Is size-dependent pricing prevalent in fisheries?

The case of Norwegian demersal and pelagic fisheries

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Size structure in fish stocks

- Fish stock are no homogeneous biomass but contain individuals with different characteristics and traits
- Individual size is a major trait and intertwined with growth, maturation, reproductive output, survival, etc.
- Size structure is relevant for:
  - population dynamics
  - recruitment potential
  - population stability
  - natural mortality

  ..and therefore for resource economics!

The fish market

However, there is also a direct connection between size and economic value..

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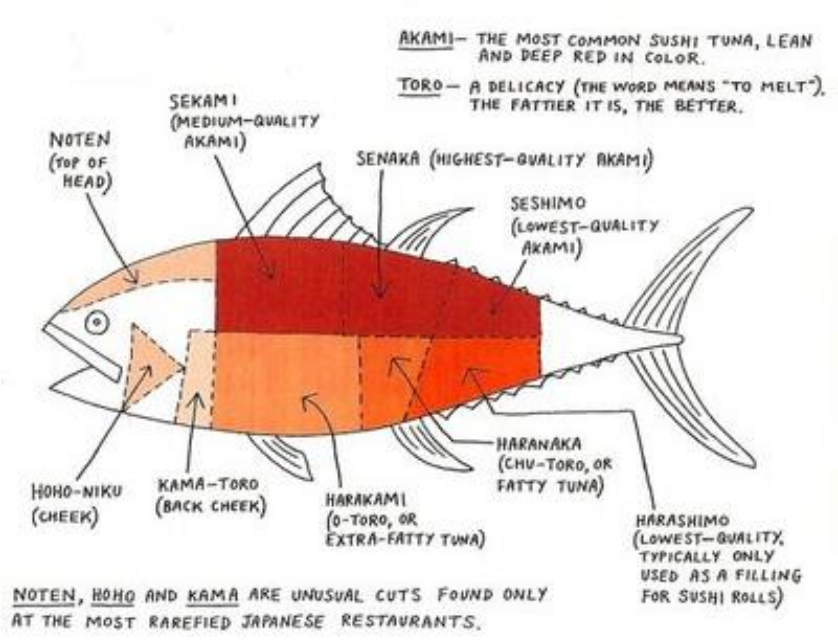
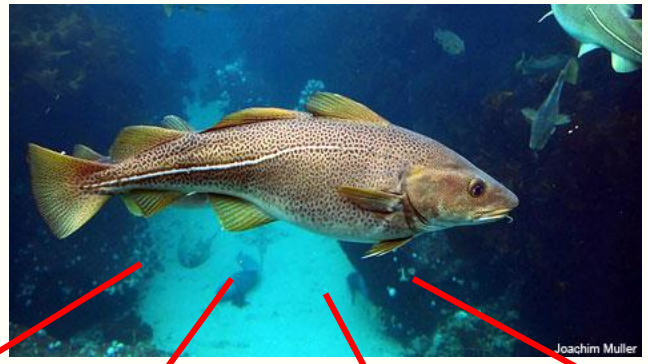
Fish attributes and price



Product state and price



Origin/fishery

End market


keep cool
Roland
WILD CAUGHT
FLAT FILLETS OF ANCHOVIES
IN OLIVE OIL, SALT ADDED
NET WT. 2 OZ. (56g)


SOUTH
EAN FISHMEAL
COMPAÑIA PESQUERA
CAMANCHACA S.A.
CORONEL-CHILE
REGISTRY Nº08351
50 KILOS BTO./NTO
NO APTO PARA CONSUMO HUMANO
NOT FOR HUMAN CONSUMPTION
100% STEAM DRIED FISHMEAL

Fish and their price

- Fish of the same species can have different prices (per kg)
- Various reasons:
  - Consumer preference
    - Fish attributes (flesh quality, fat content, fillet size, etc.)
    - State of the product (e.g. value added through processing)
    - Origin
  - End market (e.g. human consumption vs. fish meal)
  - Scarcity of particular fish in catch

