IMPACT OF CO2 EMISSION TAXATION AND FUELS TYPE ON ARCTIC SHIPPING

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TALLINN TECHNOLOGY – MAY 2025

2 WHO AM I?

- Olivier Faury
- 15 years of practionner experience (France and Morocco)
- Masters in Transport Logistic and International Trade (2011) – Kedge BS
- Ph.D – Attractiveness of the NSR (2016) – Kedge BS
- Associate professor at EM Normandie since Sept 2016

3 TODAY'S WORSHOP

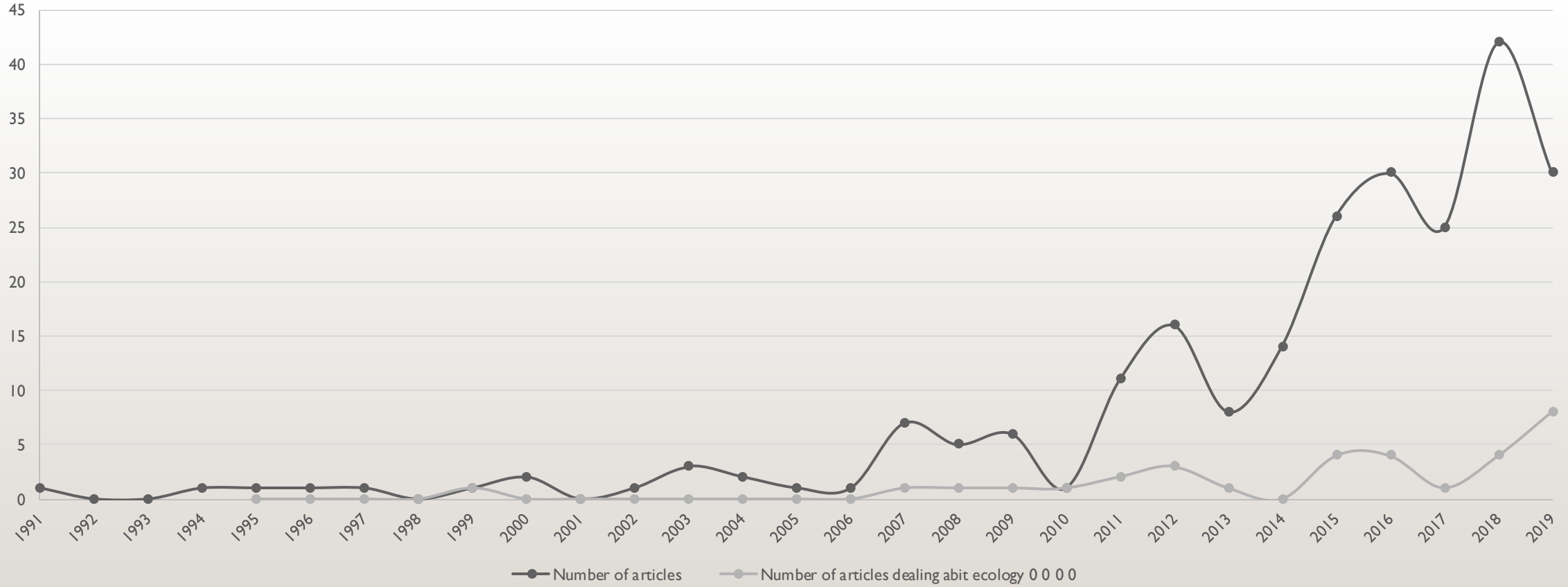
Presentation of my research

Group work

4 AIM OF THE WORKSHOP

- Work in groups in order to:
  - Define a topic that you could tackle
  - Define a journal you could target
  - What kind of data would you need and is it easy access ?
  - What would be your contribution?
  - What would be your main research question?
  - What would be the managerial implication of your research?

5 EVOLUTION OF PUBLICATION DEALING WITH ARCTIC AND SUSTAINABILITY



6 SOME BASICS

- To maintain the global climate heat below +2°C, 85% of the GHG emitted in 2010 have to be reduced by 2100 (Bouman et al, 2017)
- The use of HFO is banned fom the Arctic
- Size of vessel dedicated to Arctic navigation is different from vessels sailing on SCR.
- The Arctic is not a ECA area
- No transshipment within the NSR (containers)
- Changing transit time

7 EXISTING MEASURES TO MITIGATE CO_2 EMISSIONS

Hull design
Economy of scale
Power and propulsion (including energy saving devices)
Speed*
Fuels and alternative energy sources*
Weather routing and scheduling*

Source : Bouman et al (2017)

8 TYPOLOGY OF VESSELS WITHIN ARCTIC OCEAN

Classification	*Description*	*Examples of Ship Types*
Government vessels and icebreakers	• Designed to move and navigate in ice-covered waters • Must have a strengthened hull, an ice-clearing shape, and the power to push through ice	• Coastguard • Icebreakers (private, research, government)
Container ships	• Cargo ships that carry their load in truck-size containers	• Cargo transport
General cargo	• Carry various types and forms of cargo	• Community resupply • Roll-on/roll-off cargo
Bulk carriers	• Bulk carriage of ore (can carry either oil or loose or dry cargo, but not simultaneously)	• Timber • Oil, ore • Automobile carriers
Tanker ships	• Bulk carriage of liquids or compressed gas	• Oil, natural gas, chemical tankers
Passenger ships	• Carry passengers for remuneration	• Cruise ships • Ocean liners • Ferries
Pleasure craft	• Recreational vessels that do not carry passengers for remuneration	• Motor yachts • Sail boats • Row boats
Tugs/Barges	• Tug: Designed for towing or pushing and general work duties • Barge: Non-propelled vessel for carriage of bulk or mixed cargo	• Resupply vessels • Bulk cargo transport
Fishing vessels	• Fishing boats used in commercial fishing activities • Generally small vessels, between 30 and 100 m	• Small fishing boats • Trawlers • Whaling boats • Fish-processing boats
Oil- and gas-exploration vessels	• Designed specifically for the exploration and extraction of natural gas and oil	• Seismic, oceanic, and hydrographic survey vessels • Oil drilling/storage vessels • Offshore resupply

Source : Huntington et al (2023)

