Salmon and Feed Raw Material Markets
Atle Oglend, Frank Asche

University of Stavanger
uis.no
Background

- **Salmon production is feed intensive**
  - 80s: ~30% feed cost share of production cost, 2009-11 ~ 56%
  - *Marine Proteins* (Fishmeal) crucial to fish health, growth and quality
    - Inclusion rate of fishmeal in feed down from 50% to as low as 15%
    - Concerns about overfishing and reduction in wild-caught food fish

- **Variation in feed prices important to cost developments**
  - Marine Harvest annual report "*limited flexibility in the composition of feed raw materials, as a result of end product contract specifications combined with increasing feed raw material prices in general, are the main contributing factors to the cost increase.""
Feed and Other Costs (Unit production cost)
Salmon Feed

- Salmon feed is composed of proteins, fat, carbohydrates, pigments and micro-nutrients
  - Marine proteins: fishmeal (18.8%)
  - Vegetable proteins: soy concentrate is the major component (25.6%)
  - Fish oil (12.2%)
  - Vegetable oil: rapeseed oil (18.3%)
  - Carbohydrates: wheat (8.6%)

- Proteins are 50-60% of feed value (marine proteins most expensive)

- Composition varies over different feeds types and according to relative prices within allowable quality constraints
Fishmeal

- Fishmeal derives from fisheries of small pelagic species
  - Pelagic fisheries generally characterized as fully exploited or over-exploited (FAO)

- Peru (Anchovies fishery), U.S. (Menhaden), Northern-Europe (pout, capelin, sand eel and mackerel fisheries)
  - Fishmeal is protein rich, stores well and highly traded

- 2009: 63% of the fishmeal went to aquaculture, 25% pigs, 8% poultry
Feed Price and Fishmeal Price

- Feed Price
- Fishmeal Price

Price in $/kg over the years from 1994 to 2011.
Feed Intensity (kg. feed used/kg fish)
Research

- Higher feed cost share, together with lower productivity growth, suggest a stronger pass-through effect from feed raw material prices to salmon prices

- We investigate the relationship between salmon and feed raw material prices (fishmeal, soybean and wheat) from 1980 to 2013
  - Special focus on fishmeal, the most economically important and controversial input
Salmon Price Decomposition (Long-run)

\[ p_s = \lambda \left( \sum_{i=1}^{n} \alpha_i p_i + m \right) + \frac{\delta c_o(w,y)}{\delta y} \]

- \( \lambda \) - Feed Intensity
- \( \alpha_i \) - Feed component share
- \( p_i \) - Feed component price
- \( m \) - Feed producer markup
- \( \frac{\delta c_o(w,y)}{\delta y} \) - MC other costs
Salmon Price Decomposition (Long-run)

- Reasons to believe higher passthrough from feed raw material prices to salmon prices in recent years:
  - Higher feed intensity/higher feed cost share in variable costs
  - Stronger comovements in the feed raw material prices, more constant relative prices
    - Inability to substitute away from expensive feed raw materials means prices of feed must adjust more
  - Binding lower bound on fishmeal inclusion in feed
  - Limited ability to substitute away from feed in production
## Descriptive Statistics

<table>
<thead>
<tr>
<th></th>
<th>Salmon</th>
<th>Fishmeal</th>
<th>Soybean meal</th>
<th>Wheat</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean</strong></td>
<td>5120.6</td>
<td>667.6</td>
<td>234.4</td>
<td>172.5</td>
</tr>
<tr>
<td><strong>Standard Deviation</strong></td>
<td>1460.7</td>
<td>398.34</td>
<td>78.674</td>
<td>61.863</td>
</tr>
<tr>
<td><strong>Coefficient of Variation</strong></td>
<td>0.285</td>
<td>0.597</td>
<td>0.336</td>
<td>0.359</td>
</tr>
<tr>
<td><strong>ADF Unit-Root test (Levels)</strong></td>
<td>-2.261</td>
<td>0.4552</td>
<td>-0.7831</td>
<td>-1.816</td>
</tr>
<tr>
<td><strong>ADF Unit-Root test (1st diff.)</strong></td>
<td>-5.208**</td>
<td>-5.601**</td>
<td>-6.937**</td>
<td>-7.769**</td>
</tr>
<tr>
<td><strong>KPSS Stationarity test (Levels)</strong></td>
<td>5.636**</td>
<td>5.124**</td>
<td>4.575**</td>
<td>4.711**</td>
</tr>
<tr>
<td><strong>KPSS Stationarity test (1st diff.)</strong></td>
<td>0.0924</td>
<td>0.396*</td>
<td>0.088</td>
<td>0.1223</td>
</tr>
</tbody>
</table>
Cointegration results (full sample, all prices)