➢ Almost all attributes are directly or indirectly linked with size

➢ Size-price relationships are common in fisheries

Size-dependent pricing

- Economic value of fish size is widespread
- Often considered as general knowledge
  - Size-dependent pricing has been acknowledged in the literature for a long time (e.g. Gulland 1982)
  - However: Few facts beyond anectodal evidence

Plate-sized fish

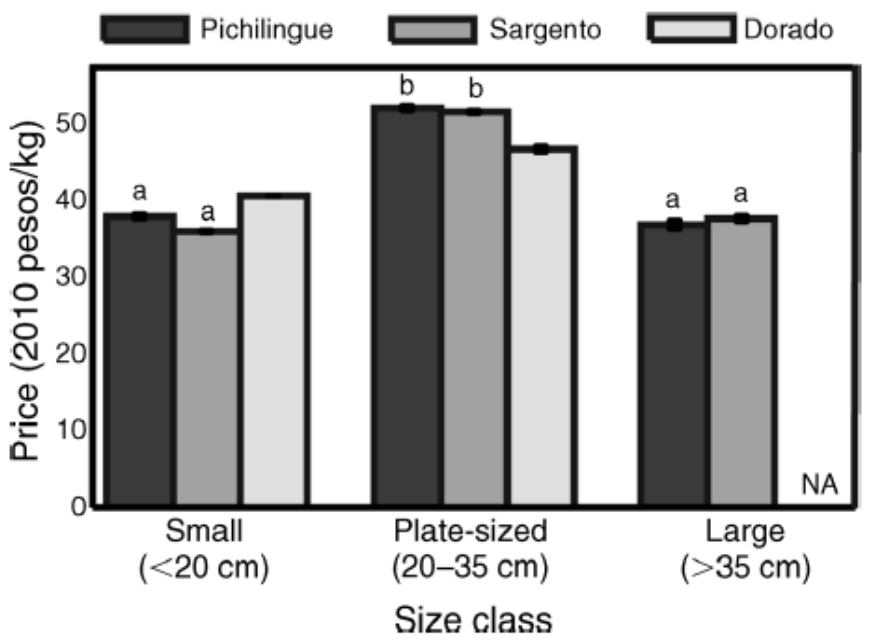


FIG. 3. The mean price of *Lutjanus peru* by size class and fishing cooperative. Pichilingue, Sargento, and Dorado are located at increasing distances away from the markets of La Paz.