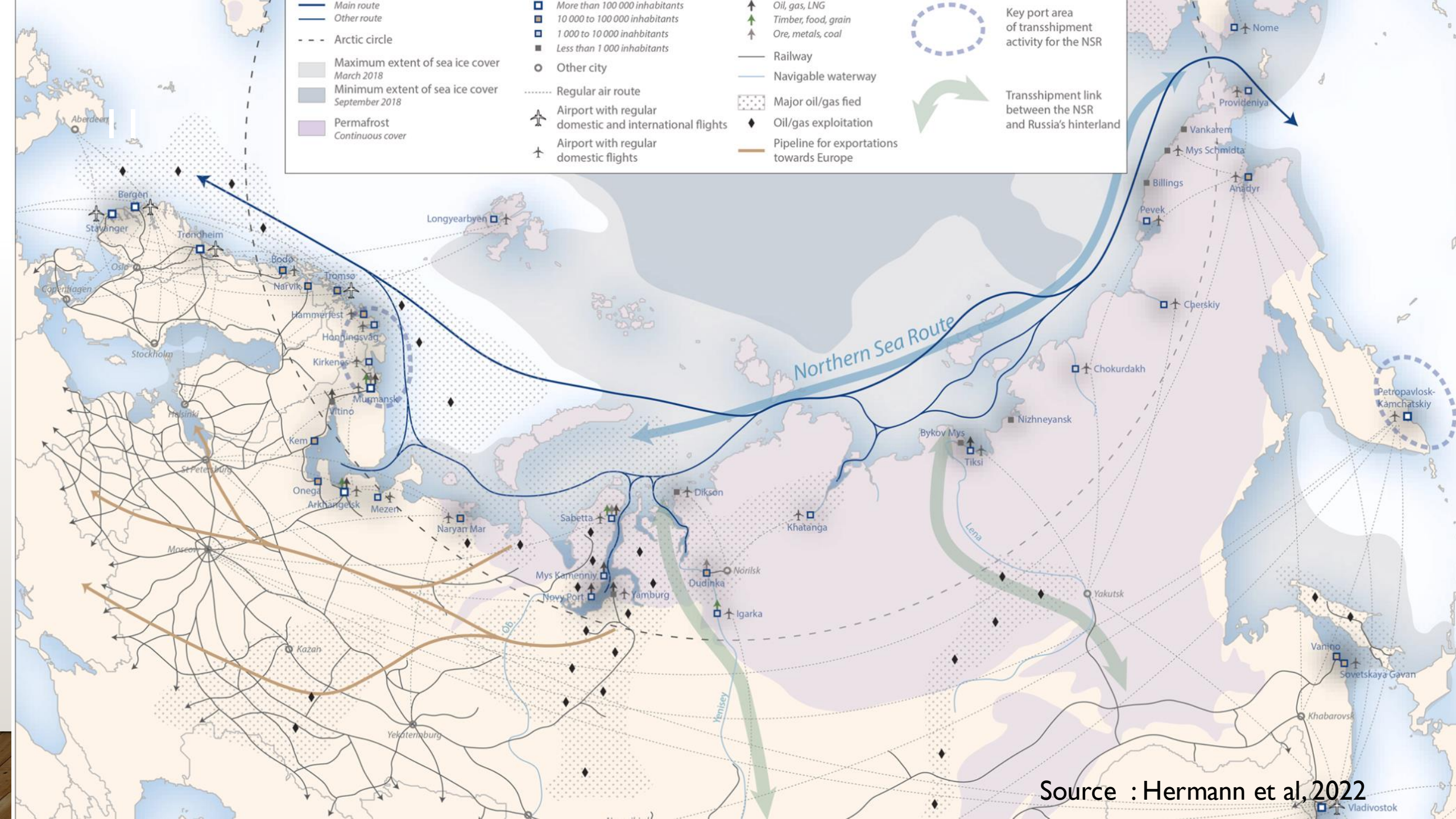
9 EVOLUTION OF KEY PARAMETERS

- 2012/2013 – beginning of academic research about Arctic
  - NSR Versus SCR (Farré et al, 2014; Cariou and Faury, 2015)
  - Economic models (Farré et al, 2014; Liu and Kronbak, 2010; Furuichi and Otsuka, 2014)
  - Focus on
    - Container (Lasserre, 2014)
    - Bulk (Schoyen and Brathen , 2011)
  - Steady speed (Verny and Grigentin, 2009, Cariou and Faury, 2015)
- 2024
  - Economic models (Theocharis et al, 2019)
  - NSR appears more as a complementary shipping lane (Hermann et al, 2022)
  - Speed variation (Cheaitou et al, ; Faury and Cariou, 2016)
  - Ecological impact (Cariou and Faury, 2016)

10 MAIN JOURNALS TO TARGET

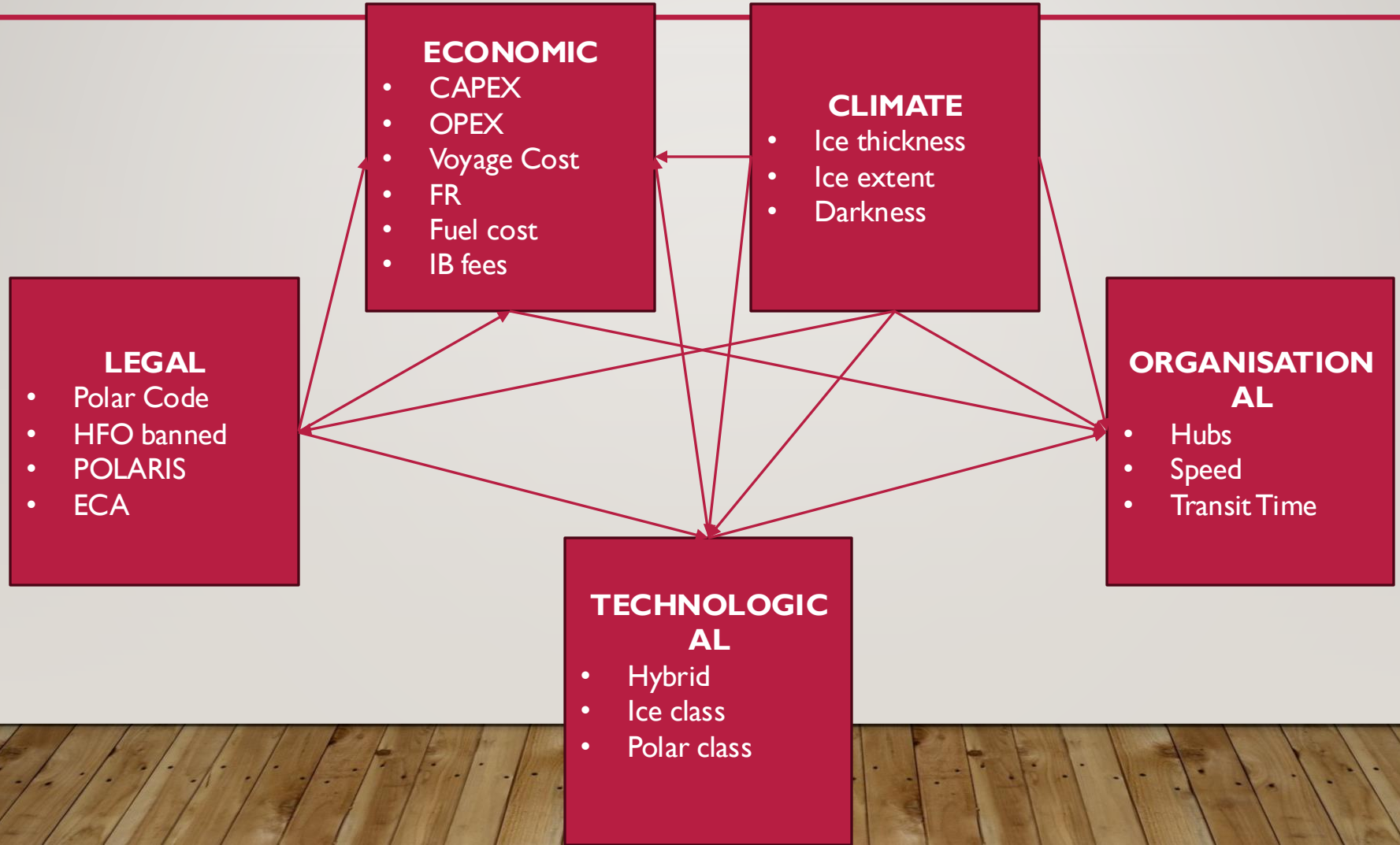
Journal of Transport Geography	Transportation Research Part A: Policy and Practice	Transportation Research Part D: Environment and Transport	Transportation Research Part E: Logistics and Transportation Review	Maritime Policy & Management	Maritime Economics & Logistics
European Journal of Operational Research	International Journal or Production Economics	The Asian Journal of Shipping and Logistics	International Journal of e-Navigation and Maritime Economy	International Journal of Geographical Information Science	4Journal of Maritime Research
Transport Policy	Polar Record	Journal of Navigation	International Challenges	Journal of Ocean Technology	Applied Mechanics and Materials
Advanced Science Letters	Transportation Research Board	Ambio	Climatic Change	Izvestiya, Atmospheric and Oceanic Physics	Journal of Nuclear Science and Technology

