NTNU
Norwegian University of Science and Technology

Faculty of Engineering Science and Technology
Department of Marine Technology

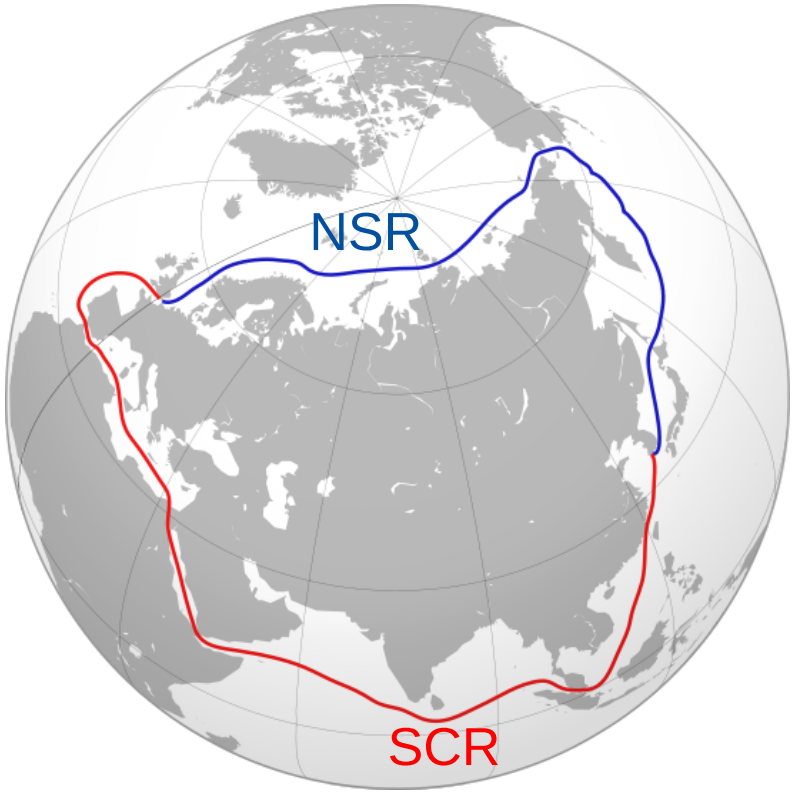
Sustainable Arctic Sea Transport Group – SAST
ntnu.edu/sast

Business Model for Commercial Trans-Arctic Shipping

Arctic 2030 WP4; Busan, South Korea; May 31th, 2016

Presenter
Aleksandar-Saša Milaković, MSc Nav Arch

Motivation



Northern Sea Route vs Suez Canal Route

How to design a transport system to maximize benefit of shorter Arctic route?

Should an investment into a fleet of ice-classed vessels be made? What is the optimal configuration of such fleet?

⬇

Use of **simulation-based** decision support tool.

Schartmüller, Milaković, Bergström, Ehlers, *A Simulation-based Decision Support Tool For Arctic Transit Transport*, OMAE 2015.

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Objectives

- Build a simulation framework both for NSR and SCR
- Develop a decision support tool to be used by the shipowners both for ad-hoc calculations or for long term planning
- Establish **feasibility index** showing dependency between profitability of use of Arctic route and variables affecting it

Challenges related to simulation model

- Accuracy of calculation of resistance in ice and consequently fuel consumption
- Uncertain effect of ice class to open water performance

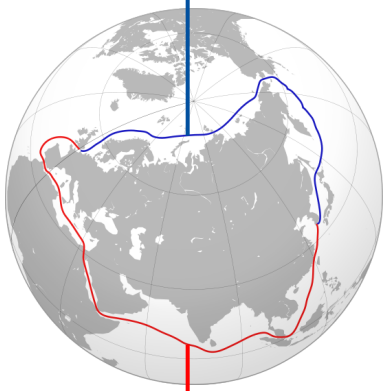
Basic concepts

$$RFR = \frac{\text{CAPEX+OPEX+VOYEX}}{\text{Amount of cargo transported}} \quad \text{[\$ / TEU(ton)]}$$

How can the fact that the NSR is shorter be utilized?