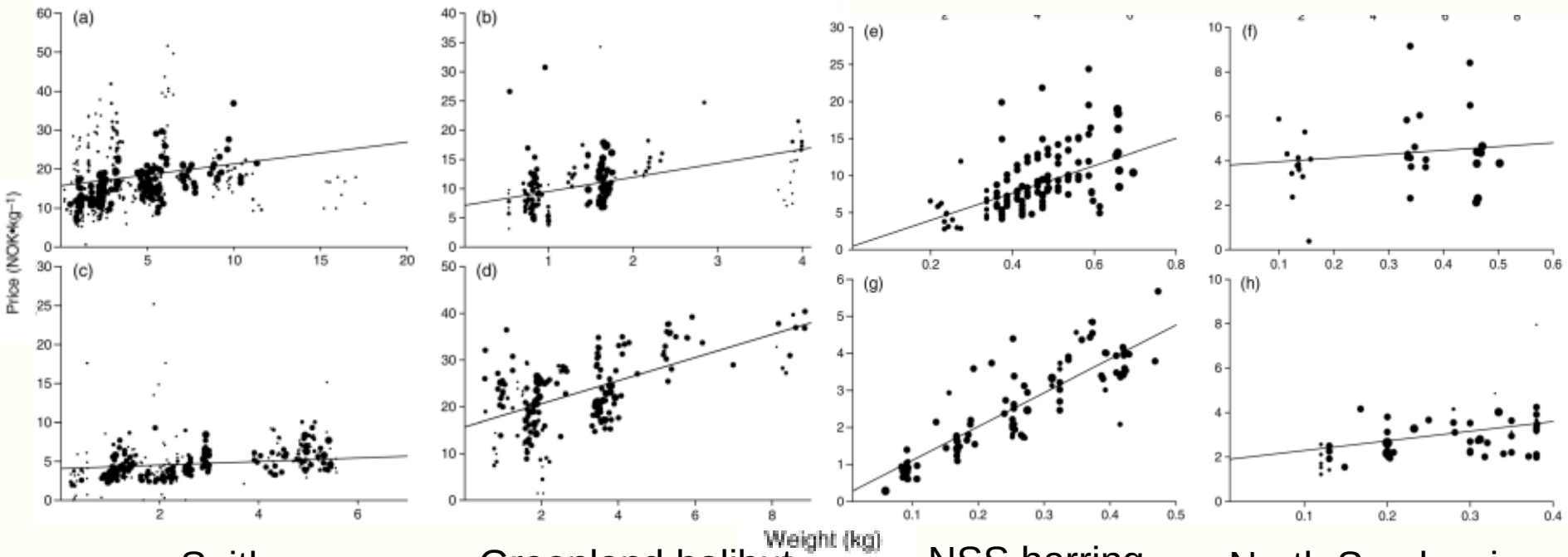
Reddy et al. 2013

Price data of Norwegian fisheries

- What is the relationship between fish size and price in Norway?
- Analysis of price data from eight Norwegian fisheries
  - Atlantic cod, Atlantic mackerel, Greenland halibut, haddock, horse mackerel, North Sea and Norwegian spring spawning herring, saithe
- Aggregated price data from 2000-2010 as registered by Norwegian sales organizations
  - Value and total yield per weight class
  - Assumed distribution of weight-at-age and catch-at-age as in ICES stock assessment
    - Mean weight per weight class
    - Average price for mean weight per weight class
    - Analysis with weight class as fixed and year as random effect

Price data of Norwegian fisheries

Atlantic cod | Haddock | Atlantic mackerel | Horse mackerel

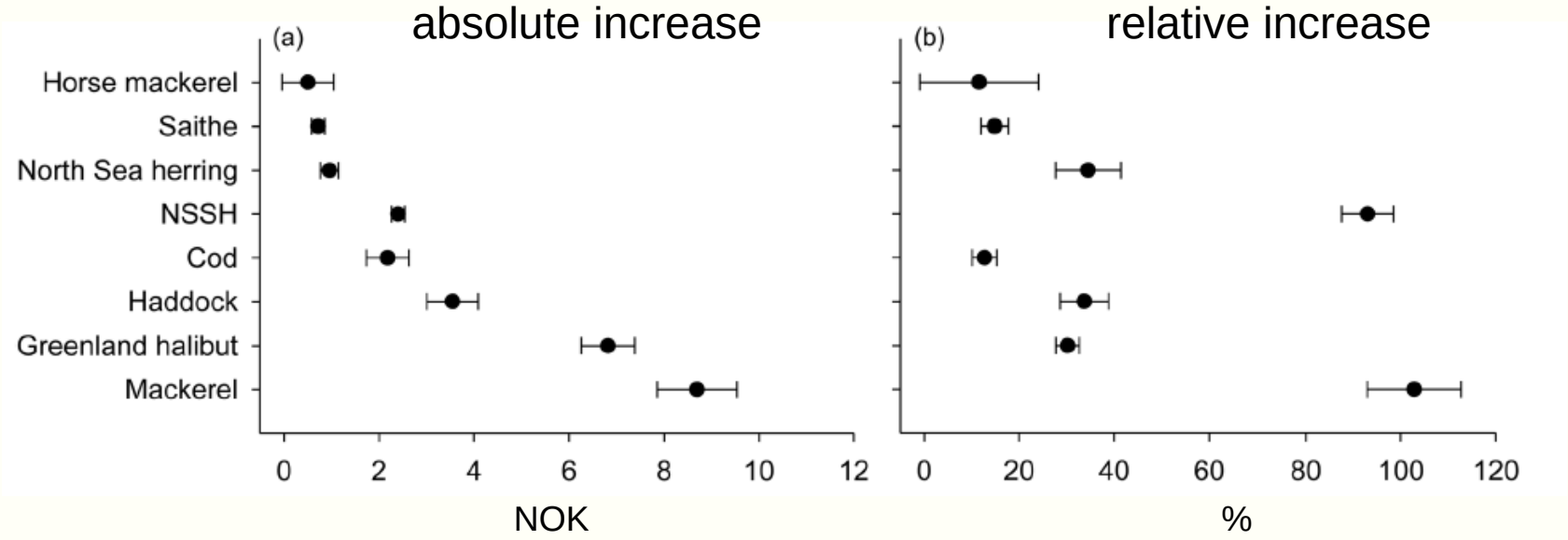


Saithe | Greenland halibut | NSS herring | North Sea herring

Zimmermann & Heino (2013)