Source : Theocharis et al (2018)



Source : Hermann et al, 2022

MAIN PARAMETER WHEN DEALING WITH ARCTIC NAVIGATION



ECONOMIC

CAPEX (Lasserre, 2014)

- Anticipation of ice conditions = adapted speed

OPEX (Erikstad and Ehlers, 2012)

- Additional cost
- The question of insurance (disagreement)

Voyage cost

- Fuel cost (ban of HFO)
- IB fees

CO_2 taxation (Cariou and Faury, 2015)

- Impact the cost of transportation
- Incrase the attractiveness of the NSR (Cariou and Faury, 2015)

14 SCC IMPACT ON TRANSPORTATION (NO SCC)

Figure 3b: Profit and Loss generated with HFO in median access scenario without SCC

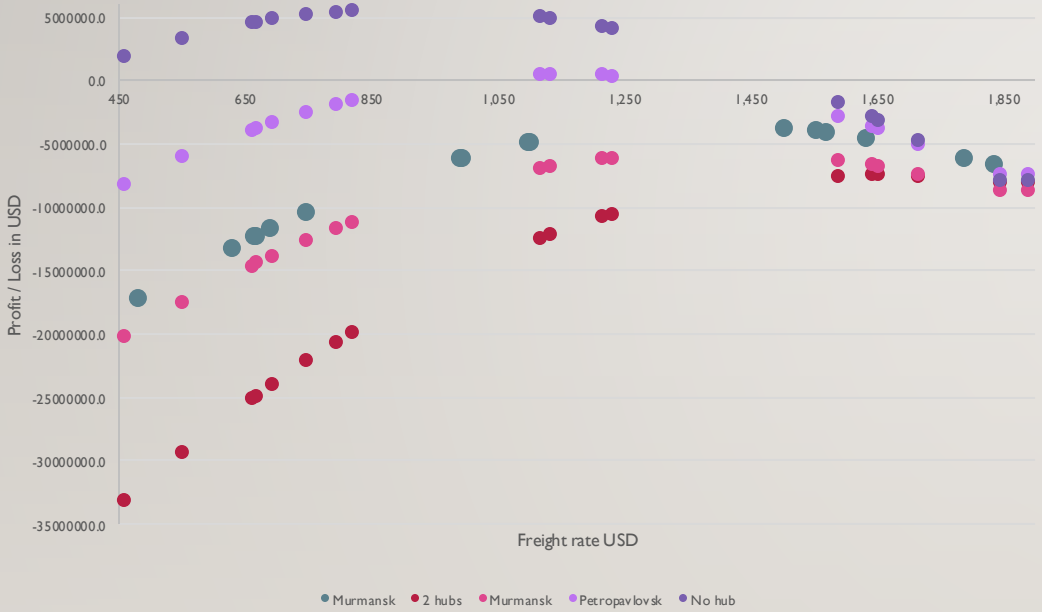
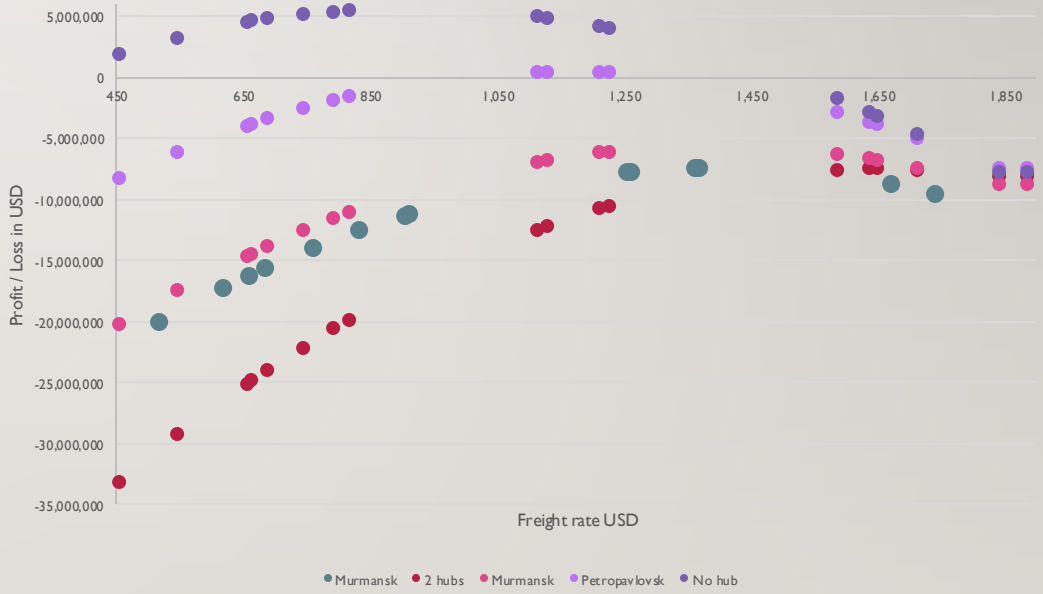


Figure 3d: Profit and Loss generated with HFO in median access scenario with SCC



15 SCC IMPACT ON TRANSPORTATION (SCC)

Figure 3a: Profit and Loss generated with VLSFO in median access scenario without SCC