1) Increased number of transits sailing the NSR with the same speed as SCR
2) Reduced fuel costs slow-steaming the NSR (container vessels)

Cost calculations overview



NSR

- CAPEX (including investment into ice class)
- OPEX
- VOYEX:
  - Fuel consumption in ice
  - Rosatomflot fee
  - Insurance fee

NSR single trip costs

SCR single trip costs

SCR

- CAPEX
- OPEX
- VOYEX:
  - Fuel consumption in open water
  - Suez Canal fee
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Cost calculations overview

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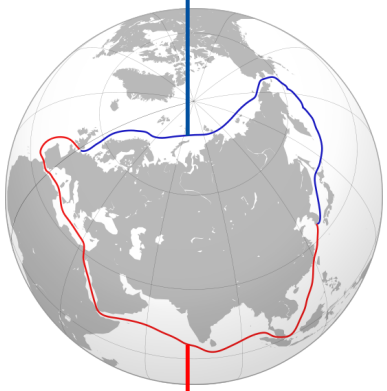

NSR single trip costs

SCR single trip costs

SCR

- CAPEX
- OPEX
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  - **Fuel consumption in open water**
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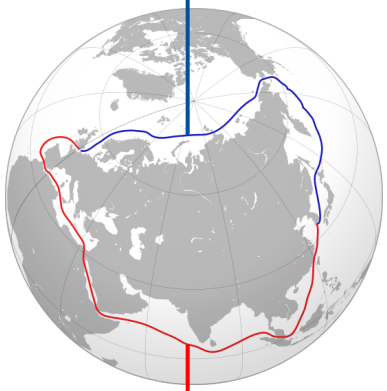
Still water resistance + wave resistance (according to metocean data for the route)

Cost calculations overview



NSR

- CAPEX (including investment into ice class)
- OPEX
- VOYEX:
  - **Fuel consumption in ice**
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Ice resistance calculations

NSR single trip costs

SCR single trip costs

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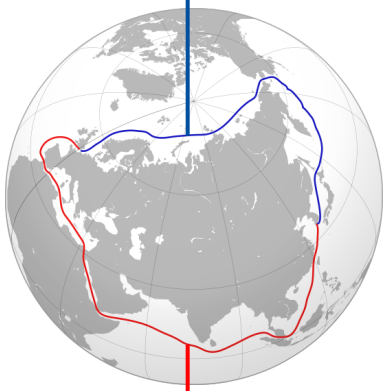

NSR

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NSR single trip costs

SCR single trip costs

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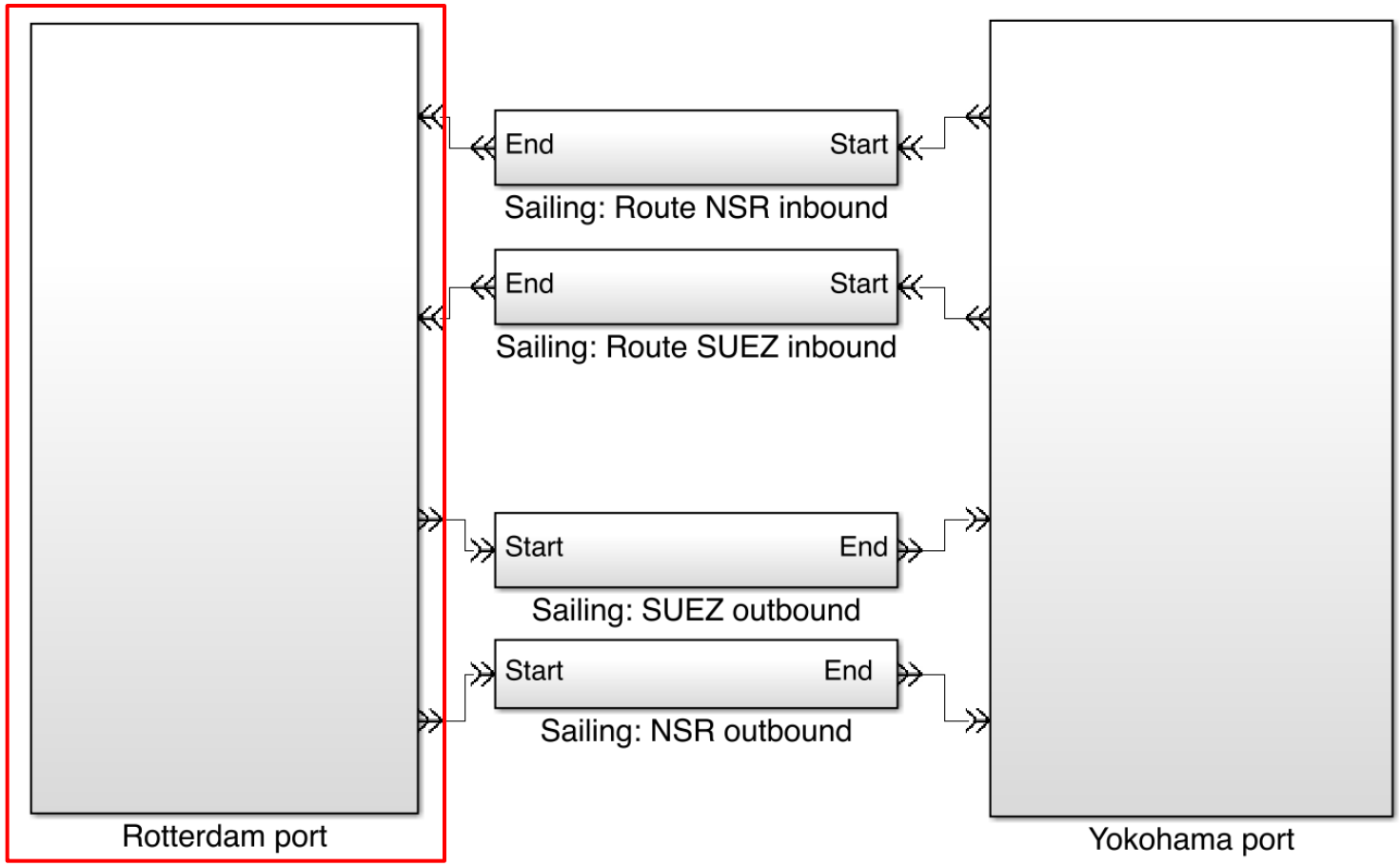
$$RFR = \frac{\text{CAPEX+OPEX+VOYEX}}{\text{Amount of cargo transported}}$$

