on its expected discounted cash flows. Increase in oil price leads to rise in production costs and reduction of profits, thus, resulting in diminution of shareholders' value and, finally, fall of stock prices. Hence, during periods of equity prices declining, correlations with crude oil would tend to decrease. Meanwhile, when common external factor negatively affects on both assets pushing prices down, the correlation between equities and crude oil most likely would increase. Our analysis supports this idea showing that in the mid of 2008, when the crude oil price reached its peak, the correlation between returns on Shariah-compliant equities and crude oil dropped, and later, with the recent financial crisis, the correlation strengthened.

Gold is well recognized to be different from the other commodities. The correlations with equities become weaker in times of unfavorable macroeconomic conditions, during which investors liquidate their equity investments and divert their funds towards the gold, known to be as a "safe-haven". Accordingly, our results show that during the global financial crisis, the correlation between gold and Islamic equities approached to zero. The behavior of the silver tends to be more or less similar to that of gold.

Finally, the shock from the 2007–2008 financial crisis is noticeable on the links between commodity and equity markets, reflecting the phenomenon of financialization of commodity markets that is documented by *Silvennoinen & Thorp (2013)* and *Li et al. (2011)* who unveiled that the integration between the equity and commodity markets emerged and reached peaks during the 2008 global economic turmoil. However, it seems that the abrupt shift up to higher correlation levels is not permanent and the recent trends suggest that there is a tendency for correlations to slide down, thus potentially providing Muslim investors with better opportunities to diversify portfolios. This is generally supported by the findings of *Öztek & Öcal (2013)* who analyzed time varying correlations among agricultural commodity, precious metals and S&P500 indices and found that the high correlation between the assets was observed only because of high volatility during the financial crisis, however in calm periods the correlation comes down to normal levels. Thus, the high values of correlation during the recent crisis can be attributed to the high volatility phase of both markets and it seems that the conditional correlation between markets may become lower when the volatility levels in both markets decline. Nevertheless, in the long-run, correlations are likely to be governed by industrialization and financialization processes, as well as by behavior of commercial and non-commercial traders.

5. CONCLUSION

This paper investigates the links between price returns for seven commodities and Shariah-compliant equities (developed and emerging markets) over the period from January 1996 to April 2013. Employing the dynamic conditional correlation (DCC) M-GARCH methodology, we show that volatility of all assets is greater during the financial turmoil, except for livestock which is quite stable throughout the period, and the correlations between commodity and stock markets evolve over time and are highly volatile, particularly during the global financial crisis, which has played a key role, emphasizing the increased integration between commodity and stock markets, and underlining the financialization of commodity markets. However, in the last couple of years the correlation between commodities and equities seems to be decaying, thus, hopefully providing Islamic investors with higher diversification benefits by the inclusion of commodities into their portfolios.

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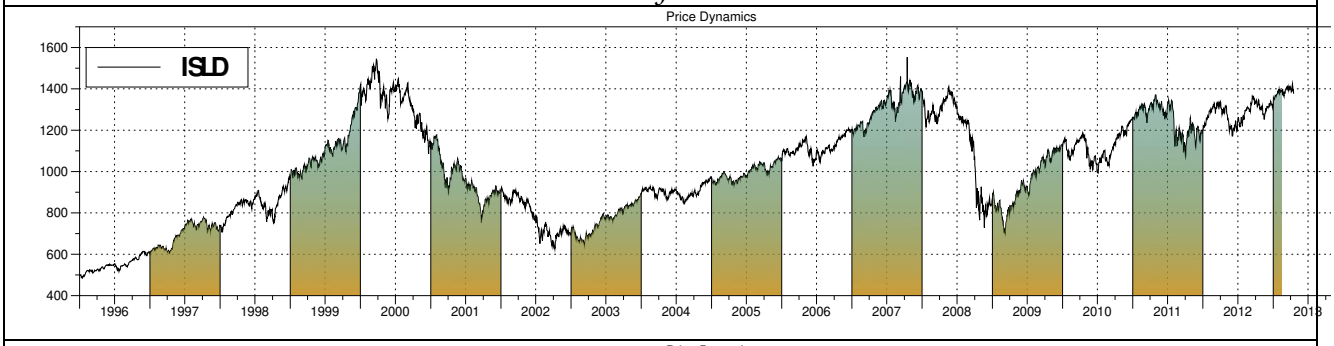
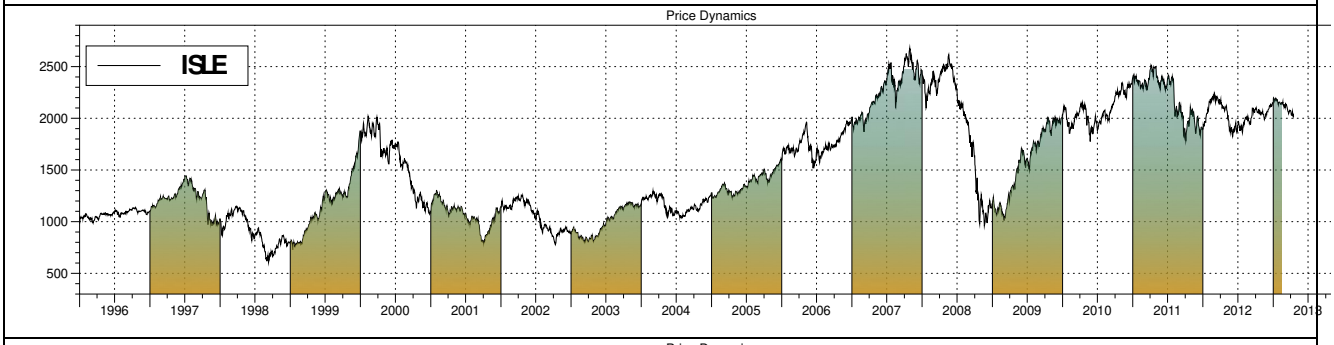
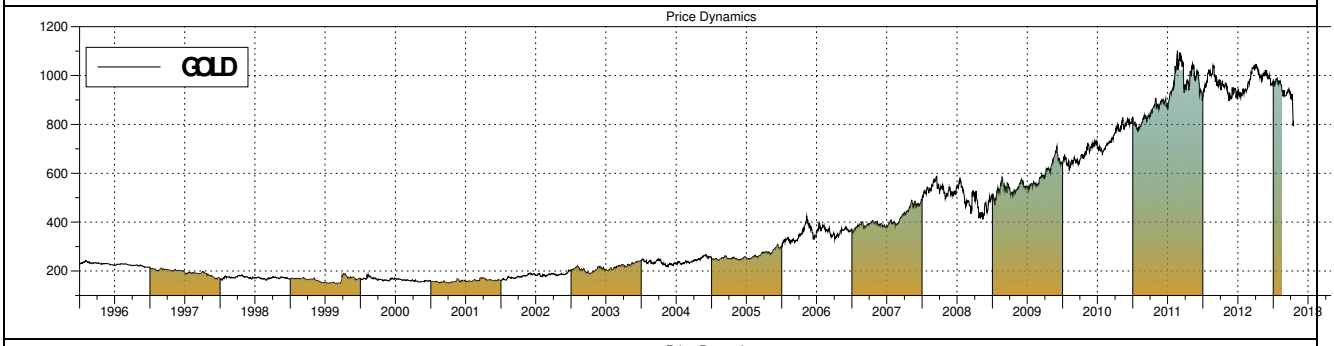
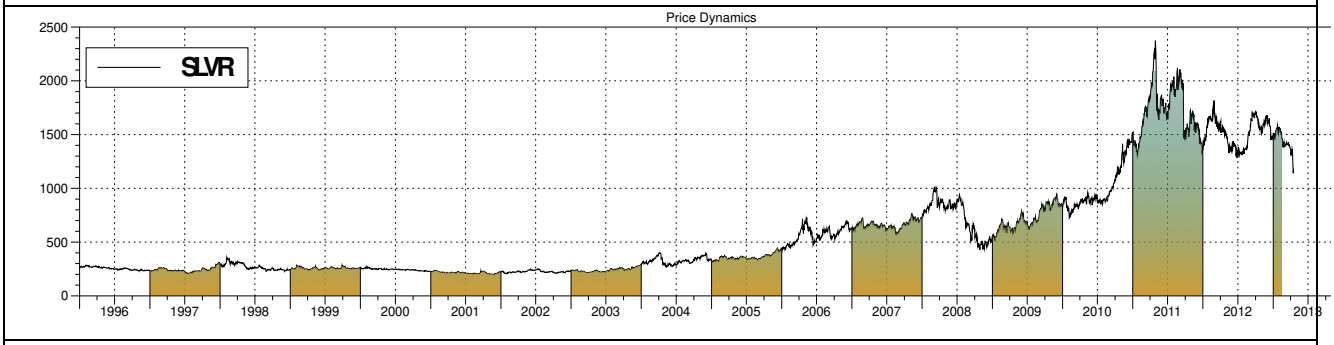
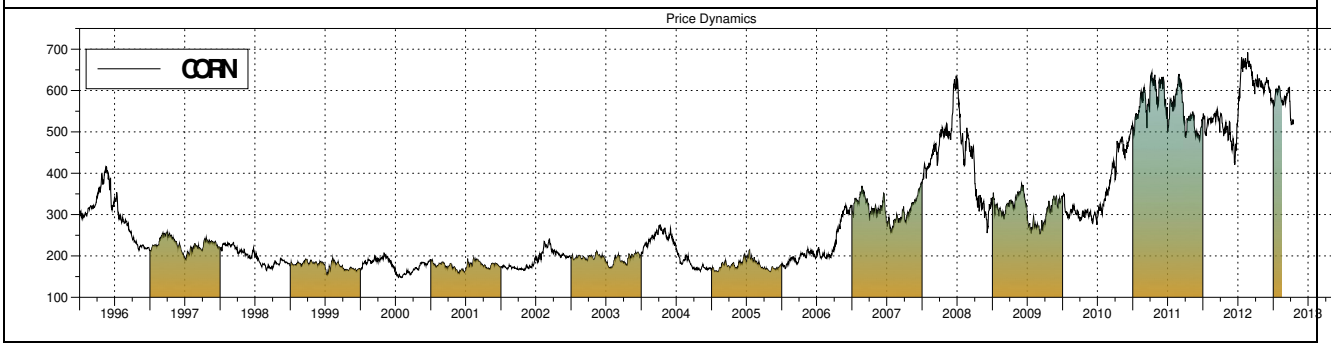
Price Dynamics

