

# *Reduced footprint by processing salmon?*

*- Economic and environmental effects of sub-chilling, freezing and filleting*



**WORKSHOP ON NORDIC SALMON PROCESSING, 19/10 2022**

Audun Iversen, Nofima  
Friederike Ziegler, RISE  
Bjørn Tore Rotabakk, Nofima



# Sub-chilled salmon?

Economic and environmental effects

- Eliminates the need for ice in the boxes
- Makes room for more salmon in each box
- Reduce transportation
- Save on packaging
- Improves traffic safety and the industry's reputation.
- Fewer trailer loads of salmon on the roads.
- Also fewer trailers with boxes for the slaughterhouse
- Provides longer shelf-life and better quality
  
- We have focused on supercooling in RSW

## Some limiting factors

1. More rigid fish – might be harder to fit into boxes?
2. Larger risk of spoilage if cooling chain is broken
3. Consumer acceptance?

# FHF-project: effects of sub-chilling or freezing of salmon



Report 44/2020 • Published November 2020

## Climate impact, economy and technology of farmed Atlantic salmon

Documentation of the current state for fresh and frozen products exported to Asia and fresh products to Europe

Bjørn Tore Rotabakk (Nofima), Kristina Bergman & Friederike Ziegler (RISE), Torstein Skåra & Audun Iversen (Nofima)



Rapport [xx/2022](#) • Utgitt [oktober 2022](#)

## Økonomiske og miljømessige effekter superkjøling av laks

Audun Iversen (Nofima), Friederike Ziegler (RISE) og Bjørn Tore Rotabakk (Nofima)



Rapport 33/2021 • Utgitt oktober 2021

## Tining av fryst laks

Effekt av fryselagringstid og tineregime

Bjørn Tore Rotabakk, Lars Helge Stien og Torstein Skåra



Rapport 14/2021 • Utgitt april 2021

## Konserveringsmetoder for sjømat

Muligheter for forlenget holdbarhet til laks

Bjørn Tore Rotabakk (Nofima) og Jørgen Lerfall (NTNU)



# Air freight to Asia

...and truck to Europe

- Norway exports more than 1,4 million tonnes of salmon
- Air-freight: around 200.000 tonnes a year from Norway
- Air-freight emits about 800.000 tonnes in CO<sub>2</sub>-equivalents
  - About the same as all norwegian inland air traffic

Table 2 Total air freight of salmon from Norway in 2019, with estimates of emission of CO<sub>2eq</sub>.

	Tonnes	Assumed landing town	Distance (from Gardermoen)	Tonn* kilometers	Emission of CO2 (tonnes)
USA	35,444	New York	5,862	207,773,877	114,276
Japan	31,472	Tokyo	8,306	261,407,429	143,774
South-Korea	26,199	Seoul	7,591	198,877,968	109,383
China	23,331	Beijing	6,906	161,125,316	88,619
Hongkong	13,758		8,508	117,052,996	64,379
Thailand	13,756	Bangkok	8,670	119,261,173	65,594
Taiwan	10,771		8,685	93,548,419	51,452
Israel	8,369		3,635	30,422,994	16,733
Singapore	7,905		10,037	79,337,798	43,636
United Arab Emirates	6,754	Dubai	5,145	34,751,347	19,113
Vietnam	4,473	Ho Chi Minh	9,267	41,454,210	22,800
Saudi-Arabia	3,909	Riyadh	4,877	19,063,271	10,485
South-Africa	2,860	Cape Town	10,622	30,374,353	16,706
Canada	1,589	Toronto	5,863	9,315,633	5,124
Morocco	1,472	Agadir	3,748	5,517,742	3,035
Malaysia	1,274	Kuala Lumpur	9,739	12,410,252	6,826
Qatar	1,180		5,038	5,947,062	3,271
Indonesia	1,125	Jakarta	10,925	12,289,926	6,759
Lebanon	942	Beirut	3,532	3,325,961	1,829
Quwait	879		4,884	4,295,248	2,362
Bahrain	518		4,913	2,545,484	1,400
Others (average)	1,969		6,988	2,217,207	1,219
Sum				1,452,315,665	798,774

These calculations must be considered estimates, as they are based on some simplifying assumptions, such as an assumed average for CO<sub>2</sub>-emissions, all airfreight leaving from Gardermoen and a single stretch to the destination. In reality, this is much more complex, which is one reason we are limiting the supply chains we study in this report.

