The Connectedness between Crude Oil Futures and Equity Markets during the pre-and post-Financialisation Eras

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Outline of Presentation

- Background
- Theoretical and Empirical View
- Research Focus
- Empirical Strategy/Framework
- Empirical Findings
- Robustness Check
- Conclusion
Background

Observed changes

- Increased investors' interest in commodities
- Expansion of trading volume and open interest
- Elevated price and volatility level

Increase in Price Level

Figure 1: Price level. Sources: Thomson Reuters.
Observed changes

- Positive correlation between net hedge fund positions and futures prices
- Evolution of market participants

Increase in Non-commercial Position

Figure 2: Non-commercial vs commercial long position for crude oil. Sources: U.S. Commodity Futures Trading Commission (CFTC)
Potential Impacts

- Efficient derivative pricing (Büyüksahin et al. 2008)
- Reduce market price risk (Pirrong 2011)
- Break the relationship between prices and inventories (Masters 2008)
- Spillover price volatility (Tang et al. 2012)
- Increase in correlation among commodities and between equities and commodities (Basak and Pavlova 2016)
- Decrease in diversification benefits (Silvennoinen and Thorp 2013, Sadorsky 2014)
Views on Speculation and Volatility

Figure 3: The competing views concerning the relationship between volatility and speculation

- Participation of non-commercial investor
- Quality of Information
  - Destabilizing effect on prices
- The competing views on speculation and volatility
- Volatility
- Market Liquidity/Transfer of risk
  - Efficiency in forecasting future prices

Mou (2010), Singleton (2011), Tang and Xiong (2012), Aulerich et al. (2014)
Irwin, Sanders and Merrin (2009), Brunetti and Büyükgüven (2009), Filimonov et al. (2014) and Brunetti et al. (2016)
The Paper in a Nutshell

Since financialisation,

Cross-market Linkage

- whether the volatility link between crude oil futures and equities varies?

Volatility

- have volatility of crude oil futures and equities started to move in sync?
- how volatility impacts on the connectedness between crude oil futures and equities?

Volatility patterns

- whether seasonal effect is altered?
- whether the impact of Samuelson's (1965) maturity and correlation effect are changed?
Empirical Strategy

Approach

- Sample period analysis
- Financialisation-specific measure

Econometric Framework

- Estimated model (VARX-DCC-GARCH)
- Regression analysis
- Granger-Causality test
- Other tests
Data Description

Sample Period

- Pre-financialisation (Jan 1993-Dec 2003)
- Post-financialisation (Jan 2004-Dec 2019)

Variables

- Volatility of returns (weekly-Tue) to (i) crude oil futures contracts (EIA) and (ii) S&P500 index (Yahoo Finance).
- The extent of speculative activity (CFTC CoT) (i) Speculation index and (ii) Open interest.
- Following Hedegaard (2009),

\[
\text{Speculation Index} = \frac{\text{Non-commercial Long Position} - \text{Non-commercial Short Position}}{\text{Total Open Interest}}
\]
Empirical Findings

Figure 4: VARX-DCC-GARCH Analysis
Empirical Findings

Figure 5: Time-varying conditional volatility and dynamic conditional correlation

[Graph showing time-varying conditional volatility and dynamic conditional correlation over time, with specific events marked such as tech bubble and GFC.]
Interconnectedness and Long-run Risks

Regression Analysis

<table>
<thead>
<tr>
<th>Impact</th>
<th>Pre-financialisation</th>
<th>Post-financialisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>( h_{SP500} - h_{Oil} )</td>
<td>No impact</td>
<td>(+) effect <code>↑</code></td>
</tr>
<tr>
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</tr>
<tr>
<td>( h_{SP500} - \rho_{SP500-Oil} )</td>
<td>Partly</td>
<td>(+) effect <code>↑</code></td>
</tr>
<tr>
<td>( h_{Oil} - \rho_{SP500-Oil} )</td>
<td>Partly</td>
<td>Mostly <code>↓</code></td>
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*Note: h and \( \rho \) represents first difference of the conditional volatility and conditional correlation respectively.*

Seasonality

- Return
- Volatility
Samuelson Maturity and Correlation Effect

Visual Inspection

- Density curve

Parametric Test

- Regression-based test

Non-parametric Test

- Kolmogorov-Smirnov
- Jonckheere–Terpstra test
Samuelson Effect on Volatility

Figure 6: Samuelson's volatility effect for (a) pre- and (b) post-financialisation period
**Samuelson Effect on Correlation**

![Graph showing the Samuelson effect on correlation for the pre- and post-financialisation periods.](image)

**Figure 7:** Samuelson's correlation effect for (a) pre- and (b) post-financialisation period
Impact of Financialisation (Financialisation-Specific Measure)