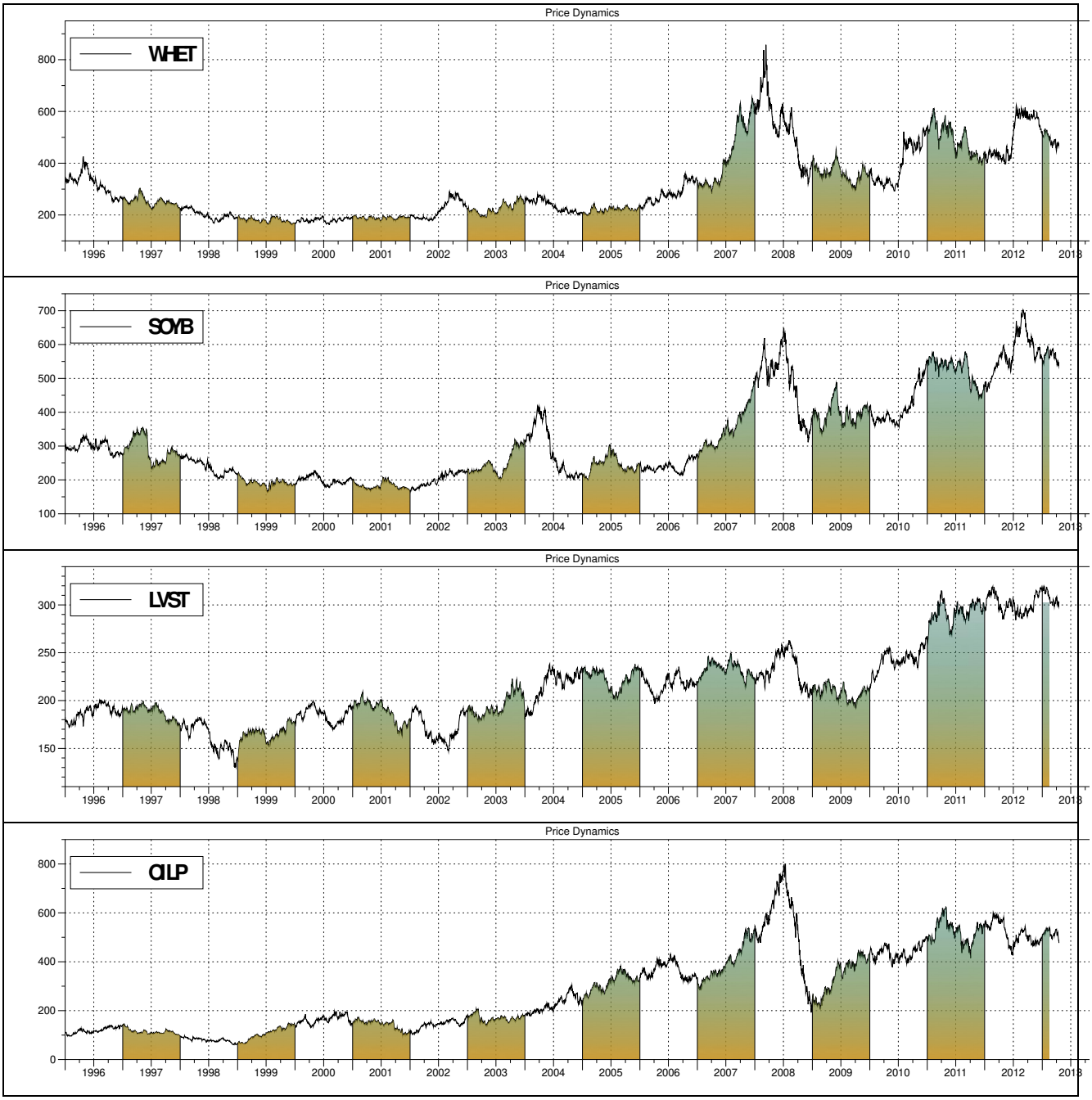


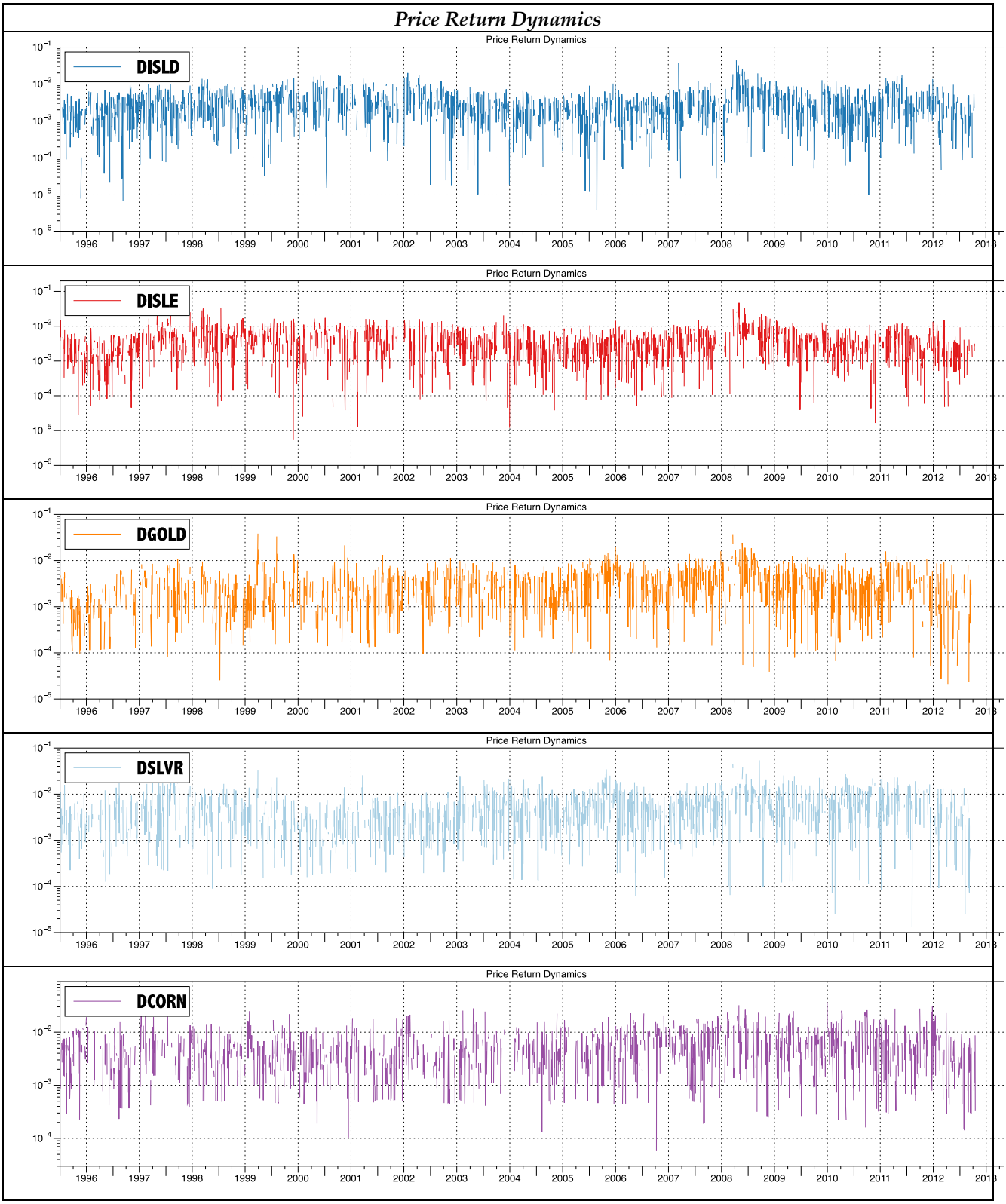




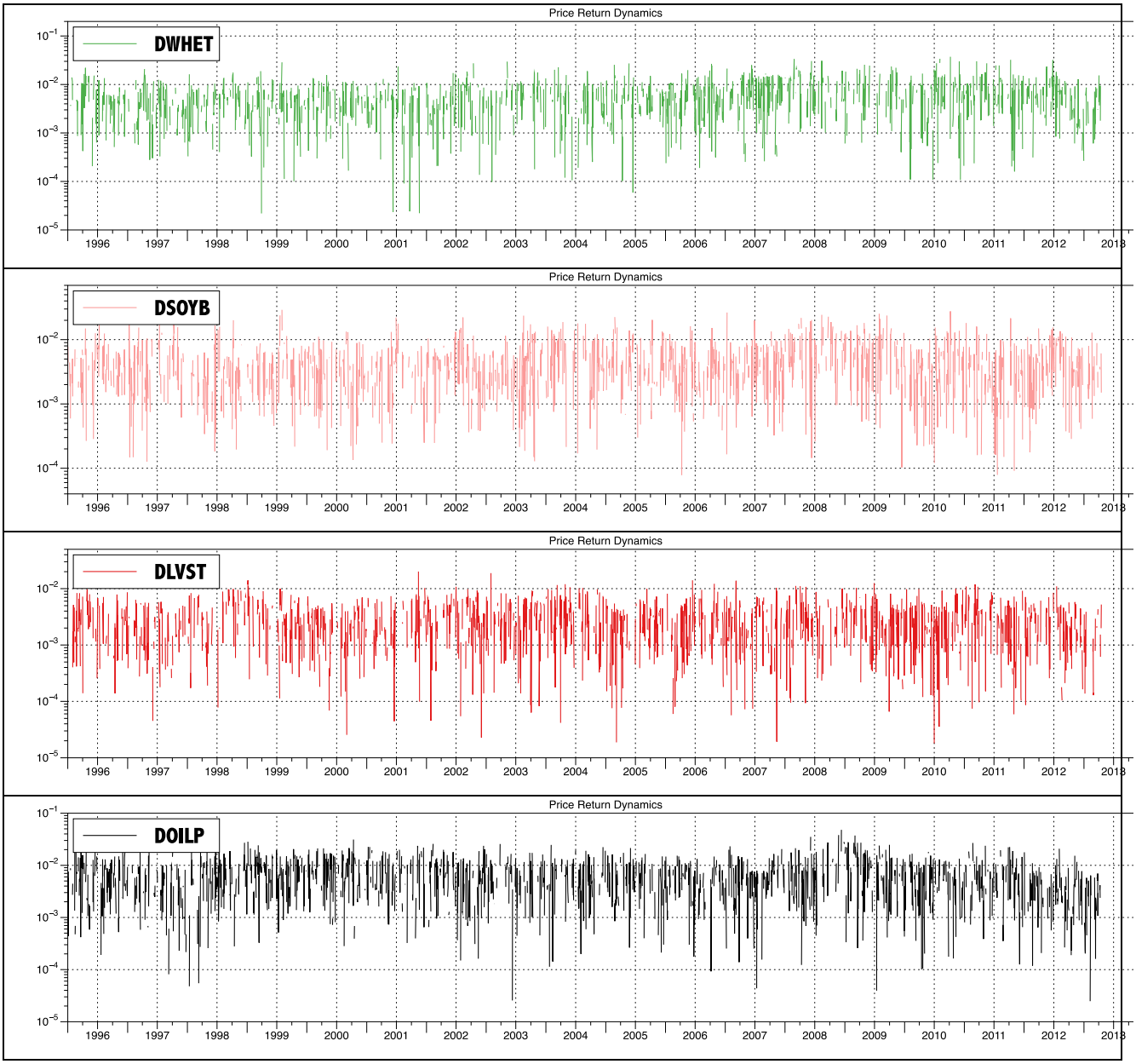





Price Dynamics
WHET
800
600
400
200
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
Price Dynamics
SOYB
700
600
500
400
300
200
100
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
Price Dynamics
LVST
300
250
200
150
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
Price Dynamics
CTLP
800
600
400
200
0
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013