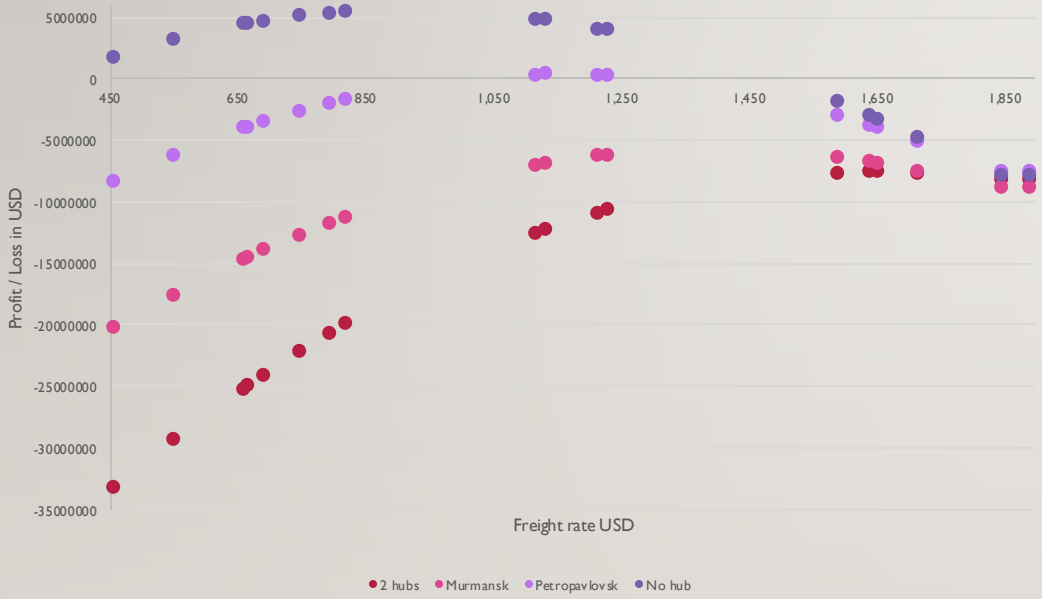
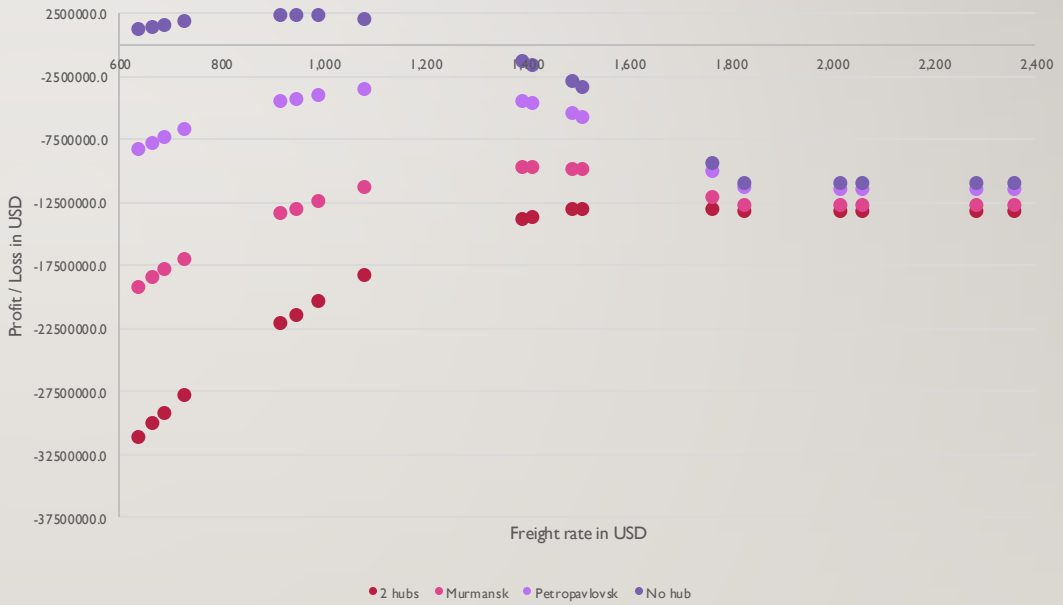
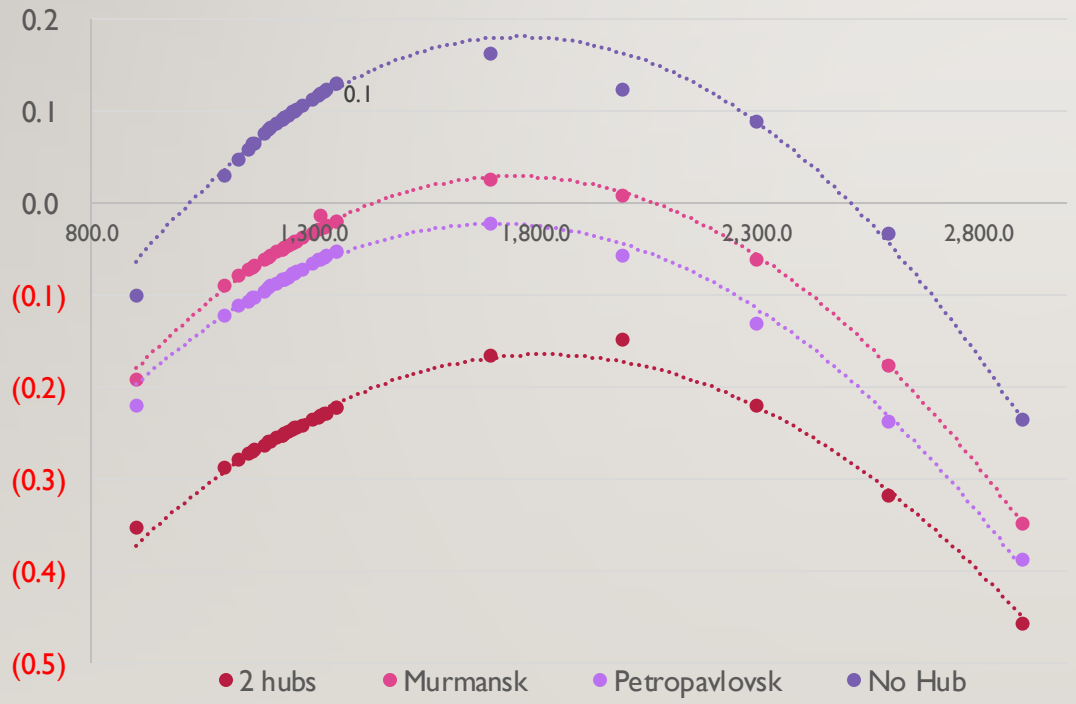


Figure 3c: Profit and Loss generated with VLSFO in median access scenario with SCC policy

