

The bigger, the better? Spatial externalities, economies of scale, and consolidation in the Norwegian fish farming industry

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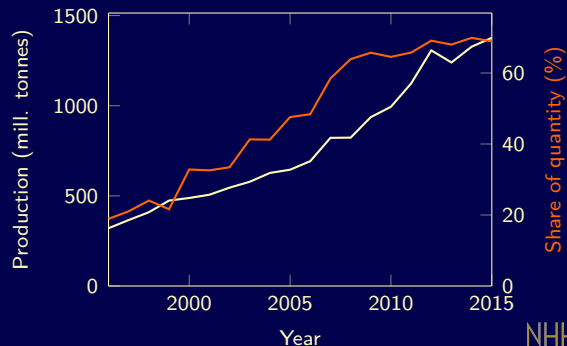
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Motivation

Part 1: Industry consolidation

- Extensive **consolidation** in the salmon farming industry since the deregulation in 1991
 - From over 800 owner-operated firms in 1991 to about 150 today
 - Production share of top 10 firms up from 18.9% in 1996 to 65.7% in 2012
- **Slowdown** since 2009
 - Production share of top 10 firms levelled off ($\approx 69\%$ since 2012)
 - Current value per license said to be NOK 50-100 mill., but few/no trades in past two year



Source: Norwegian Directorate of Fisheries

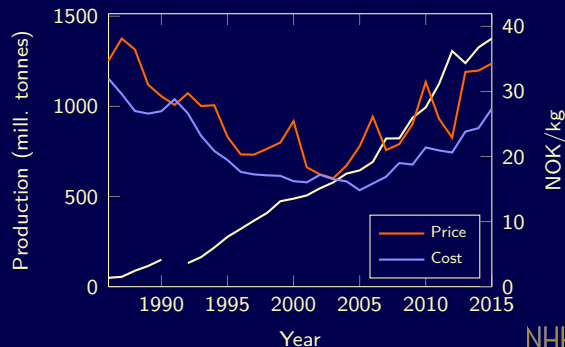
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Motivation

Part 2: Increasing production costs, lice and diseases

- Soaring costs since 2005
 - Partly due to costs of lice treatments
 - Firms currently report an additional cost of NOK 6 per kg salmon produced due to lice
 - Currently high prices and solid margins despite cost hike
- ⇒ Is it only the lice or have firms grown too large too fast (diseconomies of scale)?



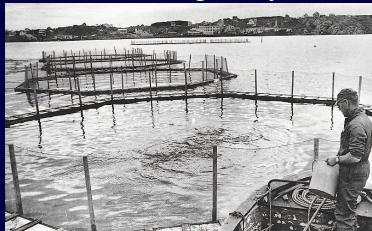
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How firm size matters

Salmon farming, early 1970s



Salmon farming today



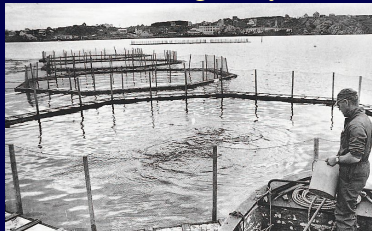
- ① **Returns to scale** (RTS), as looked at in previous work (e.g. Salvanes et al)
 - Increasing RTS from specialization, purchasing power, and capital/factor indivisibilities
 - ② **Spatial externalities**, higher concentration allows for coordination of parasite and disease management
 - Disease and parasite problems increasingly costly
 - Spatial prevention and production externality
- ⇒ Can **internalize** externality through consolidation – buy the neighbors

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Salmon farming tomorrow?



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Research question

Have consolidation in the Norwegian salmon farming industry gone too far?

- ① Can increasing **returns to scale** explain the consolidation?
- ② Can the spatial disease and parasite externality explain the consolidation?

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What this paper (currently) does:

- Theoretical predictions from a disease/parasite treatment game, to be **tested**
- Empirical analysis of RTS from 2001 – 2014

Theoretical model

- Consider a fjord with N salmon farming **firms**
 - All produce according to licensed capacity
 - All face the same salmon **lice** population
- Lice lowers value of firm's production, convex damages
- **Game** where firms decide on costly **delousing** efforts (public good)

Theoretical results

- Firms' delousing efforts are **strategic substitutes**
- The more firms ($N \uparrow$), the less each firm will delouse
- With one big firm, $N - 1$ small firms:
 - Big firm will do more, small firms less than if all are identical
 - Consolidation increases aggregate delousing efforts

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- ⇒ **Consolidation** increases total value of production
- ⇒ Incentives to consolidate in areas where the firm already produces