# The climate effects of filleting

- Calculating carbon footprint through LCA
- From the first report (2020)

1. Transporting fillet instead of head-on gutted
  - not so visible in this figure, as transportation to Europe is only 5 % of total emissions
2. Important (but hard to estimate) effect from improved rest-raw material use
  - Depends on how much rest raw material is used in markets today

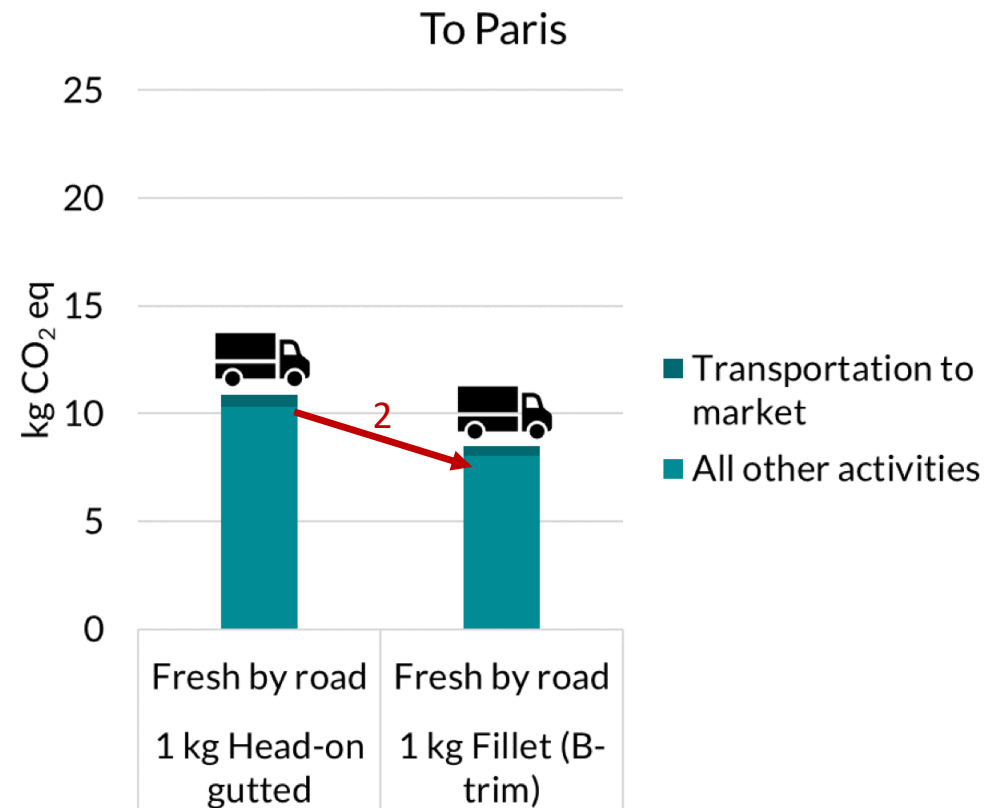
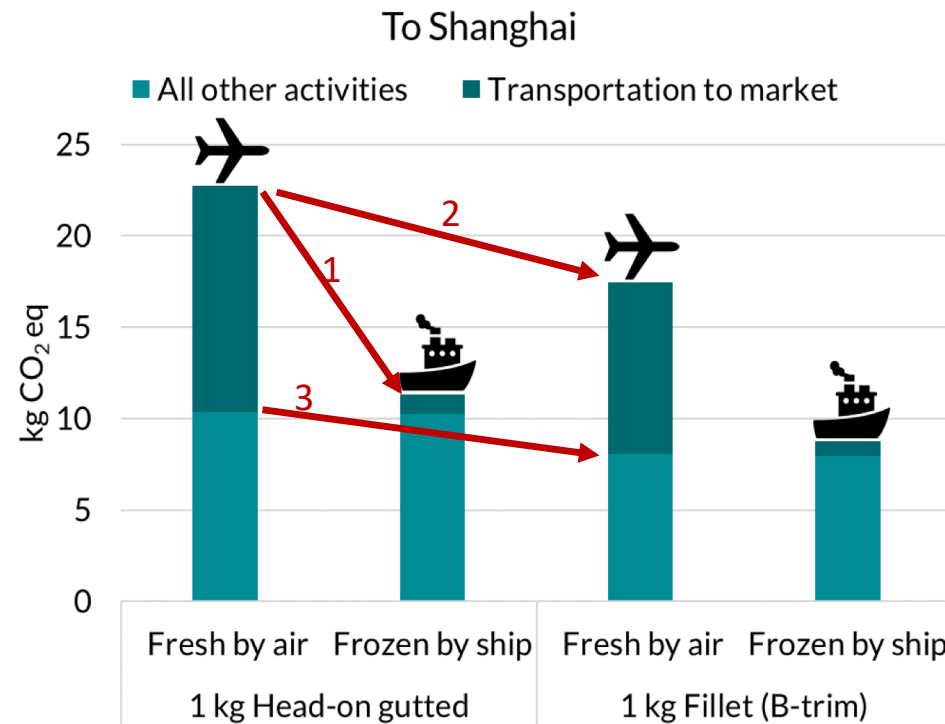