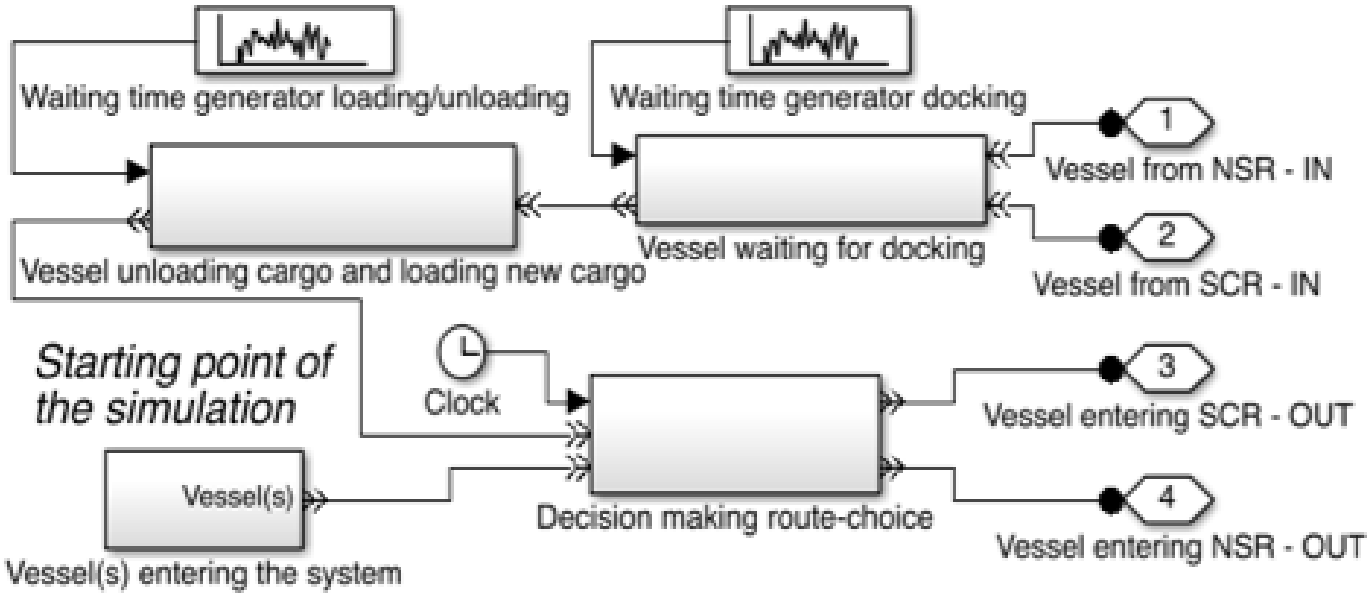
Simulation model overview



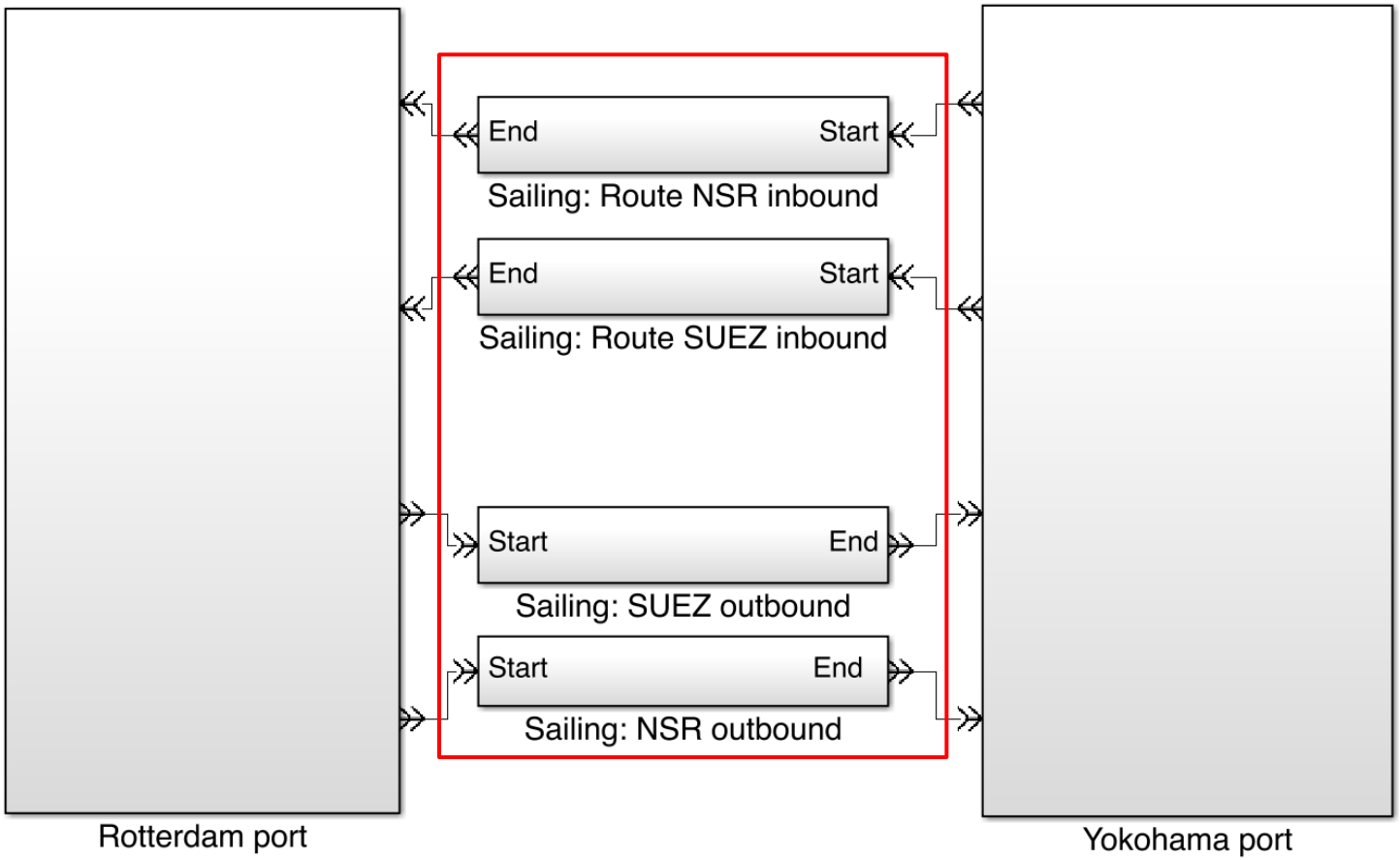
SimEvents simulation model

Modeling of waiting times in ports

Waiting time docking	[d]	Weibull	Scale=0.05, shape=2
Port service time	[d]	Gaussian	μ=1 (1.5 for CV8160), σ=0.1