Price data of Norwegian fisheries

Standardized by mean catch weight:



Zimmermann & Heino (2013)

Price data of Norwegian fisheries

Patterns over time

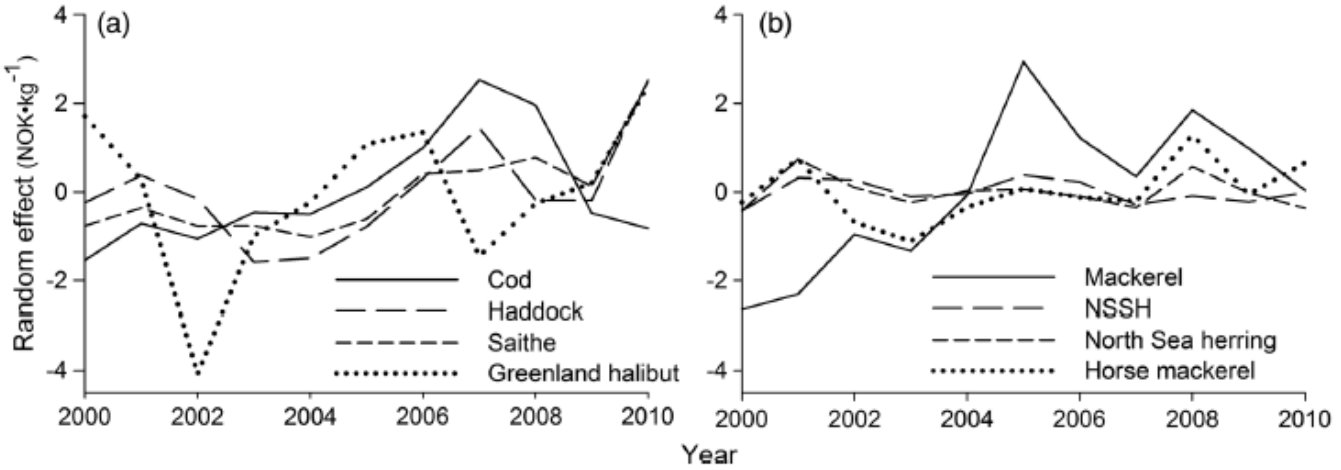


Figure 3. Temporal patterns in price as illustrated by linear mixed models regressing price against weight, with "year" as a random intercept and weighted by log-transformed total yield. For clarity, demersal (**a**) and pelagic stocks (**b**) are illustrated separately. In all cases the random effects are significant ($p<0.05$).

Table 2. The correlations (white) and correlations of detrended (i.e. after removing linear time trend; grey) time-series of yearly anomalies in price for all stocks.