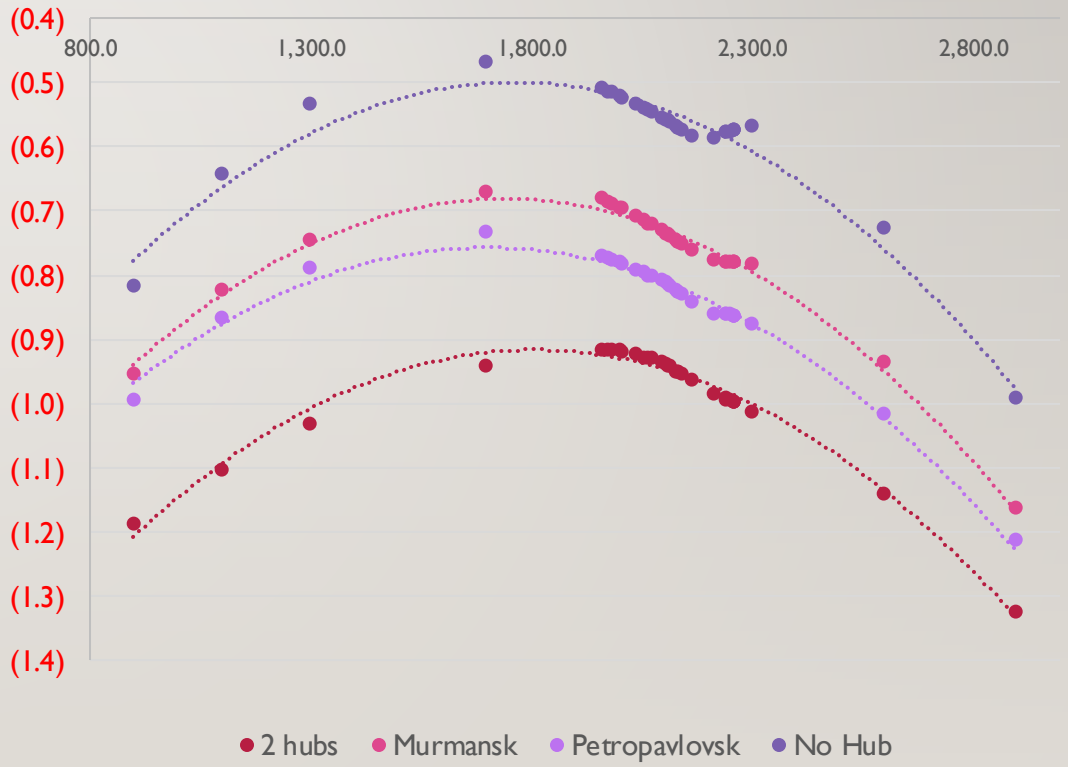


IMPACT OF ICE AND FUEL ON PROFIT PER TONNE OF CO_2 EMITTED

ULSFO



LNG



Source :Faury 2024

LEGAL

- Polar Code
- POLARIS
- ECA

18 POLAR CODE

Introduction

- Type of vessels (A, B, C)
- Different hazards

Part I :

- Technical part of the vessel

Part II :

- Environmental behavior

TECHNOLOGICAL PARAMETER

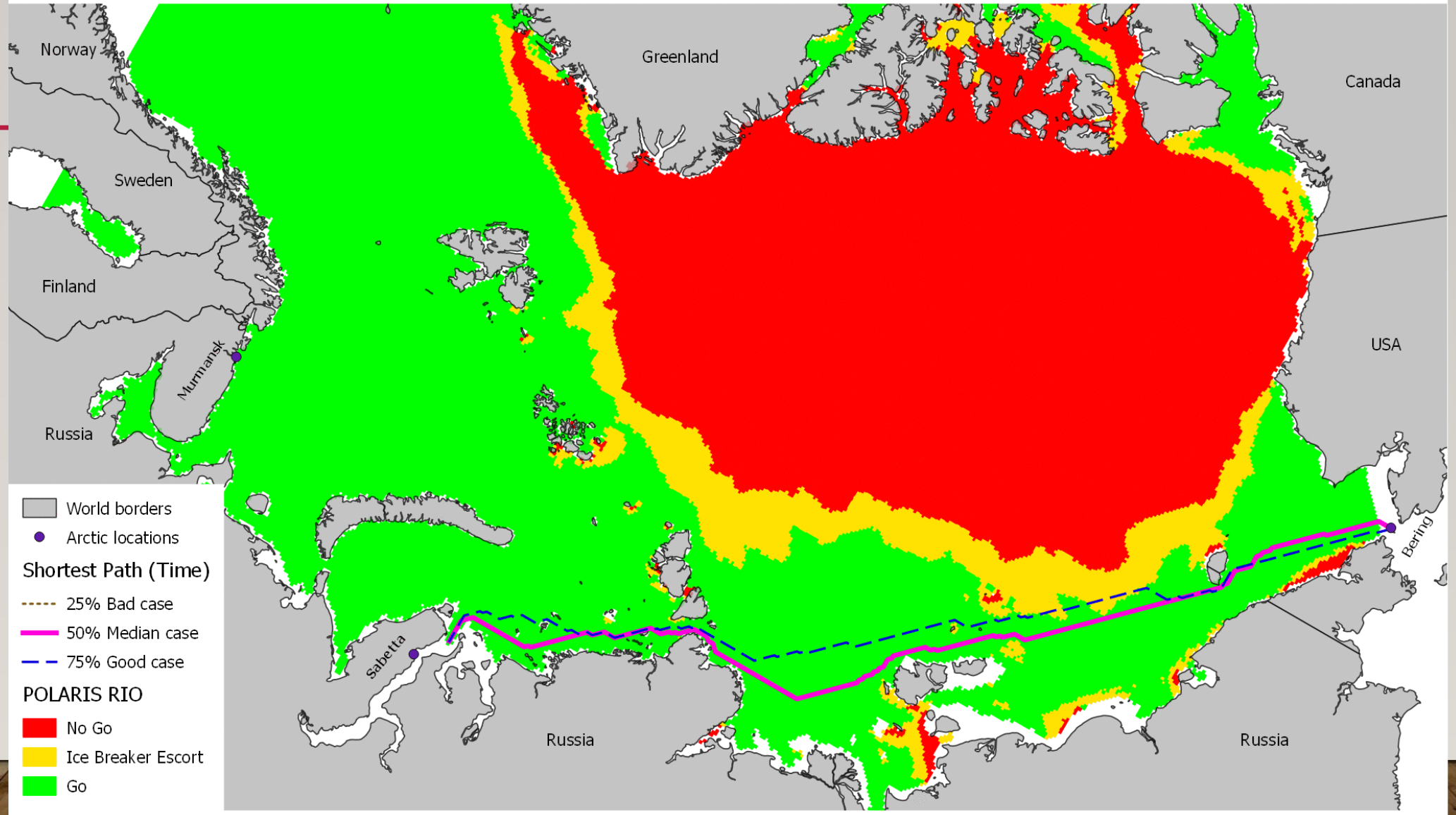
- Sailing in ice implies to use dedicated vessels:
  - Ice class
  - Polar class
- Yet, if the length of navigation increase, so is the:
  - Fuel consumption
  - CAPEX
- Thus, the loading capacity may decrease due to additional cost

		Ice free	New ice	Grey ice	Grey White ice	Thin First Year 1st Stage	Thin First Year 2nd Stage	Medium first year	Thick first year	Second year	Multi year	Heavy Multi-year
Polar Class	PC1	3	3	3	3	2	2	2	2	2	1	1
	PC2	3	3	3	3	2	2	2	2	1	1	0
	PC3	3	3	3	3	2	2	2	2	1	0	-1
	PC4	3	3	3	3	2	2	2	1	0	-1	-2
	PC5	3	3	3	3	2	2	1	1	-1	-2	-3
	PC6	3	2	2	2	2	1	1	0	-2	-3	-3
	PC7	3	2	2	2	1	1	0	-1	-3	-3	-4
Ice Class	1AS	3	2	2	2	2	1	0	-2	-3	-4	-5
	1A	3	2	2	2	1	0	-1	-3	-4	-5	-6
	1B	3	2	2	1	0	-1	-2	-4	-5	-6	-7
	1C	3	2	1	0	-1	-2	-3	-5	-6	-7	-8
Catregory II	Not Ice Class	3	1	0	-1	-2	-3	-4	-6	-7	-8	-8

POLARIS RISK INDEX OUTCOME

Median POLARIS Map (Bering / Sabetta) - IA Super Vessels - DOY 001 (01 January)

Transit time (25%): No possible path
Transit time (50%): 1 week, 2 days, 12 hours, 33 minutes
Transit time (75%): 1 week, 8 hours, 6 minutes, 33 seconds

