Variance Risk Premia in Commodity Markets

Marcel Prokopczuk
Leibniz University Hannover

&

Chardin Wese Simen
University of Reading

Thematic Semester on Commodity Derivatives Markets

Closing Conference
6th November 2015, Palais Brongniart, Paris
New: Journal of Commodity Markets
2016 Commodity Markets Conference

• Date and location: 3-4 June at Hannover

• Keynote Speakers:
  • Geert Rouwenhorst (Yale University)
  • Eduardo Schwartz (UCLA)

• paper submission until 31 Jan 2016:
  submission@fmt.uni-hannover.de

• More info:
  www.fmt.uni-hannover.de/conference_en.html
Motivation and Contribution

- Proliferation of commodity volatility instruments: corn, crude oil, gold, soybeans and wheat
- Facilitate the trading of commodity volatility risk
Motivation and Contribution

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Questions:
Motivation and Contribution

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Questions:

1. Do commodity investors require a variance risk premium (VRP)?
Motivation and Contribution

- Proliferation of commodity volatility instruments: corn, crude oil, gold, soybeans and wheat
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Questions:
1. Do commodity investors require a variance risk premium (VRP)?
2. What are the time-series dynamics of commodity VRP?
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3. How do commodity VRP relate to equity and bond VRP?

⇒ Implications for asset allocation, derivatives pricing and risk management
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Methodology

1. **Parametric Approach**
   
   Specified as a variable in a stochastic volatility model (Broadie et al., 2007)
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   Estimate variance risk premia as sample average of variance swap payoffs (Carr and Wu, 2009)
Methodology (cont’d)

Estimate the variance risk premium as the sample average of variance swap payoffs (Carr and Wu, 2009):

\[ VRP_{t,T} = RV_{t,T} - VSR_{t,T} \]

\[ RV_{t,T} = \frac{365}{T - t} \sum_{i=t+1}^{T} \left( \log \frac{F_i,T}{F_{i-1},T} \right)^2 \]

\[ VSR_{t,T} = 2e^{rt} \frac{365}{T - t} \left[ \int_{0}^{F} \frac{P(K,T)}{K^2} dK + \int_{F}^{+\infty} \frac{C(K,T)}{K^2} dK \right] \]

- \( RV_{t,T} \): Realized variance for the period \([t, T]\)
- \( VSR_{t,T} \): Variance swap rate for the period \([t, T]\)
Data

- Futures and options data on 21 markets:
  1. **Energy**: Crude oil, heating oil and natural gas
  2. **Grains**: Corn, cotton, soybeans, soybean meal, soybean oil, sugar and wheat
  3. **Livestock**: Lean hogs and live cattle
  4. **Metals**: Copper, gold and silver
  5. **Tropical**: Cocoa, Colombian coffee, oats, orange juice, rough rice
  6. **Wood**: Lumber
Data

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• American options
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- American options
- Daily settlement prices
- Data source: Commodity Research Bureau
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<thead>
<tr>
<th>Sector</th>
<th>Commodity</th>
<th>Start</th>
<th>End</th>
<th>Days</th>
<th>Calls</th>
<th>Puts</th>
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<td>6</td>
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<tr>
<td>Wood</td>
<td>Lumber</td>
<td>1987</td>
<td>2010</td>
<td>5,680</td>
<td>10</td>
<td>7</td>
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</table>
Example of Selected Commodities

- Crude Oil
- Wheat
- Live Cattle
- Copper
- Cocoa
- Lumber
Is Variance Risk Priced in Commodity Markets?

Sample average of variance swap payoffs: $RV_{t,T} - VSR_{t,T}$

<table>
<thead>
<tr>
<th></th>
<th>Sig</th>
<th>Neg</th>
<th>Pos</th>
<th>Min</th>
<th>Max</th>
<th>Min SR</th>
<th>Max SR</th>
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<tbody>
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<td>VRP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>90-day</td>
<td>19/21</td>
<td>16/19</td>
<td>3/19</td>
<td>−9.1%</td>
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<tr>
<td>60-day</td>
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<td>−10%</td>
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<td>9.4%</td>
<td>66%</td>
</tr>
</tbody>
</table>

⇒ Yes!
⇒ Mainly negative VRP
⇒ High cross-sectional variation
⇒ Sizeable Sharpe ratios

M. Prokopczuk
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$\Rightarrow$ High cross-sectional variation

$\Rightarrow$ Sizeable Sharpe ratios
Is the Variance Risk Premium a Recent Phenomenon?

Pre-Financialization: Before Dec 2004

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</tbody>
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<td>6.1%</td>
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<td>1/16</td>
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<td>1.5%</td>
</tr>
</tbody>
</table>
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<td>VRP 60-day</td>
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Financialization: After Dec 2004

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<td>1/16</td>
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<td>1.5%</td>
</tr>
</tbody>
</table>

⇒ No! Significantly negative VRP in both periods
Are There Commonalities in Commodity VRP? Part I

We compute

1. Within sector correlations
2. Across sector correlations
Are There Commonalities in Commodity VRP? Part I

We compute

1. Within sector correlations
2. Across sector correlations

<table>
<thead>
<tr>
<th>Sector</th>
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<tr>
<td>Grains</td>
<td>21.02%</td>
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<tr>
<td>Livestock</td>
<td>20.07%</td>
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<tr>
<td>Metals</td>
<td>33.05%</td>
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<td>Tropical</td>
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Are There Commonalities in Commodity VRP? Part II

Across Sectors

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<th>Livestock</th>
<th>Metals</th>
<th>S&amp;P500</th>
<th>Treasury</th>
<th>Tropical</th>
<th>Wood</th>
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<tbody>
<tr>
<td>Energy</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>Livestock</td>
<td>11.69%</td>
<td>15.81%</td>
<td>-</td>
<td>-</td>
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<td>-</td>
<td>-</td>
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<tr>
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<tr>
<td>S&amp;P 500</td>
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The correlation becomes stronger post 2004!!!
Are There Commonalities in Commodity VRP? Part II

### Across Sectors

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