- All feed raw material prices are cointegrated with each other, none with salmon (over 1980-2012)

<table>
<thead>
<tr>
<th></th>
<th>Rank = 0, trace statistics</th>
<th>Rank = 1, trace statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salmon</td>
<td>Salmon</td>
<td>Salmon</td>
</tr>
<tr>
<td>Fishmeal</td>
<td>5.041</td>
<td>1.237</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>10.378 19.107*</td>
<td>3.7673 0.5065</td>
</tr>
<tr>
<td>Wheat</td>
<td>8.752 15.675* 30.527*</td>
<td>3.0738 0.3966 2.8823</td>
</tr>
</tbody>
</table>

All feed raw material prices are cointegrated with each other, none with salmon (over 1980-2012).
Salmon and Fishmeal prices
Cointegration (salmon and fishmeal, subsamples)

- Salmon and Fishmeal are cointegrated from 2001 (robust to variations in the sample split around the start of the century).
- Salmon also cointegrated with soybean and wheat from 2001 (allowing for a linear trend in the long-run relationship).

<table>
<thead>
<tr>
<th>Rank</th>
<th>Trace Test</th>
<th>p-value</th>
<th>Max test</th>
<th>p-value</th>
<th>Trace Test</th>
<th>p-value</th>
<th>Max test</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>7.87</td>
<td>0.832</td>
<td>6.48</td>
<td>0.733</td>
<td>23.06</td>
<td>0.018*</td>
<td>19.37</td>
<td>0.012*</td>
</tr>
<tr>
<td>1</td>
<td>1.38</td>
<td>0.881</td>
<td>1.38</td>
<td>0.88</td>
<td>3.69</td>
<td>0.472</td>
<td>3.69</td>
<td>0.471</td>
</tr>
</tbody>
</table>
Salmon and Fishmeal (dynamic relationships)

- Fishmeal found (weakly) long-run exogenous in the dynamic relationship (after 2001)
- No short-run lagged dependencies
- Mostly a trend effect (salmon inherits the trend from fishmeal prices)

<table>
<thead>
<tr>
<th></th>
<th>Long-run weak exogeneity tests</th>
<th>Short-run weak exogeneity tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salmon exogenous</td>
<td>$x^2(1)$</td>
<td>15.362</td>
</tr>
<tr>
<td>Fishmeal exogenous</td>
<td>$x^2(1)$</td>
<td>0.155</td>
</tr>
</tbody>
</table>
Impulse Responses Salmon and Fishmeal

- Salmon -> Fishmeal
- Fishmeal -> Salmon

Impulse Response vs. Months Since Shock
Variance Decomposition

Variance Decomposition of Salmon Price

Variance Decomposition of Fishmeal Price

Months

Salmon Share
Fishmeal Share

Months

Salmon Share
Fishmeal Share
Concluding Remarks

- Salmon price are now more informed by feed-raw material prices and especially fishmeal prices
  - Salmon prices gone from productivity driven to feed-cost driven

- No evidence of price causality from salmon to fishmeal prices
  - The salmon price inherits the trend from the fishmeal prices

- Feed costs are more important than ever, and the status of feed raw material markets are important for variable cost developments