Asymmetric volatility connectedness between Islamic stock and commodity markets

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Introduction

• Market Connectedness
  • Connectedness, or the ‘spillover effect’, reflecting information transmission between different markets or assets, is a crucial component of portfolio concentration risk, risk measurement and risk management (Diebold and Yilmaz, 2014).
Introduction

• Market Connectedness
  • Market risk (return connectedness and portfolio concertation) (DeMiquel et al, 2009),
  • Default risk and credit risk (Lux, 2016),
  • Counter party risk (Brunnermeier, 2009; Lowenstein, 2010),
  • Systemic risk (system-wide connectedness) (Acharya et al., 2010; Brunnermeier et al., 2012),
  • Business cycle and financial crisis (intra-and inter-country real activity connectedness) (Aruoba et al., 2011; Apostolakis et al., 2015)
Introduction

• Asymmetric volatility spillover
  • Asymmetric volatility’ behaviors suggest that negative shocks to stock returns increase volatility to a greater extent than do positive shocks of the same size (BenSaïda, 2019; Newaz and Park, 2019).
  • This phenomenon is attributed to either the leverage effect (Black, 1976; Christie, 1982) or feedback effect (Campbell and Hentschel, 1992; French et al., 1987; Pindyck, 1984).
  • Consistent with the presence of asymmetric volatility behaviors, volatility spillovers also exhibit asymmetries in responses to bad and good news (Baruník et al., 2016; BenSaïda, 2019)—referred to as ‘asymmetric volatility spillovers’.
  • Negative shocks in a market may result in the transmission of higher levels of volatility to other asset markets than do positive shocks.
  • Asymmetric volatility spillovers indicate a market to be more influenced by bad news from another market, thus establishing asymmetric information spillovers.
Introduction

• Market connectedness Network
  • The network of connectedness visualizes the propagation path of volatility shocks across financial markets (Cimini, 2015; Liu et al., 2017).
  • Billio et al., (2012) apply principal components analysis and pairwise Granger-causality networks to measure systemic risk in financial industry sectors.
  • Diebold and Yilmaz (2014) use a spillover index to measure system-wide and pairwise connectedness in US financial firms.
Research Questions

• We ask the following questions:

• Are asymmetries in volatility present between the Dow Jones Islamic indices (DJIM) and commodity markets (Brent crude oil, gold, and silver)?

• If asymmetry is a common phenomenon, then how do markets transmit this asymmetry?

• Are there any differences in the way one particular market receives (contributes to) asymmetric volatility spillover from (in) other markets?

• To make answers on above questions, we capture the volatility spillover asymmetry and connectedness by using a high frequency data and a spillover asymmetry measure and a network approach.
Econometric modelling framework

- “Realized variances” \( (RV_t) \) are the square of intraday returns \( (r_t) \) estimated at every 5-minute interval.

\[
RV_t = \sum_{s=1}^{N} r_{t,s}^2, s = 1,2, \ldots, 288, t = 1,2, \ldots, T
\]  

(1)

The negative \( RS_t^- \) and positive \( RS_t^+ \) are defined as follows:

\[
RS_t^- = \sum_{s=1}^{N} r_{t,s}^2 I(r_{t,s} < 0)
\]  

(2)

\[
RS_t^+ = \sum_{s=1}^{N} r_{t,s}^2 I(r_{t,s} > 0)
\]  

(3)

The \( RS_t^- \) (\( RS_t^+ \)) term implies negative or bad (positive or good) semivariance/volatility due to negative (positive) news.
Econometric modelling framework

- Connectedness (Spillover) matrix table (Reproduced: Baruník, et al.(2015))