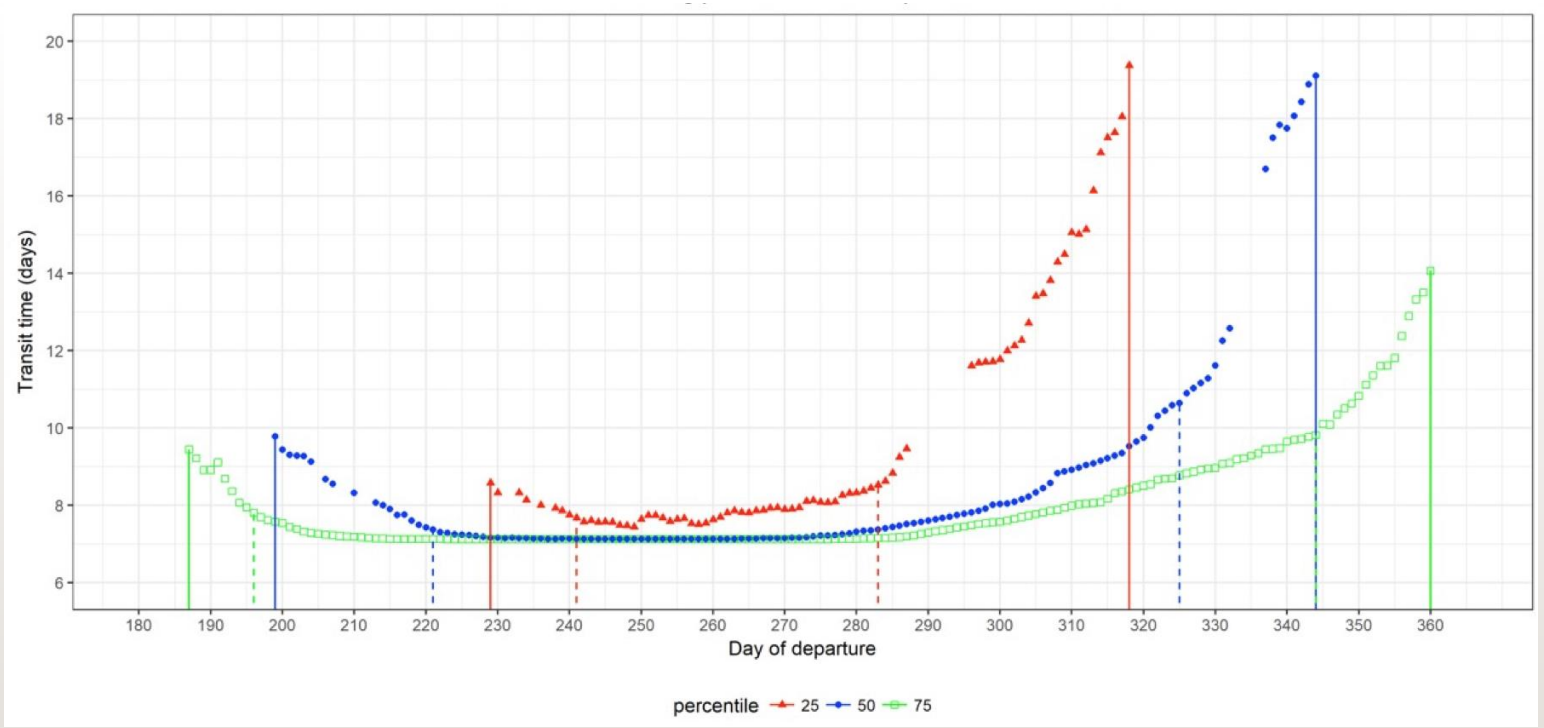


Production : L. ETIENNE 2018
Sources : COPERNICUS - ARCTIC_REANALYSIS_ PHYS_002_003, 12.5 km x 12.5 km, 1991-2015

