Price Responsiveness of Salmon Supply in the Short and Long Run

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Introduction

• Productivity growth and competitiveness among salmon producers indicates a responsive salmon supply in the long run

• Several studies have documented salmon productivity growth and other aspects of supply

• However, no study have investigated the supply responsiveness to price changes of salmon producers, which is surprising given the cyclical behaviour of salmon supply
  – Steen, Asche and Salvanes (1997)
Introduction

- The industry has experienced prolonged periods of low and high profits, which indicate that salmon supply is not easily adjusted in the short run.

- In this paper we try to shed some light on the cyclical behaviour of the industry by using a translog profit function to estimate short- and long-run supply elasticities for salmon.
Norwegian export price, unit cost and unit margin 1985-2006 (2006=1)

*Estimate
Background

- Although the productivity growth across the industry implies a strong supply response to increased competition, it is unclear how responsive supply is to prices in the short and in the long run

1. Because of the biological production cycle there is a substantial lag before producers are able to respond

2. Regulations on production volumes, inputs, location etc. influence the salmon suppliers ability to respond

3. It takes time to adjust production capacity because of quasi-fixed capital

4. Production risk such as disease outbreaks can misalign demand and supply
1. The biological production process

- Cyclical profitability of the salmon industry has been associated with characteristics of the biological production process

- Salmon production is carried out in two phases;
  - The first is a fresh water phase where the ova are hatched and the smolts reared in tanks or in cages in fresh water lakes. This takes around 11 - 12 months.
  - The second phase involves growing the smolts in cages in sea water until they reach market size, which may take around 10 - 18 months.
2. Regulations affecting salmon supply

- Regulations in Norway
  - Farming concession (license)
    - 12 000 m³
    - maximum biomass of 780 (900) tonnes
  - Location of farm site
  - Cage volume
  - Fish density (from 1991)
    - maximum density of fish is 65kg/m³
  - Feed quota (1995)

- Types of regulations varies, but salmon producers in all countries faces some degree of regulation that affects production possibilities
3. Capital Investments

• Production and marketing of farmed salmon are associated with sunk cost in the form of investment in education and training of personnel, capital equipment, market research and advertisement.

• Since level of investment is chosen conditional on information before production begin, it may later turn out to be suboptimal compared to the realised output level and market prices.
Model

- We estimate a restricted profit function where some quasi-fixed input factors are fixed in the short run


- The profit function is
  - restricted (or partial) because firms are assumed to be in a static equilibrium with respect to a subset consisting of the variable inputs and output
  - static because future levels of quasi-fixed factors are not affected by past departure from long-run equilibrium
Model

• The short-run (restricted) and long-run profit functions describe the technology and costs in the short- and the long-run equilibriums.

• The restricted profit function:
  \[ HR(P; Z) \]
  \( P \): prices (variable inputs and outputs)
  \( Z \): levels of quasi-fixed factors

• The long-run total profit function:
  \[ HT(P, P_Z) = HR(P, Z^*(P, P_Z)) - P'_Z Z^*(P, P_Z) \]
  \( P^*_Z \): shadow prices (equal to the market rental prices \( P_Z \) of the quasi-fixed by the envelope condition)
Short- and long run average cost
Translog restricted profit function

\[
\ln HR = \sum_r A_r D_r + \sum_i A_i \ln P_i + \sum_i \sum_j A_{ij} \ln P_i \ln P_j \\
+ A_z \ln Z + A_{zz} \ln Z^2 + \sum_i A_{iz} \ln P_i \ln Z \\
+ A_T T + A_{TT} T^2 + \sum_i A_{iT} \ln P_i T + A_{zT} \ln Z T
\]

• The conditional revenue cost shares obtained by Hotelling’s lemma are

\[
\frac{\partial \ln HR}{\partial \ln P_i} = \frac{P_y}{HR} = S_i = A_i + \sum_j A_{ij} \ln P_j + A_{iz} \ln Z + A_{iT} T
\]
Long-run elasticities

\begin{align*}
E_{ii} &= \frac{(A_{ii} + S_i^2 - S_i)}{S_i} - \frac{(A_{iz} + S_i S_z)^2}{S_i \left( A_{zz} + S_z^2 - S_z \right)} \\
E_{ij} &= \frac{(A_{ij} + S_i S_j)}{S_i} - \frac{(A_{iz} + S_i S_z)(A_{jz} + S_j S_z)}{S_i \left( A_{zz} + S_z^2 - S_z \right)} \\
E_{zz} &= \frac{S_z}{A_{zz} + S_z^2 - S_z} \\
E_{iz} &= \frac{S_z (A_{iz} + S_i S_z)}{S_i \left( A_{zz} + S_z^2 - S_z \right)} \\
E_{zi} &= \frac{(A_{iz} + S_i S_z)}{(A_{zz} + S_z^2 - S_z)}
\end{align*}
Data

• Annual data from 1985-2004
• Source: Norwegian Directorate of Fisheries
• Firm level data on
  – Revenue
  – Costs
  – Output
  – Input
  – Region
Empirical results

### Short-run elasticities

<table>
<thead>
<tr>
<th></th>
<th>Output</th>
<th>Feed</th>
<th>Labour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output</td>
<td>0.0484</td>
<td>-0.048</td>
<td>-0.001</td>
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<tr>
<td>Feed</td>
<td>0.516</td>
<td>-0.487</td>
<td>-0.029</td>
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<tr>
<td>Labour</td>
<td>1.618</td>
<td>-0.672</td>
<td>-0.946</td>
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</table>

### Long-run elasticities

<table>
<thead>
<tr>
<th></th>
<th>Output</th>
<th>Feed</th>
<th>Labour</th>
<th>Capital</th>
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<tbody>
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<td>1.415</td>
<td>-0.767</td>
<td>-0.080</td>
<td>-0.568</td>
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<td>Feed</td>
<td>1.827</td>
<td>-1.191</td>
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<td>-0.538</td>
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<tr>
<td>Labour</td>
<td>2.943</td>
<td>-1.378</td>
<td>-1.024</td>
<td>-0.541</td>
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<tr>
<td>Capital</td>
<td>5.810</td>
<td>-1.575</td>
<td>-1.201</td>
<td>3.034</td>
</tr>
</tbody>
</table>
Concluding remarks

• Salmon producers have limited possibilities to respond to price changes in the short run
  – Changing feed volume or formulations may give some room for adjustments in production

• In the long run the industry is price responsive

• The combination of high responsiveness in the long run and limited responsiveness in the short run is most likely the chief reason for the pronounced cycles in the industry

• As long as the industry remain competitive with many producers the cycles will most likely remain