Figure 4 Climate impact of two types of salmon products transported from Norway to Paris by truck.

# Asia: huge effects from freezing and filleting

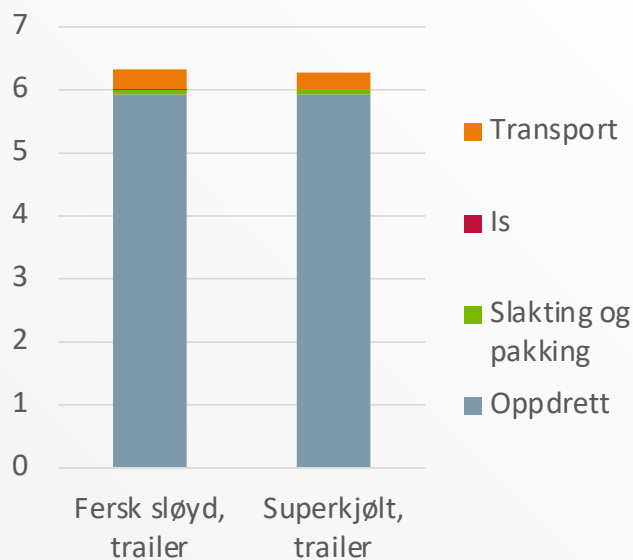
1. Frozen instead of fresh
2. Transporting fillet instead of head-on gutted
3. And some effect from rest-raw material use



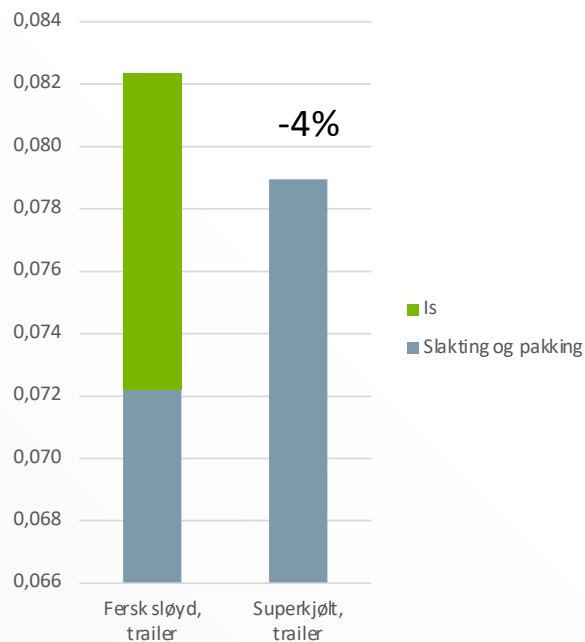
**Figure 3** Climate impact of four types of salmon products transported from Norway to Shanghai by two different transportation modes assuming no use of by-products after export. Non-transport activities have slightly lower emissions for fillet than whole because by-product use before export is more extensive than after, and by-products account for a part of upstream emissions when further utilized.