0 500 1000 1500 km

EPSG : 3995

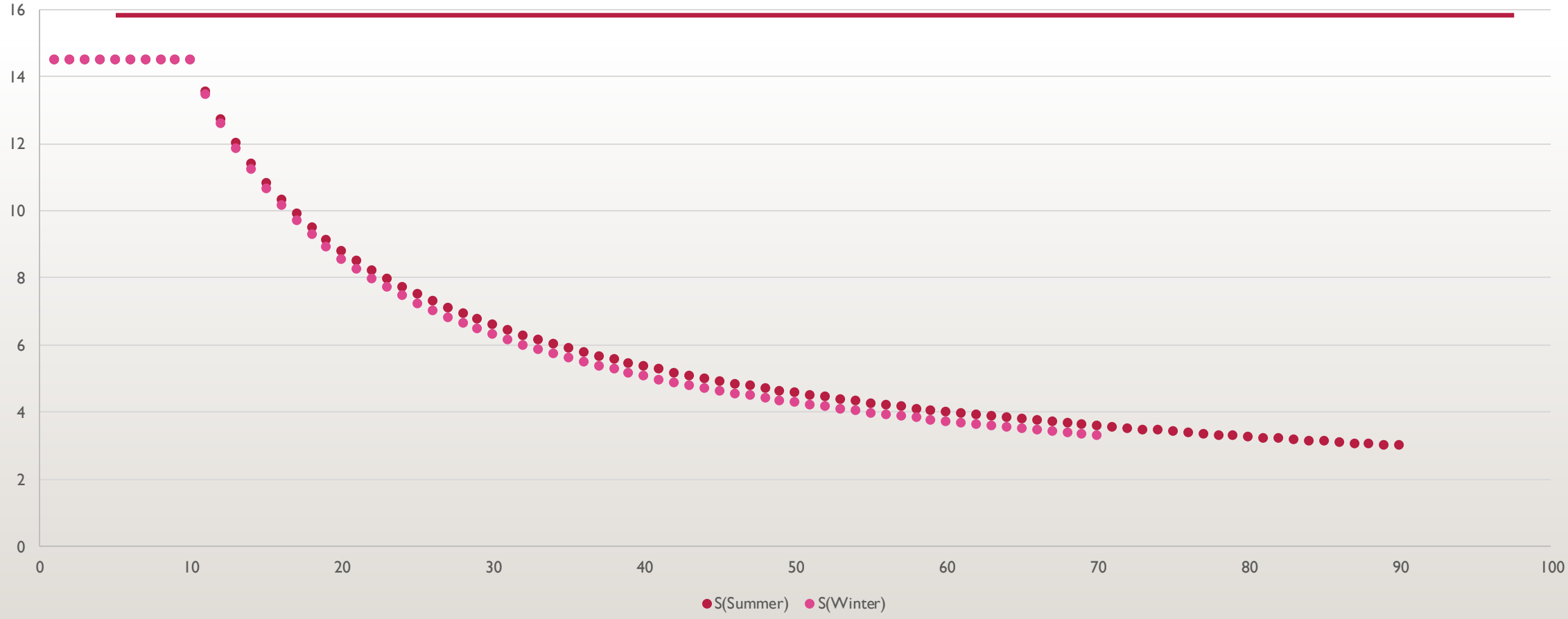
IMPACT OF ICE UPON SAILING PERIOD



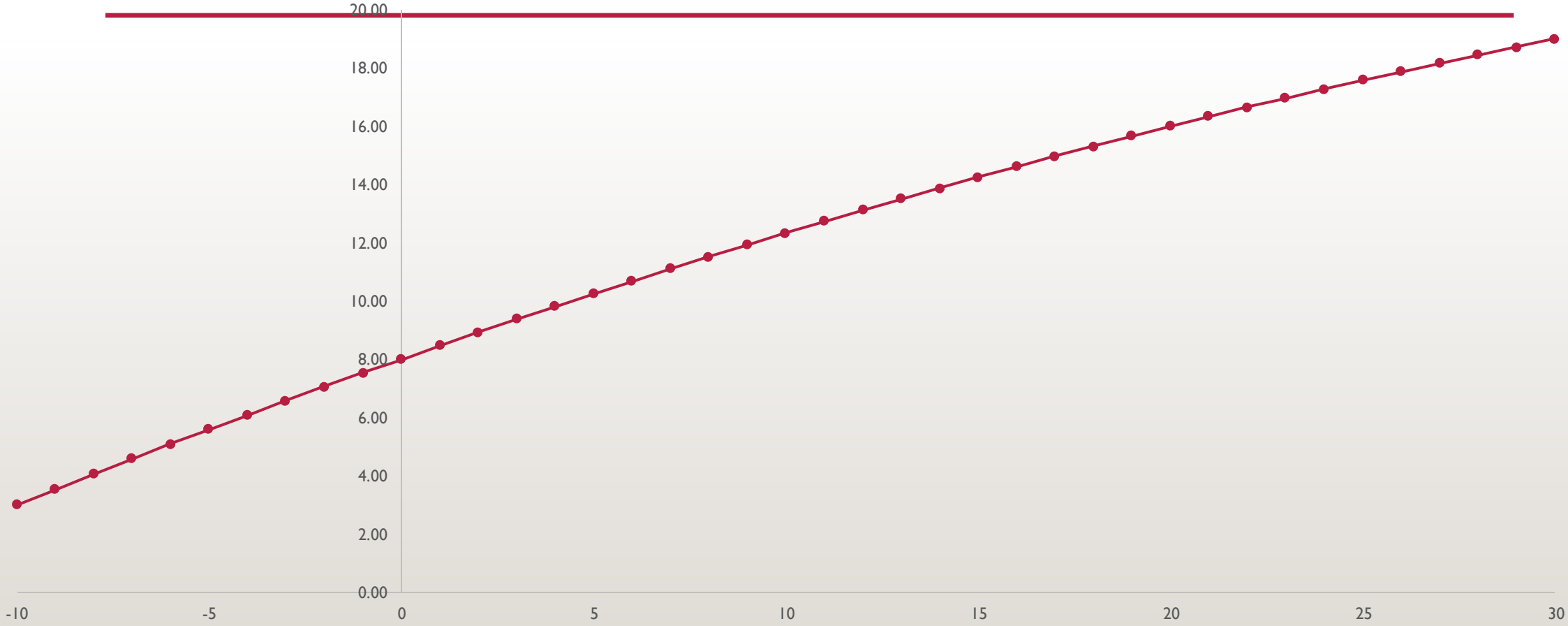
ORGANISATIONAL

- Hubs
- Speed
- Transit Time

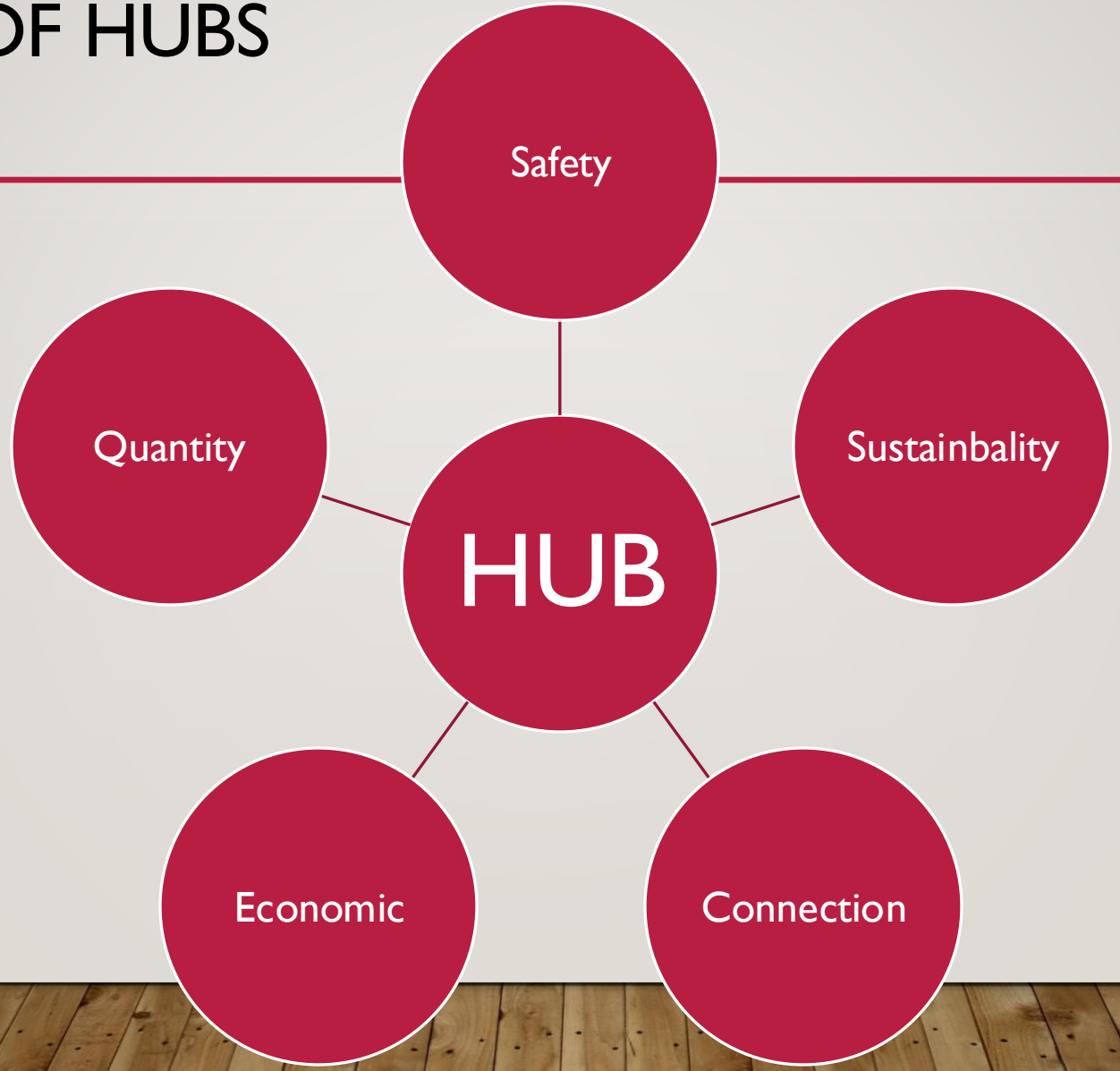
SPEED OF THE VESSEL BASED ON ICE THICKNESS