Regression Analysis

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<th>Impact</th>
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<th>Post-financialisation</th>
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</thead>
<tbody>
<tr>
<td>Speculative activity on <code>h</code></td>
<td>(-) Nearby crude oil</td>
<td>No impact</td>
</tr>
<tr>
<td>Open interest on <code>h</code></td>
<td>(-) S&amp;P500</td>
<td>(-) Crude oil</td>
</tr>
<tr>
<td>Speculative activity on <code>ρ_{SP500-Oil}</code></td>
<td>No impact</td>
<td>No impact</td>
</tr>
<tr>
<td>Open interest on <code>ρ_{SP500-Oil}</code></td>
<td>No impact</td>
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*Note: h and ρ represents first difference of the conditional volatility and conditional correlation respectively.*

Granger Causality

- Speculative activity → volatility
- Open interest ↔ volatility
Robustness Check

- Alternative model
- Alternative financialisation measure
- Detrended open interest
Since financialisation,

- Inter-market dependence in volatility
- Weaken seasonality
- Diminishing Samuelson volatility effect
- Prominent (inverse) Samuelson correlation effect in oil futures (equity-oil)
- Change in speculative activity may drive volatility to change
- Other factors
Thanks!
References


References


Appendix

Measures of Speculative Activity

- Following Robles and Von Braun (2009),

\[
\text{Speculation Index} = \frac{\text{Non-commercial Long Position}}{\text{Total Open Interest}}
\]

- Following De Roon, Nijman, and Veld (2000), Sanders, Boris, and Manfredo (2004) and Sanders, Irwin, and Merrin (2010),

\[
\text{Speculative Pressure} = \frac{NCL - NCS}{NCL + NCS}
\]

where NCL and NCS represents non-commercial long position and non-commercial short position respectively.
VARX DCC GARCH Model

Mean Equation: \( r_t = \mu_t + \Phi r_{t-1} + \Psi d_t + \epsilon_t; \epsilon_t|F_{t-1} \sim N(0, H_t) \)

where \( r_t = (r_{t_{SP500}}, r_{t_{CL01}}, r_{t_{CL02}}, r_{t_{CL03}}, r_{t_{CL04}})' \) is a \( k \times 1 \) dimensional vector representing returns at time \( t \). \( \mu_t \) is a \( k \times 1 \) vector of constant terms. \( d_t = (d_{t_{winter}}, d_{t_{summer}}, d_{t_{fall}})' \) is a \( 3 \times 1 \) vector. \( \epsilon_t \) is a \( k \times 1 \) vector of the residual returns in \( r_t \).

Time-varying covariance matrix, \( H_t \)

\[ \epsilon_t = H_t^{\frac{1}{2}} \nu_t, \nu_t \sim N(0, 1) \]

Where, \( \nu_t \) is a \( k \times 1 \) vector of IID errors.

Following Engle (2002), \( H_t \) takes on the form,

\[ H_t = D_t R_t D_t \]

where \( D_t = \text{diag}(\sqrt{h_{t_{SP500}}}, \sqrt{h_{t_{CL01}}}, \sqrt{h_{t_{CL02}}}, \sqrt{h_{t_{CL03}}}, \sqrt{h_{t_{CL04}}}) \), \( R_t \) is a symmetric \( k \times k \) matrix of time-varying conditional correlation coefficients that includes \( [R_t]_{ij} = \rho_{ij,t} \)
The conditional variances are derived through a first order univariate GARCH (1, 1) process,

\[ h_t = \omega + A\varepsilon^2_{t-1} + Bh_{t-1} + \gamma d_t \]

The unconditional variance estimate \( Q_t = E_{t-1}[v_t v'_t] \)

then \( R_t \) can be rewritten as,

\[ R_t = [\text{diag}(Q_t)]^{-\frac{1}{2}} Q_t [\text{diag}(Q_t)]^{-\frac{1}{2}} \]

where \( Q_t \) is a \( k \times K \) symmetric positive-definitive matrix. Thereafter, the correlation coefficient \( \rho_{ij,t} \) should be parametrised. To achieve that the model assumes that \( Q_t \) follows an autoregressive process.

\[ Q_t = \bar{Q}(1 - \theta_1 - \theta_2) + \theta_1 \varepsilon_{t-1} \varepsilon'_{t-1} + \theta_2 Q_{t-1} \]

where, \( \theta_1 \) and \( \theta_2 \) are non-negative i.e. \( \theta_1 \geq 0 \) and \( \theta_2 \geq 0 \) and \( \theta_1 + \theta_2 < 1 \), which ensures that \( Q_t \) is positive and mean-reverting.
Link between Conditional Correlation and Conditional Volatility

\[ \rho_{ij,t} = \xi_0 + \xi_1 h_{i,t} + \sum_{t=1}^{4} \xi_2 h_{j,t} + \vartheta_{ij,t} \]

Link among Conditional Volatility of Assets

\[ h_{j,t} = \Xi_0 + \Xi_1 h_{S&P500} + \vartheta_{i,t} \]

\[ h_{S&P500} = \Upsilon_0 + \sum_{t=1}^{4} \Upsilon_1 h_{j,t} + \vartheta_{j,t} \]
Figure 8: Speculation Index and Open Interest