Co-Movement between Commodity and Equity Markets Revisited - an Application of the Thick Pen Method

Sania Wadud, University of Aberdeen, UK and Curtin University, Australia

Marc Gronwald, Xi’an Jiaotong-Liverpool University, China
Robert B. Durand, Curtin University, Australia
Seungho Lee, University of Aberdeen, UK

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Background

- Increased co-movements/correlation
  - between equities and commodity returns
  - between non-energy and energy commodities
  - between index commodities > off-index
- Equilibrium levels of codependency
- Price information of commodities
- Investment decision
This paper in a nutshell

- Return co-movement between commodity futures and equities
- Use of a novel approach called **Thick Pen Transform**
- Short-run and long-run components of co-movement
- Potential interest to investors, policy makers
Data and Methodology

Data

- Daily log-returns on prices of S&P500 Index
- Daily log-returns on prices of 22 commodity futures (nearby contracts)
- Period: 04 Jan 1993 - 24 Dec 2019 (6835)

Model

- Thick Pen Measure of Association (TPMA) by Fryzlewicz and Oh (2011)
- Multi-thickness Thick Pen Measure of Association (MTTPMA) by Jach (2021)
Why?

- Stationary and non-stationary
- More than two time series
- Time-evolving
- Given time scale
- Across different time scale
- Visually interpretable

In comparison with traditional co-movement measures

- Lack the multi-frequency outlook (e.g. cross-correlation of multi-period, rolling-window cross correlation)
- Impose particular structure on the data-generating mechanism/ co-movement dynamics (e.g. wavelet-based metrics)
- Lack cross-term co-movement (Gorrostieta et al. 2019)
Thick Pen Transform (TPT)

Let,

- $X = (X_t)_{t=1}^{T}$ - a univariate time series;
- $\mathcal{T}$ - set of positive constant thickness parameters i.e. $\tau_i \in \mathcal{T}, i = 1, 2, \ldots, |\mathcal{T}|$ (where $|\mathcal{T}|$ is the cardinality of $\mathcal{T}$);
- lower boundaries of the area
  \[ L_t^\tau(X) = \min(X_t, X_{t-1}, \ldots, X_{t-\tau}) \]
- upper boundaries of the area
  \[ U_t^\tau(X) = \max(X_t, X_{t-1}, \ldots, X_{t-\tau}) \]
- A collection of $n$ pairs of boundaries (2$n$ $T$ random variables in total) denoted as
  \[ TP_{\mathcal{T}}(X) = \{(L_t^\tau(X), U_t^\tau(X))_{t=1}^{T}\}_{\tau \in \mathcal{T}} \]
Thick Pen Measure of Association (TPMA)

- Quantify co-movement between two/more time series for a given time scale

\[
\rho_t^\tau(X^{(1)}, X^{(2)}, \ldots, X^{(K)}) = \frac{\min_k (U_t^\tau(X^{(k)})) - \max_k (L_t^\tau(X^{(k)}))}{\max_k (U_t^\tau(X^{(k)})) - \min_k (L_t^\tau(X^{(k)}))}
\]

Multi-thickness Thick Pen Measure of Association (MTTPMA)

- Quantify co-movement between two/more time series for multi-time scale

\[
\rho_t^{(\tau^{(1)}, \tau^{(2)}, \ldots, \tau^{(K)})}(X^{(1)}, X^{(2)}, \ldots, X^{(K)}) = \frac{\min_k (U_t^{\tau^{(k)}}(X^{(k)})) - \max_k (L_t^{\tau^{(k)}}(X^{(k)}))}{\max_k (U_t^{\tau^{(k)}}(X^{(k)})) - \min_k (L_t^{\tau^{(k)}}(X^{(k)}))}
\]

- This measure is restricted to interval \(\rho_t(X^{(1)}, X^{(2)}) \in (-1, 1]\) and is time-varying.
Empirical Results

Figure 1: Thick Pen Transform daily returns (normalised) of equity index and commodity futures) for several thickness upto 252 trading days.
Empirical Results

Figure 2: Multi-thickness Thick Pen Measure of Association of daily returns (normalised) of the equity index and crude oil futures (energy index). Thickness 22, 126, 252 and 756 represents short term (1-month, 6-month) and long-term (1-year, 3-year) component respectively.
Empirical Results

TPMA of daily realised return of equity index and commodity futures

<table>
<thead>
<tr>
<th></th>
<th>6-month</th>
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<th>3-year</th>
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<tbody>
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<td></td>
<td>Since financialisation</td>
<td>Changing point</td>
<td>Since financialisation</td>
<td>Changing point</td>
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<td>S&amp;P500-energy index</td>
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<td>2004</td>
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<td>2004</td>
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<td>Natural Gas</td>
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<td>2006/2007</td>
<td>higher</td>
<td>2004</td>
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<td>S&amp;P500-off-index</td>
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<tr>
<td>Minneapolis Wheat</td>
<td>lower</td>
<td>2008</td>
<td>lower</td>
<td>2004/2005</td>
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<tr>
<td>Soybean Meal</td>
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<td>2004</td>
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<td>2004 and 2011</td>
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<tr>
<td>Rough Rice</td>
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<td>higher</td>
<td>2004</td>
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<tr>
<td>Oats</td>
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<td>2004 and 2012</td>
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<tr>
<td>Orange Juice</td>
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<td>2008</td>
<td>higher</td>
<td>2004</td>
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<tr>
<td>Lumber</td>
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Empirical Results (Continued)

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<th>Commodity</th>
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<th>3-year</th>
<th>Changing point</th>
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<td>Chicago wheat</td>
<td>higher</td>
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<td>Kansas City Wheat</td>
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<td>Soybean Oil</td>
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<td>Coffee</td>
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<td>similar</td>
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<td>Sugar</td>
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<td>similar</td>
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<tr>
<td>Cocoa</td>
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<td>2004</td>
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<tr>
<td>Cotton</td>
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<td>2004</td>
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<td>Live Cattle</td>
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<td>Feeder Cattle</td>
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<td>lower</td>
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<td>Copper</td>
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<td>higher</td>
<td>2004</td>
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<tr>
<td>Gold</td>
<td>similar</td>
<td>2007</td>
<td>similar</td>
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Key Findings

• Overall, increased association between equity and commodity futures
• Co-dependency between equity and off-index futures are lower than with other commodities (both SR & LR)
• Energy index futures and equities co-move to a larger extent since financialisation (LR)
• Weak co-movement between the equity index and soybean based and livestock futures (both SR & LR)
• Evidence of asymmetric effects in cross-comovement i.e. MTTPMA
Conclusions

- Promising technique to quantify cross-dependency
- Short-term and long-term policy perspectives
- Uncertainty caused by energy transition $\rightarrow$ structural change (Fattouh et al. 2018)
- Formulate trading strategy
- Energy transition
• Co-movement between commodity and equity markets revisited - an application of the Thick Pen method (with M. Gronwald, R. B. Durand, and S. Lee) USAEE/IAEE Working Paper Series No. 21-521 (2021)
Thanks!

Sania Wadud
email: s.wadud.18@abdn.ac.uk
sania.wadud@postgrad.curtin.edu.au
References