# Sub-chilling case 1: Europe (Paris by truck)

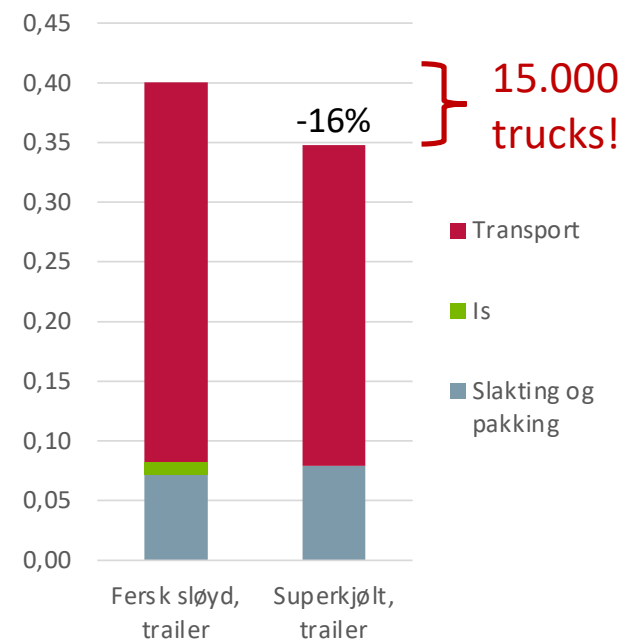
## Total emissions



## Slaughter and packaging

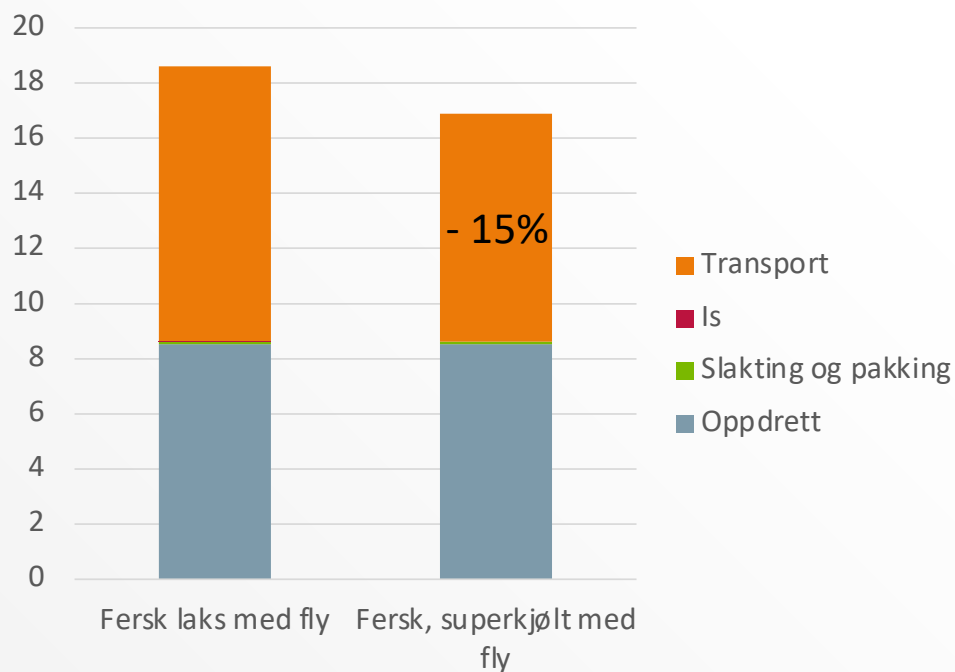


## Slaughter, packaging and transportation

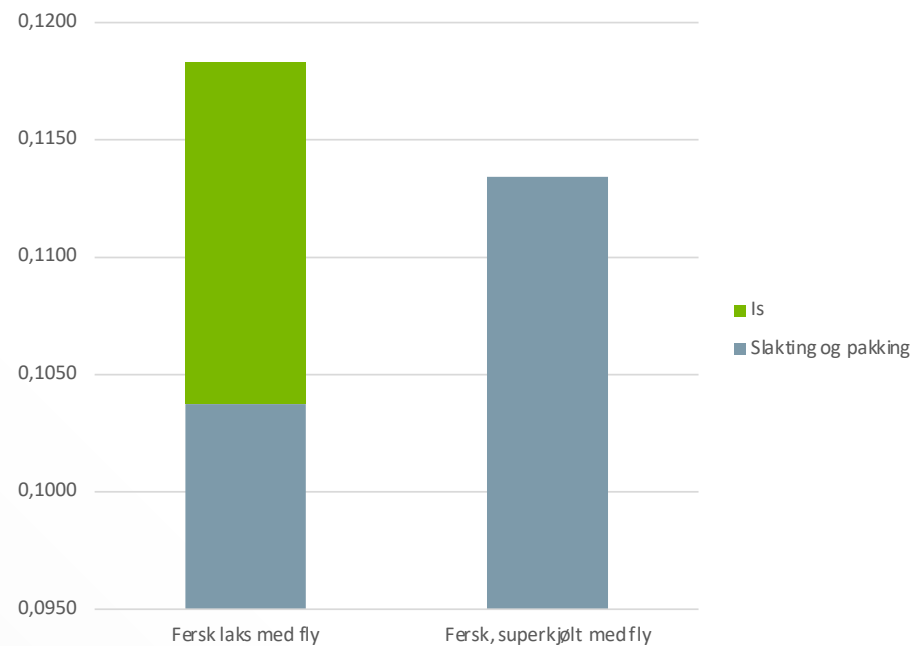


## Sub-chilling case 2: Asia (Shanghai by plane)

### Total emissions



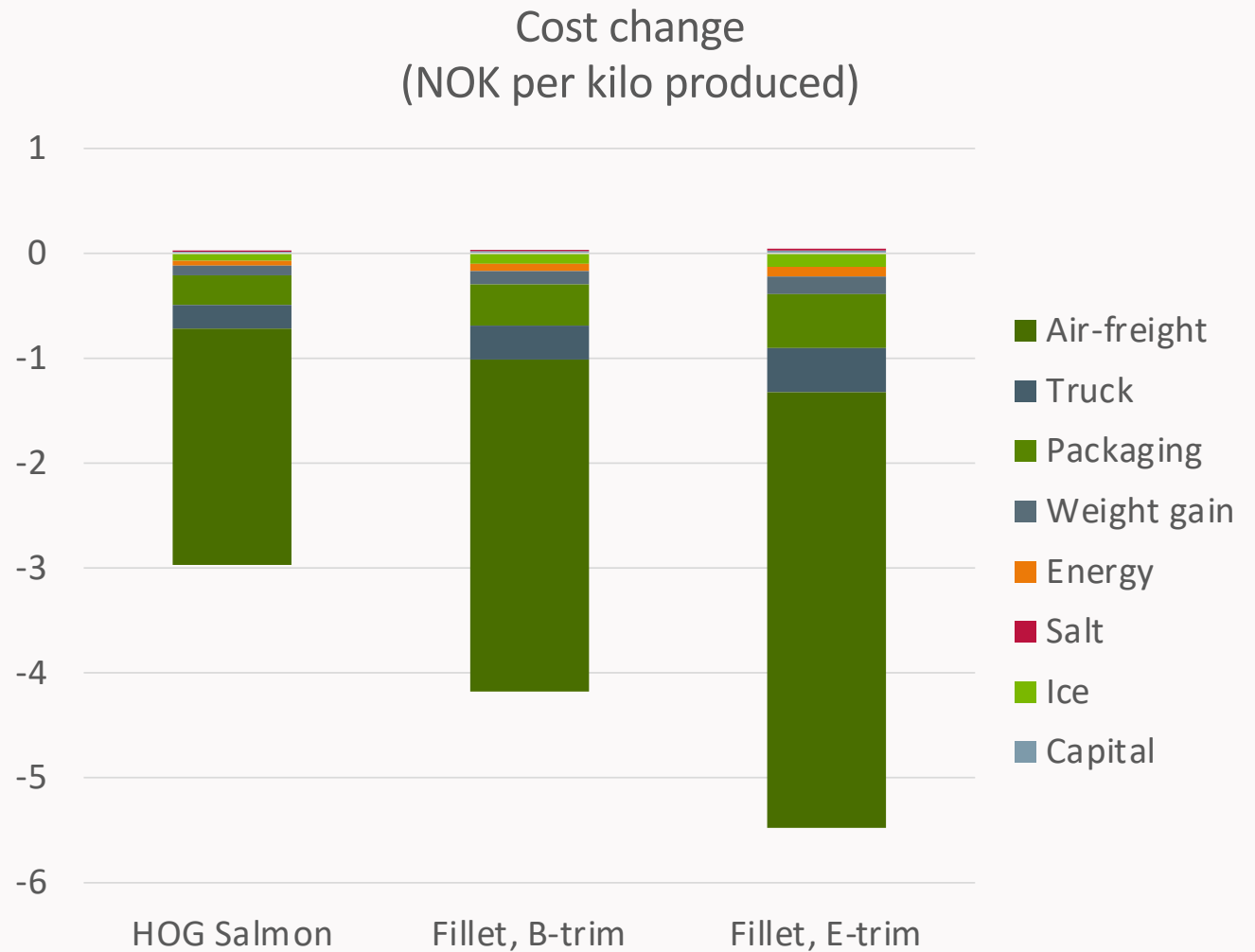
### Slaughter and packaging





# Economics of superchilling

- Investment costs have negligible effects
- The same with salt
- Saved electricity is also moderate (but uncertain)
- Saved ice cost is moderate
- Weight gain increase value
- Huge effects in
  - Packaging
  - Transportation (and in particular air-freight)





# Consumers attitudes towards thawed salmon



## Data and methods

- Data collected through a survey in Japan and the United States,
- Sensory blind testing of fresh and thawed salmon in Norway
- Segmentation analysis: who may buy thawed salmon?
- Further investigations to
  - confirm willingness to pay and the
  - results from blind tests of fresh and thawed salmon are recommended.

## Results

Consumers from the USA and Japan had different associations and attitudes towards fresh and thawed salmon.

- Attempts to influence attitudes towards thawed salmon with information about carbon footprints had no great effect.