<table>
<thead>
<tr>
<th></th>
<th>$RS^+_i$</th>
<th></th>
<th>$RS^-_i$</th>
<th></th>
<th>From Others</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>A</td>
</tr>
<tr>
<td>$RS^+_i$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$w_{1,5}$</td>
</tr>
<tr>
<td>A</td>
<td></td>
<td>$w_{1,1}$</td>
<td>$w_{1,2}$</td>
<td>$w_{1,3}$</td>
<td>$w_{1,4}$</td>
</tr>
<tr>
<td>B</td>
<td>$w_{2,1}$</td>
<td></td>
<td>$w_{2,2}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
<td>$w_{3,3}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>$w_{4,4}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$RS^-_i$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$w_{5,5}$</td>
</tr>
<tr>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$w_{5,1}$</td>
</tr>
<tr>
<td>B</td>
<td>$w_{6,1}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
<td>$w_{7,3}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>$w_{8,4}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To others:

- $\sum_{i=1}^{2N} w_{i,1}, i \neq 1$
- $\sum_{i=2}^{2N} w_{i,2}, i \neq 2$
- $\sum_{i=3}^{2N} w_{i,3}, i \neq 3$
- $\sum_{i=4}^{2N} w_{i,4}, i \neq 4$
- $\sum_{i=5}^{2N} w_{i,5}, i \neq 5$
- $\sum_{i=6}^{2N} w_{i,6}, i \neq 6$
- $\sum_{i=7}^{2N} w_{i,7}, i \neq 7$
- $\sum_{i=8}^{2N} w_{i,8}, i \neq 8$

$N=1, 2, ..., 4$
Econometric modelling framework

• The spillover asymmetry measure \((SAM_{2N}(H))\) can be defined as follows:

\[
SAM_{2N}(H) = \sum_{i=1}^{N} S_{2N,i\rightarrow*}(H) - \sum_{i=N+1}^{2N} S_{2N,(i+N)\rightarrow*}(H)
\]

(13)

• \(S_{2N,i\rightarrow*}\) and \(S_{2N,(i+N)\rightarrow*}\) identify asymmetries in the directional spillover indices, respectively, due to positive and negative volatilities

• The values of \(SAM_{2N}(H)\) measure the magnitude of asymmetric spillovers due to \(RS_t^-\) and \(RS_t^+\).

• When the values of \(SAM_{2N}(H)\) are negative, it means that the bad volatility of \(RS_t^-\) dominates the good volatility of \(RS_t^+\).

• However, if the magnitude of spillover from \(RS_t^-\) and \(RS_t^+\) are equal, \(SAM_{2N}(H)\) is zero indicating no evidence of asymmetric spillover effect.
Data

• In order to calculate the daily realized volatility, we consider the Dow Jones Islamic Market index (DJIM) and commodities (Brent crude oil, gold, and silver) with 5-minute returns over the 4 January 2010-27 June 2018 period.

• In order to avoid potential bias, we exclude weekends due to trading activity on the market being low, holiday days, December 24-26, and December 31-January 2.

• We calculated realized volatility (RV) measure into negative and positive semi-variances ($RS^-$ and $RS^+$), with each semi-variance corresponding to its respective set of negative or positive returns.
Data (Realized variances)

Fig. 1. Realized volatilities of Islamic stock and commodity markets

Note: This figure illustrates the daily realized variances of the five assets calculated by the sum of squared five-minute intraday returns.
Spillovers in realized volatility

Table 2. Total spillovers in daily realized volatility

<table>
<thead>
<tr>
<th></th>
<th>DJIM</th>
<th>Brent</th>
<th>Gold</th>
<th>Silver</th>
<th>From</th>
</tr>
</thead>
<tbody>
<tr>
<td>DJIM</td>
<td>87.77</td>
<td>2.31</td>
<td>5.96</td>
<td>3.96</td>
<td>12.2</td>
</tr>
<tr>
<td>Brent</td>
<td>5.22</td>
<td>92.52</td>
<td>0.47</td>
<td>1.79</td>
<td>7.5</td>
</tr>
<tr>
<td>Gold</td>
<td>6.4</td>
<td>0.24</td>
<td>66.48</td>
<td>26.88</td>
<td>33.5</td>
</tr>
<tr>
<td>Silver</td>
<td>3.47</td>
<td>1.04</td>
<td>23.4</td>
<td>72.09</td>
<td>27.9</td>
</tr>
<tr>
<td>To</td>
<td>15.1</td>
<td>3.6</td>
<td>29.8</td>
<td>32.6</td>
<td>81.1</td>
</tr>
<tr>
<td>All</td>
<td>102.9</td>
<td>96.1</td>
<td>96.3</td>
<td>104.7</td>
<td></td>
</tr>
<tr>
<td>Net</td>
<td>2.9</td>
<td>-3.9</td>
<td>-3.7</td>
<td>4.7</td>
<td></td>
</tr>
</tbody>
</table>