Price Return Dynamics


Price Return Dynamics
DWHET
Price Return Dynamics
DSOYB
Price Return Dynamics
DLVST
Price Return Dynamics
DOILP
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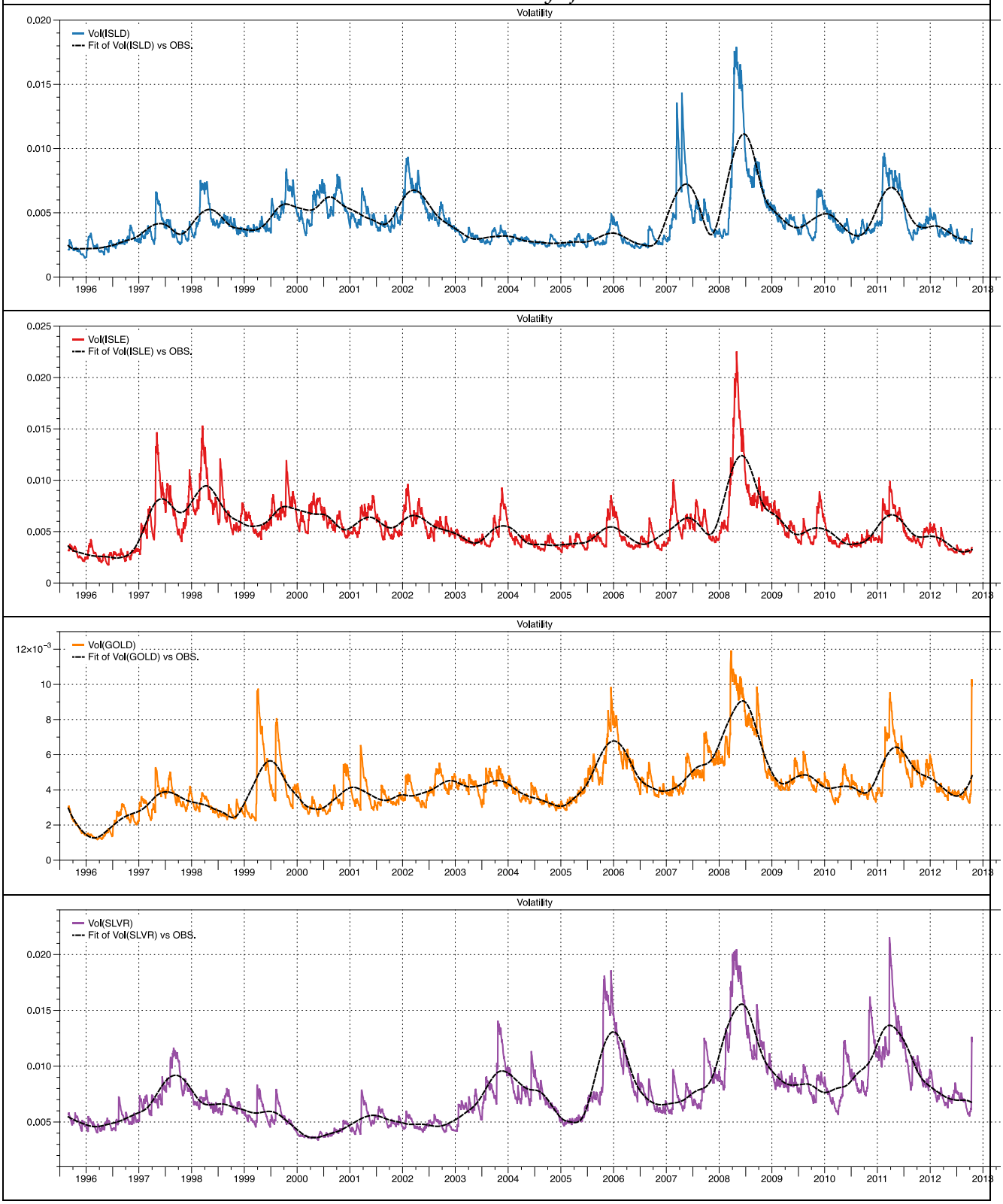
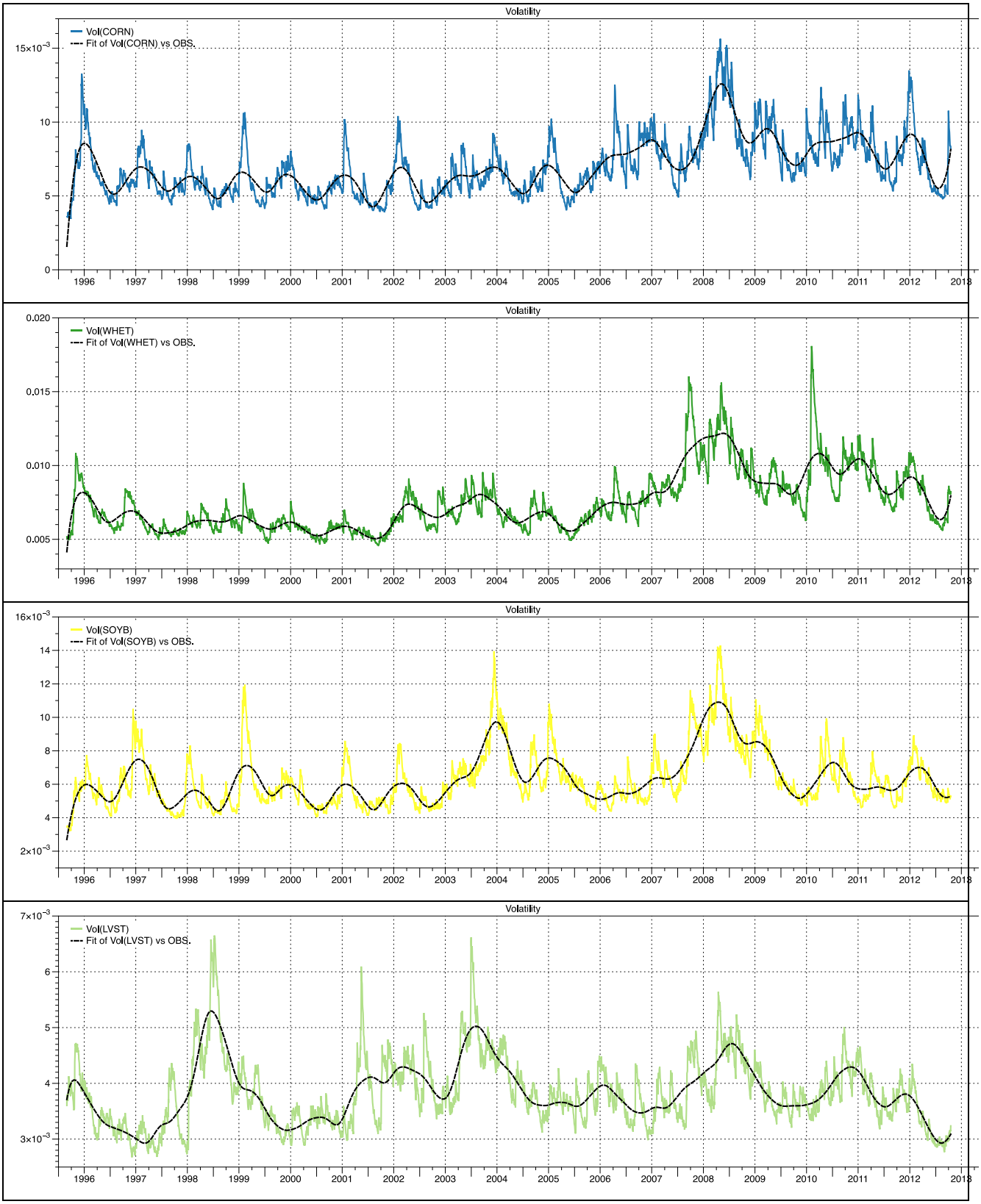
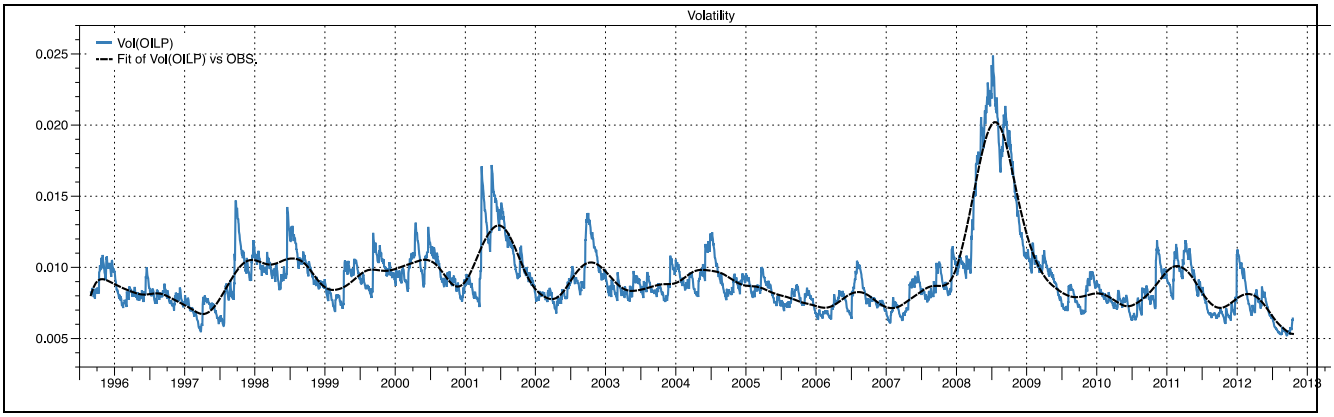
Conditional volatility of assets