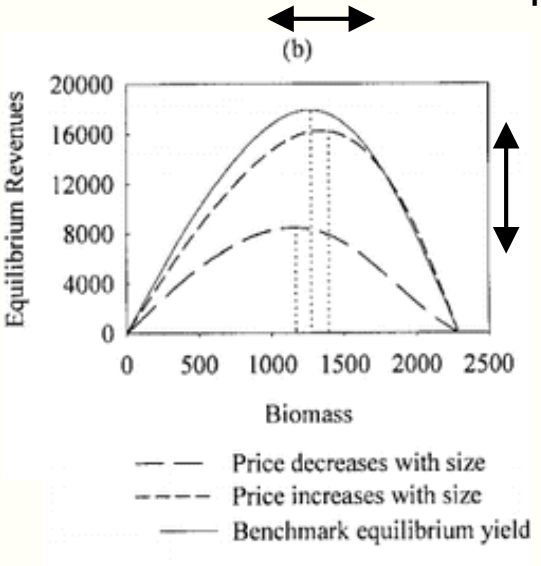
	Atlantic cod	Haddock	Saithe	Greenland halibut	Atlantic mackerel	NSS herring	North Sea herring	Horse mackerel
Atlantic cod	1.000	0.213	0.308	−0.120	0.581*	−0.093	0.119	0.299
Haddock	−0.037	1.000	0.844**	0.272	0.013	−0.065	−0.204	0.464
Saithe	−0.149	0.854**	1.000	0.423	0.294	−0.103	−0.152	0.585*
Greenland halibut	−0.295	0.172	0.367	1.000	0.138	−0.116	−0.195	0.435
Atlantic mackerel	0.382	−0.520	−0.569*	−0.060	1.000	0.256	0.094	0.293
NSS herring	−0.024	0.007	0.019	−0.082	0.502	1.000	0.539*	0.133
North Sea herring	0.215	−0.160	−0.075	−0.167	0.264	0.530*	1.000	0.563*
Horse mackerel	0.122	0.331	0.466	0.373	0.013	0.214	0.684**	1.000

Significant correlations ($p<0.05$) are indicated with two asterisks, and marginally significant correlations ($0.05 \leq p<0.10$) with one asterisk.

Implications of size-dependent pricing

How does size-dependent pricing influence economic yield and optimal harvest?

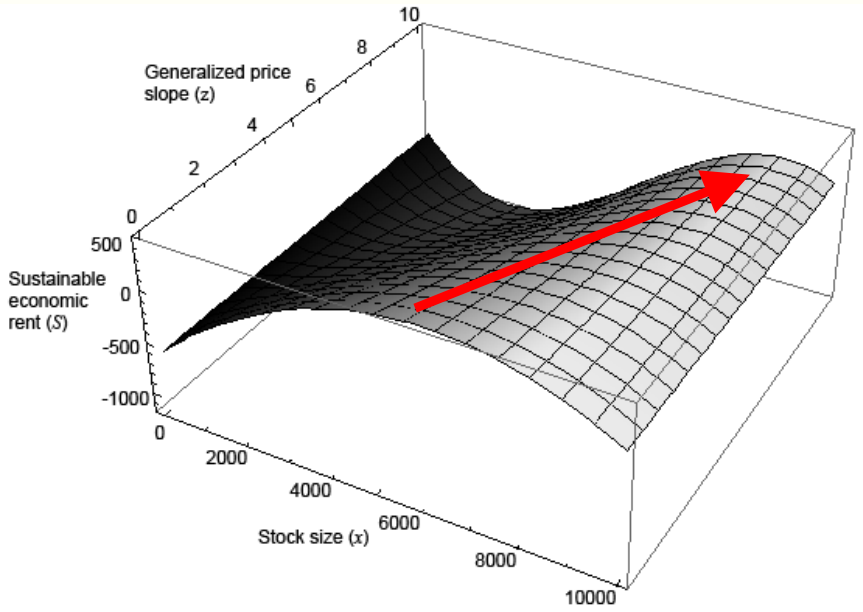
Shift in biomass that produces MEY



Shift in equilibrium revenue

Tahvonen (2009)

Maximum sustainable economic rent shifts towards higher stock sizes



Zimmermann, Steinshamn & Heino (2011)

Conclusions

- Size-dependent pricing is prevalent in most fisheries
- However: Correlation is not causality
  - Demand and supply determines prices dynamically
  - Market value of size is linked with other quality attributes
  - Size may be a proxy than the cause itself
  - Further, more detailed analysis will reveal influence of other variables and temporal dynamics

Conclusions

- Influences optimal harvest strategies
  - Fishermen know price structures and try to utilize them
  - Ignoring size-dependent pricing may create unwanted incentives and undermine management policies
- To find the true efficient solutions the biological and economic relevance of size should be considered
  - Management strategies should account for value of size
  - Size-dependent pricing can create unwanted incentives (e.g. high-grading)
  - Size-dependent pricing may enhance long-term costs of decreasing catch sizes