SPEED OF THE VESSEL BASED ON POLARIS

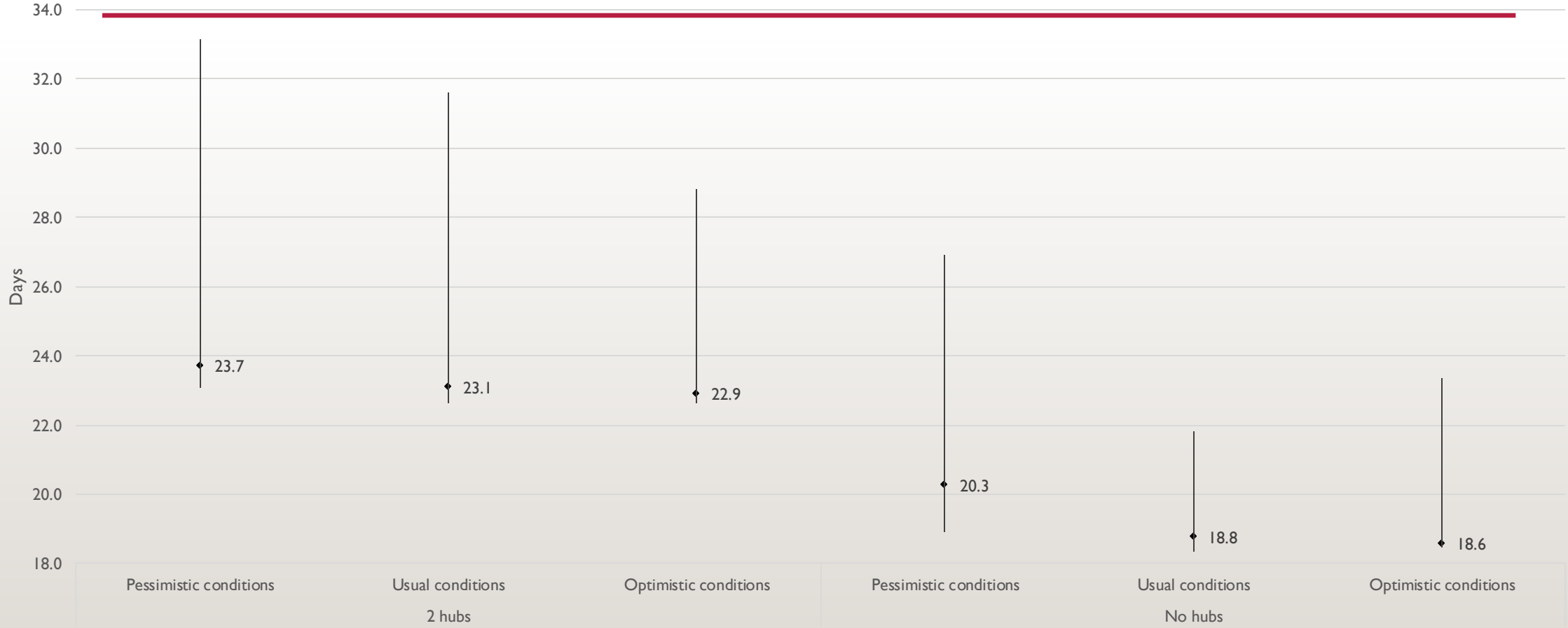


26 ASPECT OF HUBS

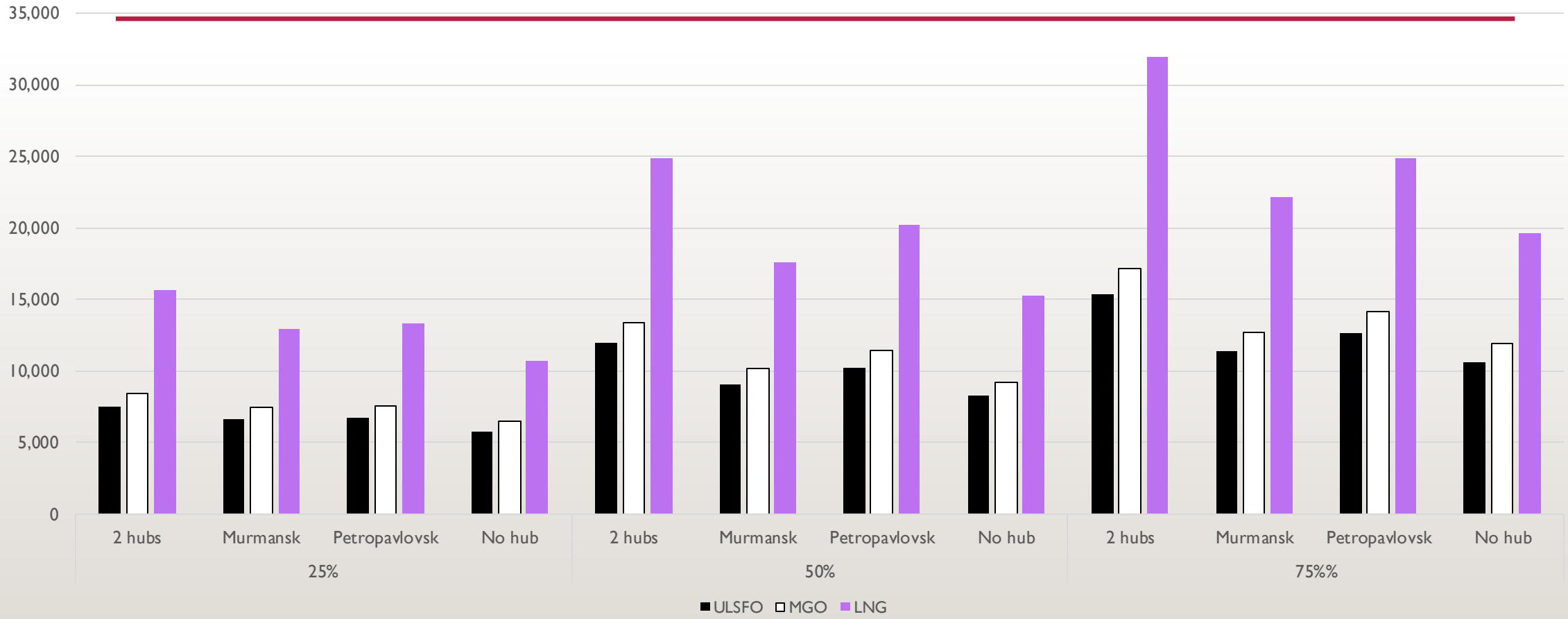


Source : Based on Hermann et al, 2022 and Cheaitou et al, 2022

TRANSIT TIME VARIATION



COST OF FUEL BY LOGISTICAL ORGANISATION AND ICE CONDITIONS



WHERE IS THE GAP?

	NEP	NSR	NWP
Cruise		2	
Hinterland		2	
Maritime	1	30	
Port		13	
Shipping	1	58	7
Tourism		1	
Transport		26	

Source : Based on Lavissiere et al (2020)

NEXT STEP

- IA
- Optimization
- Integration of new technologies
- Autonomous vessels
- LNG, MGO, bio-fuel…
- Cruise navigation

ARCTIC AND BALTIC

- Synchromodality
- Hubs
- ECA area
- TEN-T Model

ANY QUESTIONS?