Volatility
Vol(CORN)
Fit of Vol(CORN) vs OBS.
15×10⁻³
10
5
0
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
Volatility
Vol(WHET)
Fit of Vol(WHET) vs OBS.
0.020
0.015
0.010
0.005
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
Volatility
Vol(SOYB)
Fit of Vol(SOYB) vs OBS.
16×10⁻³
14
12
10
8
6
4
2×10⁻³
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
Volatility
Vol(LVST)
Fit of Vol(LVST) vs OBS.
7×10⁻³
6
5
4
3×10⁻³
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013


Volatility
Vol(OILP)
Fit of Vol(OILP) vs OBS
0.025
0.020
0.015
0.010
0.005
1996
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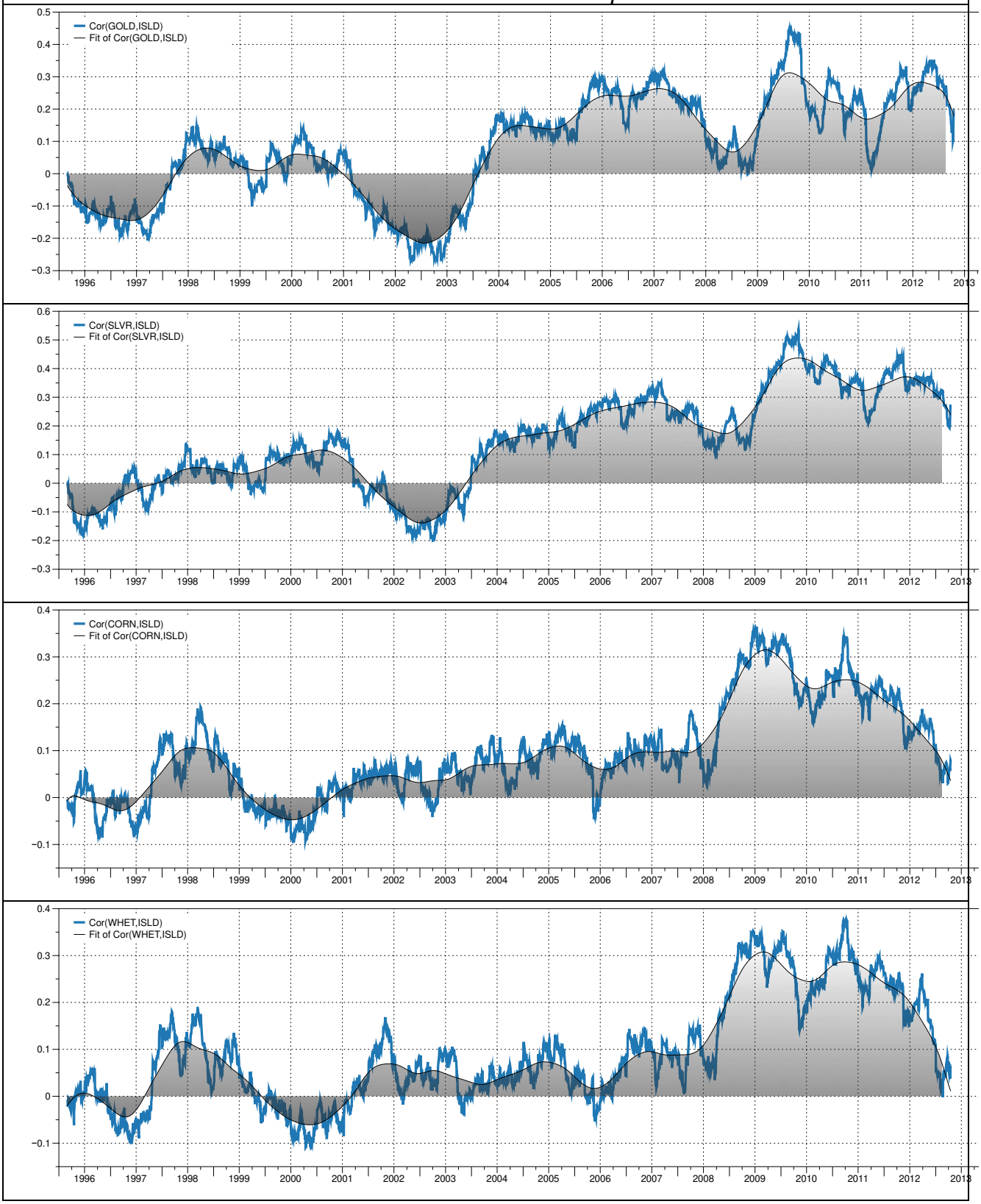
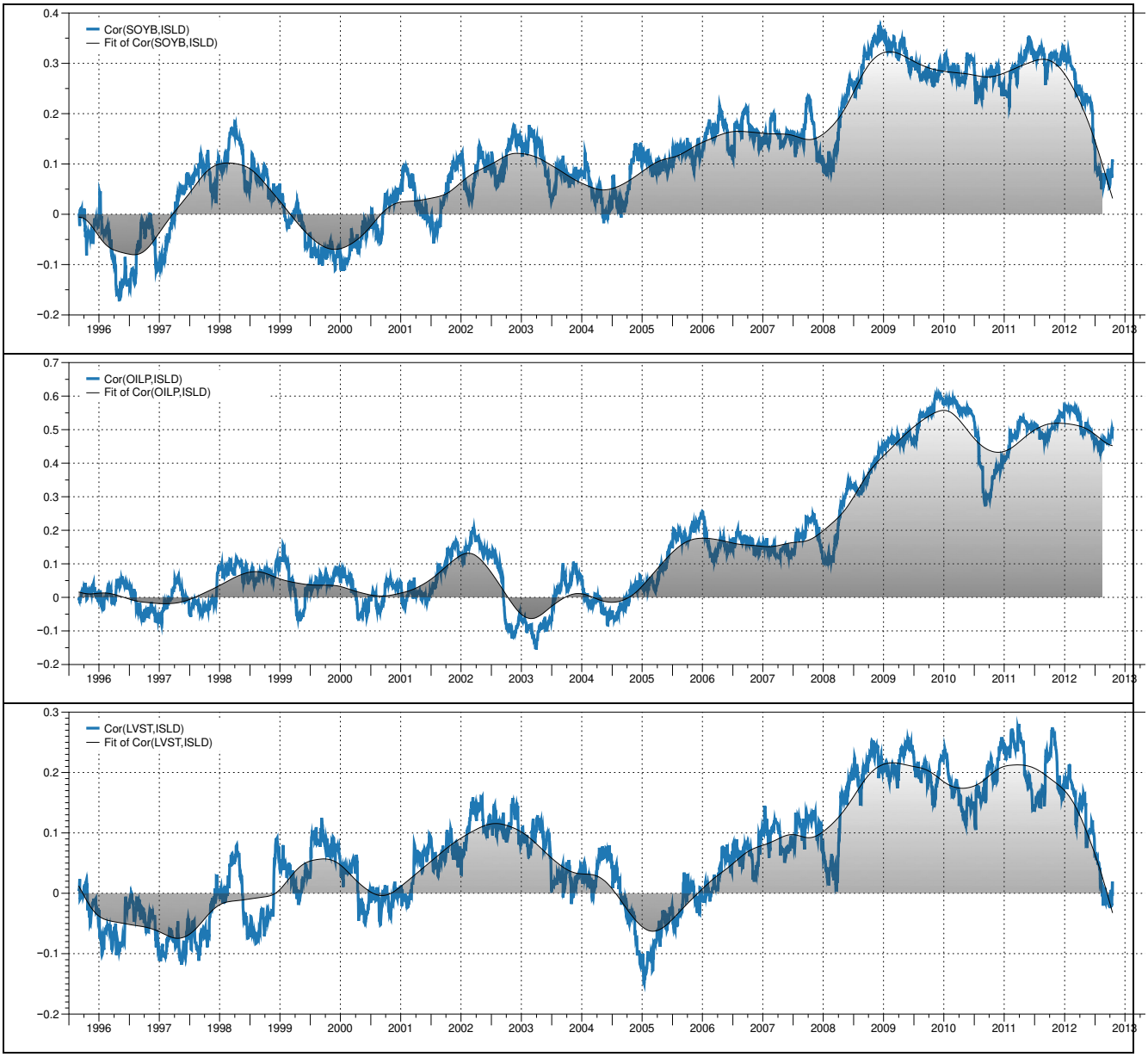
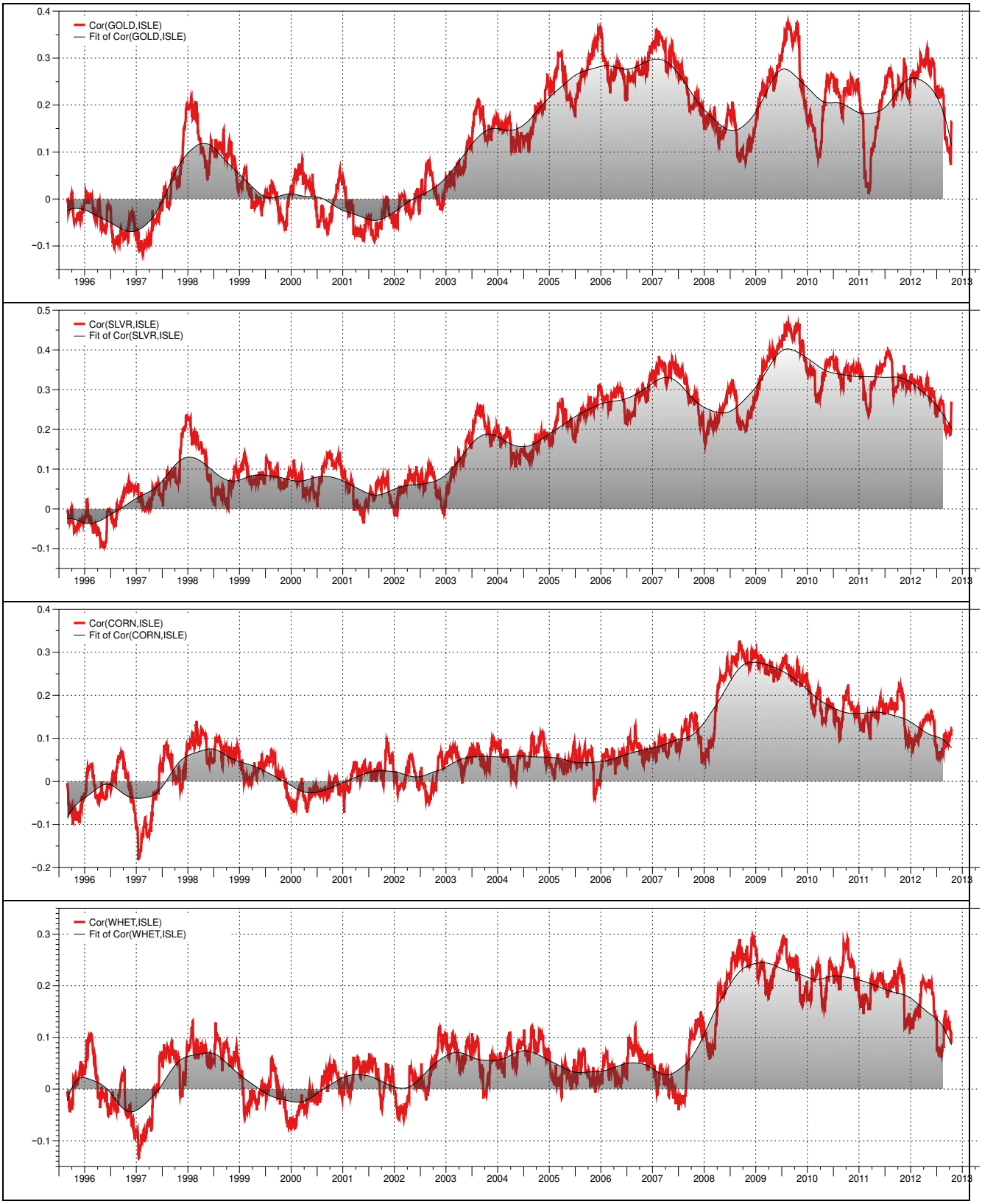
2013