Conclusions: Net-transmitter Net-recipient Net-recipient Net-transmitter

Total: 20.30%
Time-varying volatility spillovers

Fig. 2. Time-varying total volatility spillovers between the DJIM and commodity markets

Notes: Dynamics of total spillovers are based on the use of a rolling-sample analysis based on a 200-day rolling sample window and a 10-day ahead forecasting horizon.
Net volatility spillovers

Fig. 3. Net volatility spillovers in daily realized volatility

Note: The indices of net volatility spillover represent the difference between directional ‘To’ spillovers and directional ‘From’ spillovers. The positive (negative) value for spillovers indicate a net transmitter (recipient) of volatility spillovers.
Asymmetric volatility spillover index

Table 3. Asymmetric volatility spillover index in semi-variances $R^+$ and $R^-$

<table>
<thead>
<tr>
<th></th>
<th>$R^+$</th>
<th>$R^-$</th>
<th>From</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DJIM</td>
<td>Brent</td>
<td>Gold</td>
</tr>
<tr>
<td>$R^+$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DJIM</td>
<td>58.41</td>
<td>0.75</td>
<td>4.13</td>
</tr>
<tr>
<td>Brent</td>
<td>2.25</td>
<td>84.77</td>
<td>0.19</td>
</tr>
<tr>
<td>Gold</td>
<td>3.02</td>
<td>0.13</td>
<td>40.54</td>
</tr>
<tr>
<td>Silver</td>
<td>0.83</td>
<td>0.03</td>
<td>7.47</td>
</tr>
<tr>
<td>$R^-$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DJIM</td>
<td>14.94</td>
<td>0.1</td>
<td>1.61</td>
</tr>
<tr>
<td>Brent</td>
<td>1.68</td>
<td>5.47</td>
<td>1.27</td>
</tr>
<tr>
<td>Gold</td>
<td>2.41</td>
<td>0.11</td>
<td>19.69</td>
</tr>
<tr>
<td>Silver</td>
<td>0.8</td>
<td>0.03</td>
<td>5.65</td>
</tr>
<tr>
<td>To</td>
<td>25.9</td>
<td>6.6</td>
<td>40</td>
</tr>
<tr>
<td>All</td>
<td>84.3</td>
<td>91.4</td>
<td>80.6</td>
</tr>
</tbody>
</table>
Spillover asymmetry measure

Fig. 4. Spillover asymmetry measure-$SAM$

Notes: The dynamics of the spillover asymmetry measure are calculated via the 200-day rolling-sample approach. The negative values indicate that spillovers from bad volatility ($RS^-$) dominate spillovers from good volatility ($RS^+$).
Network of asymmetric volatility spillover

Fig. 5 Net-pairwise directional network in semi-variances ($RS^+$ and $RS^-$)
Conclusions

• A summary of our empirical results follows.
  • We identify volatility spillover effects between the DJIM and commodity (gold, silver, and Brent crude oil) markets.
  • Spillovers are intensified during times of financial distress, triggering higher levels of volatility
  • Spillover between Islamic stock and commodity markets—evidencing financial contagion.
  • Silver is identified as the largest transmitter of negative shocks to other markets, as evidenced via asymmetries in the transmission of semi-volatility.
  • We conclude that the volatility spillovers are more pronounced for negative shocks than positive shocks, supporting the leverage effect hypothesis.
  • The network of asymmetric connectedness shows that silver imposes negative volatility on the positive volatilities of other markets (silver, DJIM, gold, and Brent crude oil), indicating asymmetric volatility spillover across these markets.