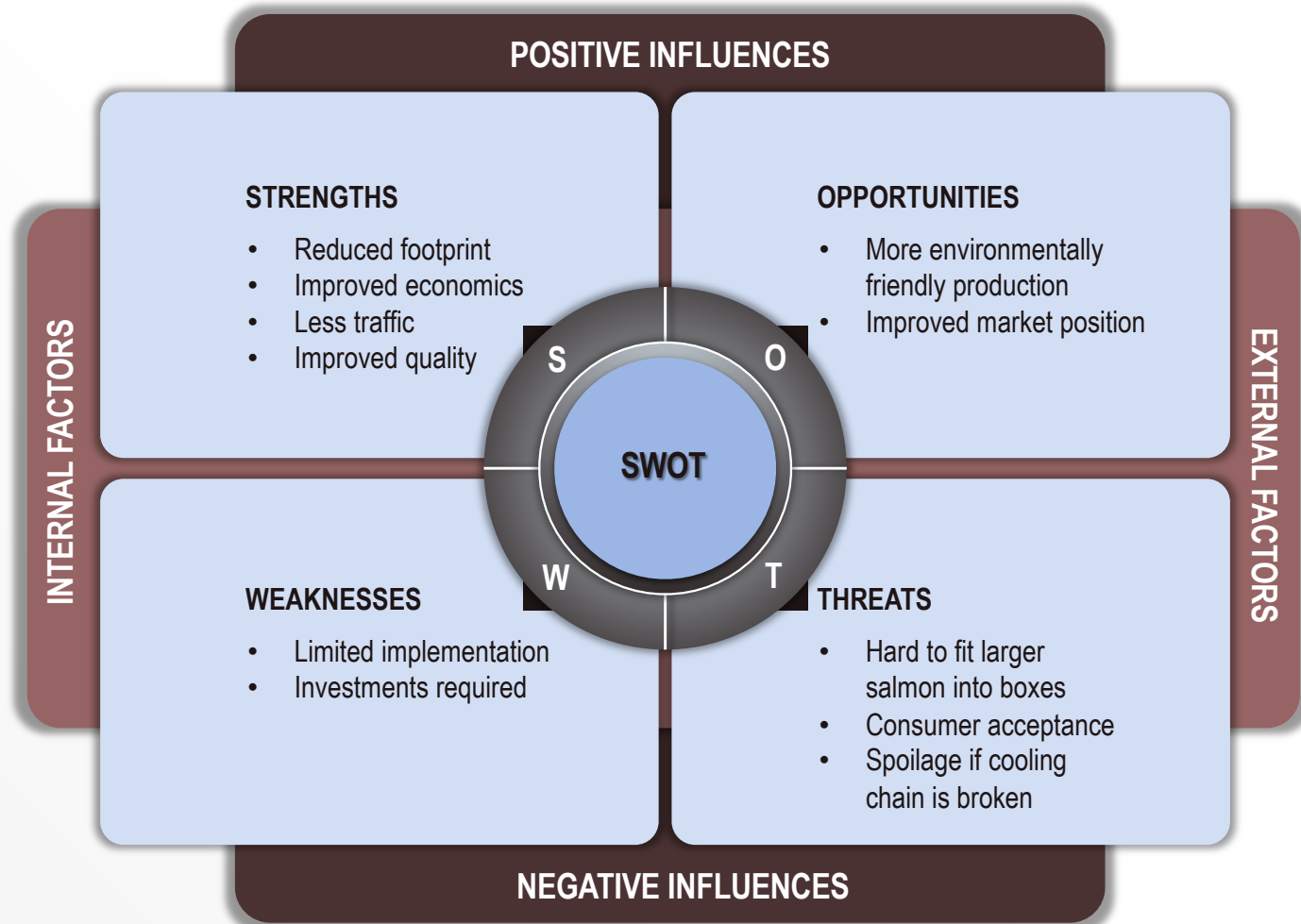
Thawed products must be at least as good quality as fresh

Blind test showed that consumers did not perceive sensory differences between fresh and thawed salmon (cooked or raw).

Willingness to pay for thawed salmon was 30% lower in both markets.

there is a group of environmentally conscious consumers in both markets who wanted salmon with a low carbon footprint.


Could be interesting as a target group for thawed salmon.



# Take-home messages


- Less energy use for chilling and transportation:
  - may reduce greenhouse gas emissions related to slaughtering/packaging and transport by 15-20%
- Lower cost for transport and packaging
  - - 0,60 NOK per kilo (trailer to Europe)
  - Sub-chilling for the entire industry: around 860 million saved on trailer transport.
  - For air transport: around 2.50 per kilo, around half a billion for the entire industry.
- Improves traffic safety and the industry's reputation
  - 15,000 fewer trailer loads of salmon on the roads. Also fewer trailers with boxes for the slaughterhouse
  - Processing in Norway may lead to in even less transport and better utilization of the rest raw material
  - Large reduction in climate emissions
- Even greater reductions than with sub-chilling can be achieved by freezing
  - Sub-chilling yields a better product: improved quality and shelf life



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Audun Iversen  
**Forsker**

 [Audun.iversen@nofima.no](mailto:Audun.iversen@nofima.no)

 [www.nofima.no](http://www.nofima.no)

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