Part 1: ***Conditional Correlations - Developed Markets***





Part 2: ***Conditional Correlations - Emerging Markets***


Cor(GOLD,ISLE)
Fit of Cor(GOLD,ISLE)
Cor(SLVR,ISLE)
Fit of Cor(SLVR,ISLE)
Cor(CORN,ISLE)
Fit of Cor(CORN,ISLE)
Cor(WHET,ISLE)
Fit of Cor(WHET,ISLE)
1996
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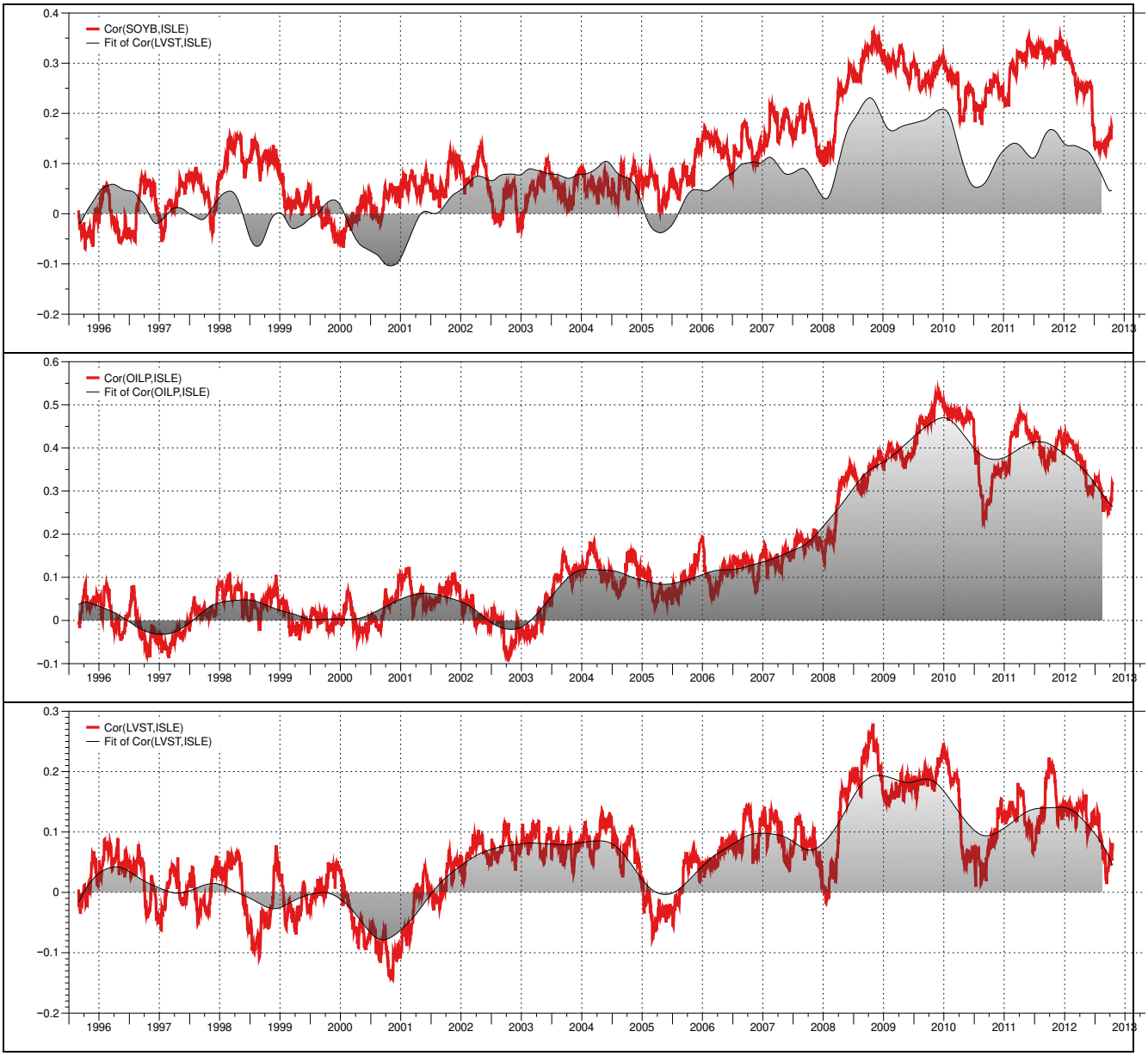
Cor(SOYB,ISLE)
Fit of Cor(LVST,ISLE)
0.4
0.3
0.2
0.1
0
−0.1
−0.2
1996
1997
1998
1999
2000
2001
2002
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Cor(OILP,ISLE)
Fit of Cor(OILP,ISLE)
0.6
0.5
0.4
0.3
0.2
0.1
0
−0.1
1996
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2008
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2011
2012
2013
Cor(LVST,ISLE)
Fit of Cor(LVST,ISLE)