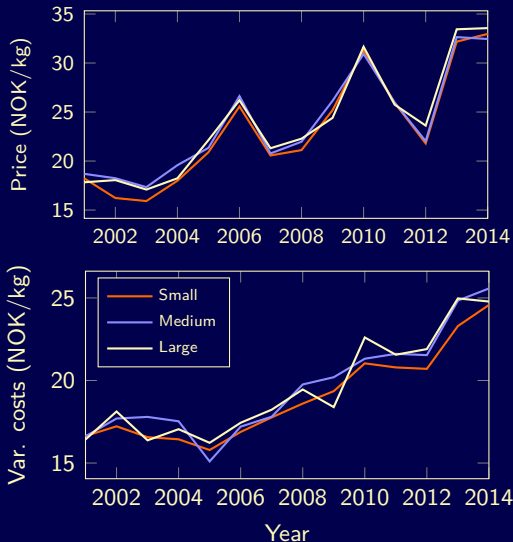
Data

- Annual **production and profitability** data from Dir. of Fisheries (2001-14)
 - Approx. 70% of licences (and production)
- Monthly/weekly farm-level **lice count and treatment** data from Food Safety Authority (2009/2012-)
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Average **price** and **variable cost** by size of firm/owner →

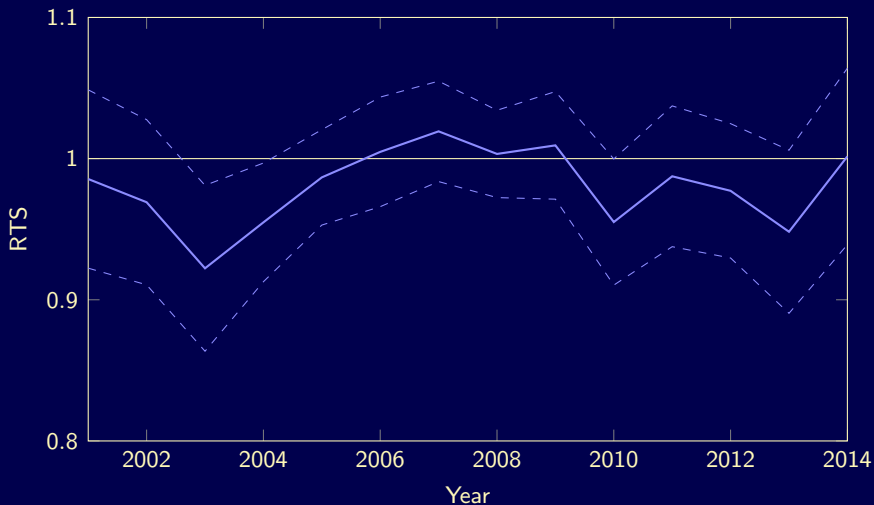
Data



Analysis: Returns to scale

- Significant RTS found in studies focusing on the 1980-90s (Salvanes 1989, Bjørndal & Salvanes 1995)
- Estimate the long-run cost function using a translog as specified by Salvanes (1989)
 - Three inputs: fish feed, labor, capital
 - Estimate cost function and cost share equations simultaneously (SURE)
 - R-sq around 90% for all equations
- Can calculate RTS based on cost function estimates

Estimation results: RTS over time for the average firm



Returns to scale

Results

- No longer significant economies of scale in the industry
- Industry average RTS not significantly higher than one for any year since 2001
- At the firm level results suggest:
 - Some firms have become too large
 - Still economies of scale present at other firms

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Results

- No longer significant economies of scale in the industry
- Industry average RTS not significantly higher than one for any year since 2001
- At the firm level results suggest:
 - Some firms have become too large
 - Still economies of scale present at other firms
- Considerable consolidation between 2001 and 2014
 - The relatively constant RTS over the same period
 - The 'ideal' firm size have increased over time due to innovation, regulations, etc.

Are large firms doing more to fight lice?

'Other operating costs' per kg



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Concluding remarks

- Economies of scale exhausted years ago, especially for large firms
 - Some consolidation justified by innovation, regulations, etc.
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 - Value of a salmon farming license higher with optimal disease and parasite effort
 - Externality problem causes too little effort by individual firms
 - Consolidation gives more coordination and increases value per license

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 - Some consolidation justified by innovation, regulations, etc.
- Consolidation continued, mainly driven by larger firms buying smaller ones
- **Spatial externalities** related to diseases and parasites can justify this
 - Value of a salmon farming license higher with optimal disease and parasite effort
 - Externality problem causes too little effort by individual firms
 - Consolidation gives more coordination and increases value per license
- Ownership limitations: No firm could own more than 25% of aggregate licensed capacity, or 50% of licensed capacity within each of five regions (until 2015)



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Salmon farming in the Faroe Islands

Three companies, one fjord each (almost)