0.3
0.2
0.1
0
−0.1
−0.2
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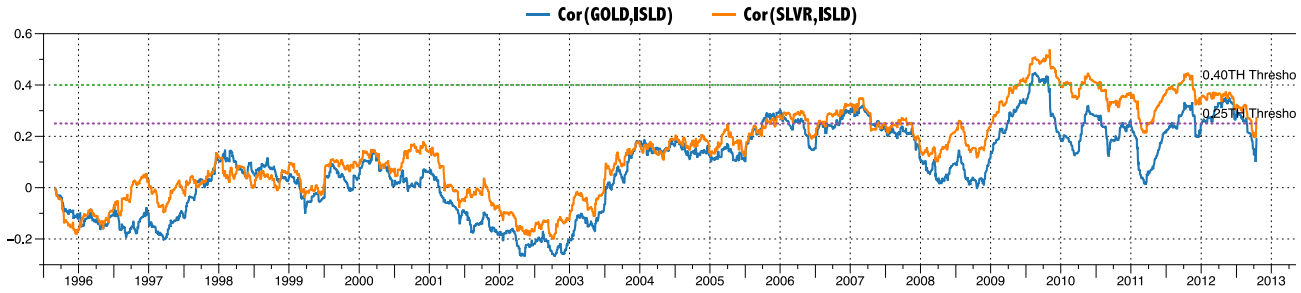
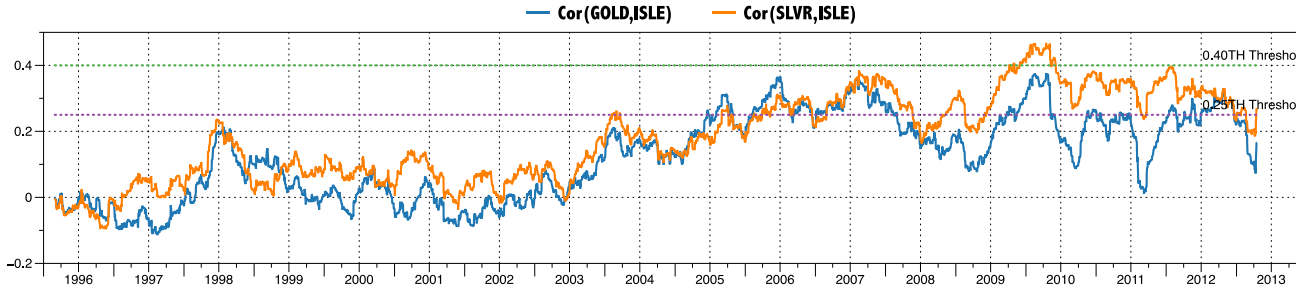
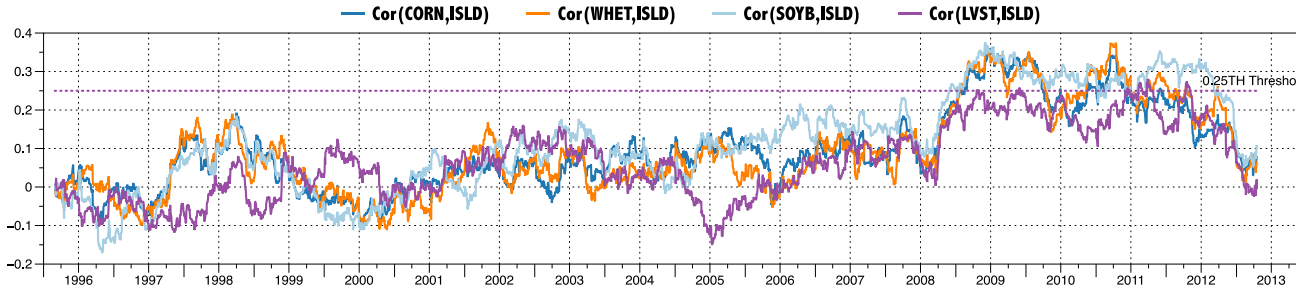
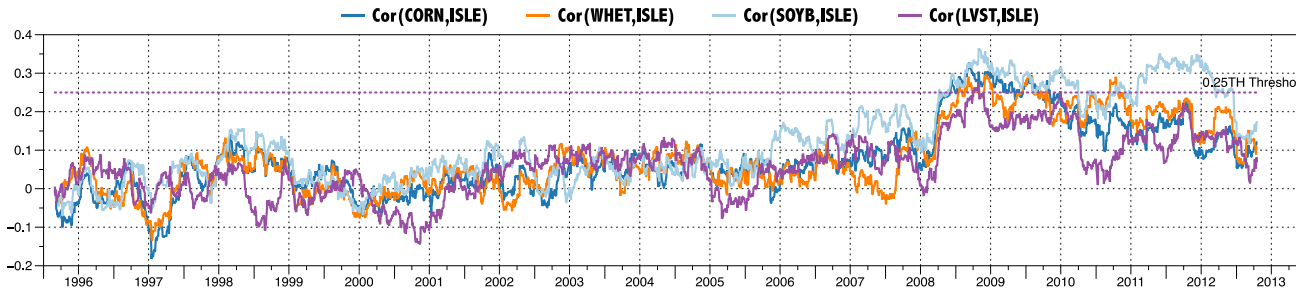
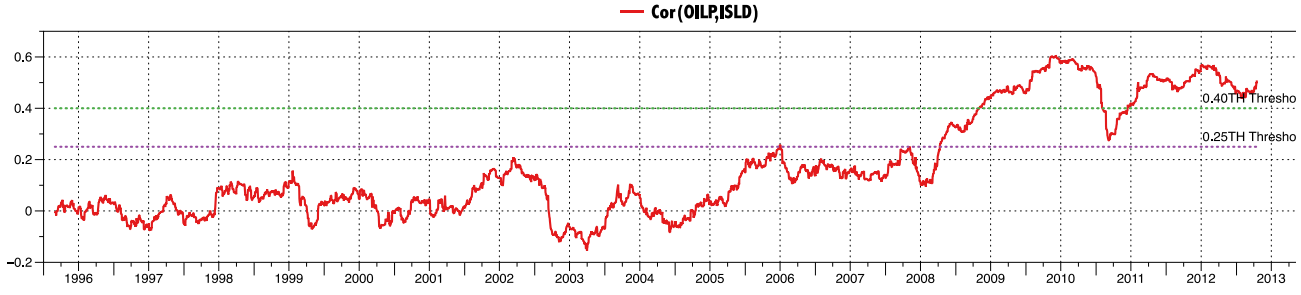
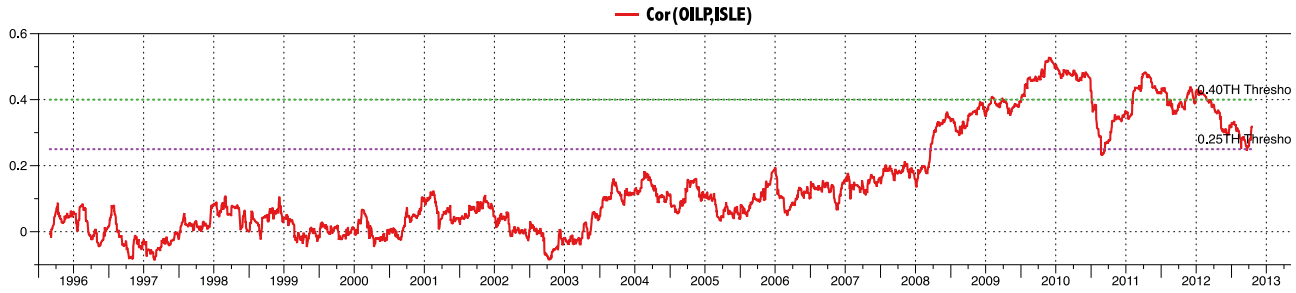

Cor(GOLD,ISLD)
Cor(SLVR,ISLD)
0.40TH Thresho
0.25TH Thresho


Cor(GOLD,ISLE)
Cor(SLVR,ISLE)
0.40TH Thresho
0.25TH Thresho


Cor(CORN,ISLD)
Cor(WHET,ISLD)
Cor(SOYB,ISLD)
Cor(LVST,ISLD)
0.25TH Thresho


Cor(CORN,ISLE)
Cor(WHET,ISLE)
Cor(SOYB,ISLE)
Cor(LVST,ISLE)
0.25TH Thresho


Cor(OILP,ISLD)
0.40TH Thresho
0.25TH Thresho


Cor(OILP,ISLE)
0.6
0.4
0.2
0
0.40TH Thresho
0.25TH Thresho
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