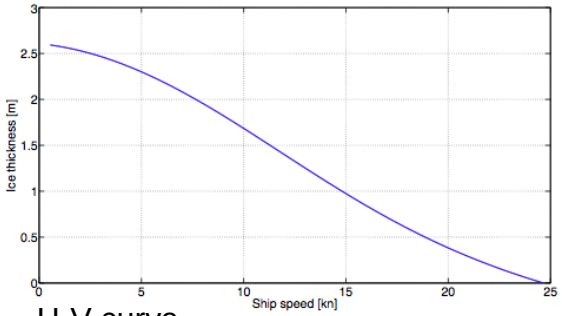


Simulation model overview



SimEvents simulation model

Costs of cargo transportation

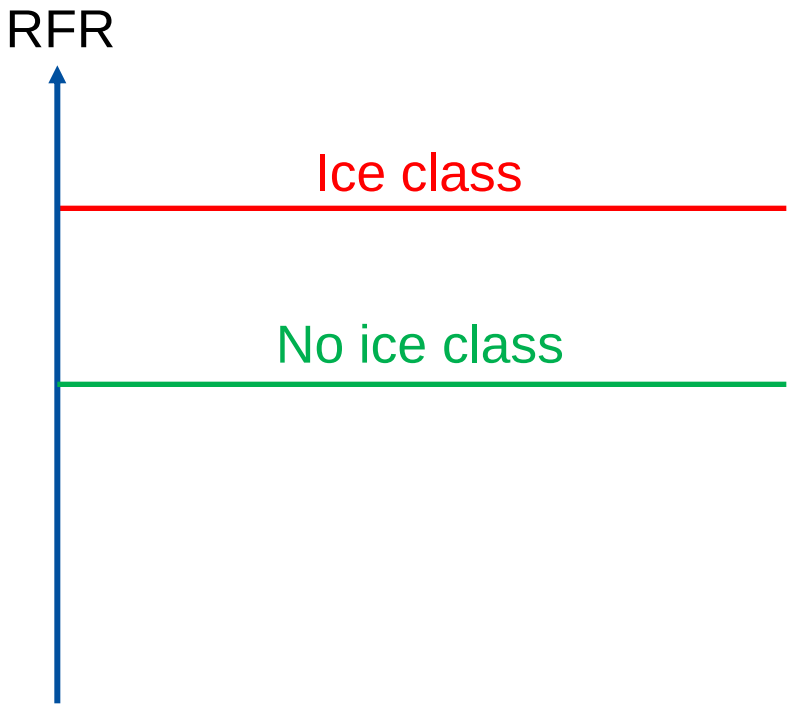


H-V curve

Conditions for profitability of NSR

Shipowner 1: Builds ice-classed fleet
Shipowner 2: Builds non ice-classed fleet

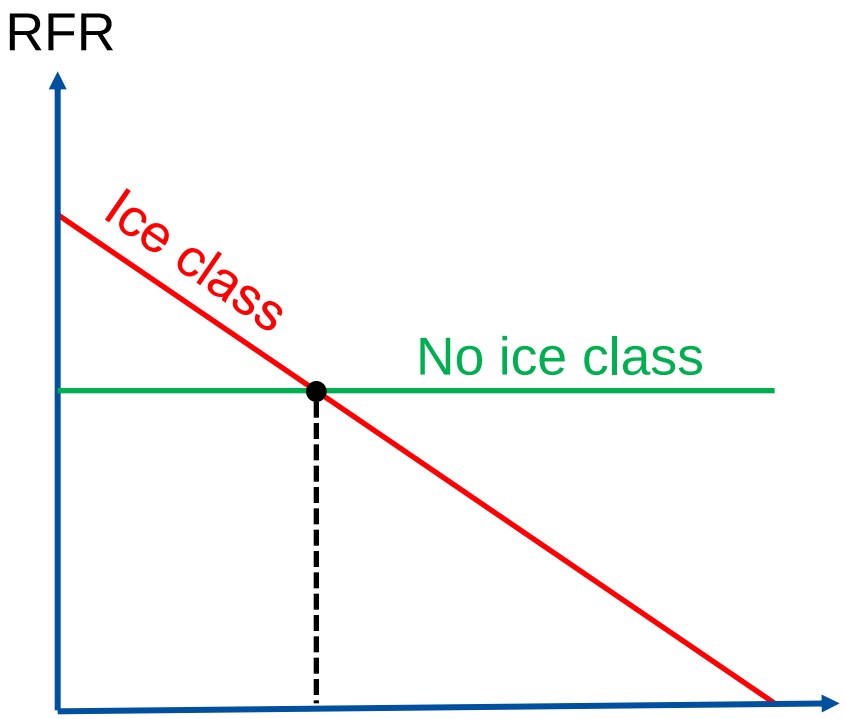
Scenario 1:
Number of operational days along the NSR = 0



Conditions for profitability of NSR

Shipowner 1: Builds ice-classed fleet
Shipowner 2: Builds non ice-classed fleet

Scenario 2:
Number of operational days along the NSR > 0



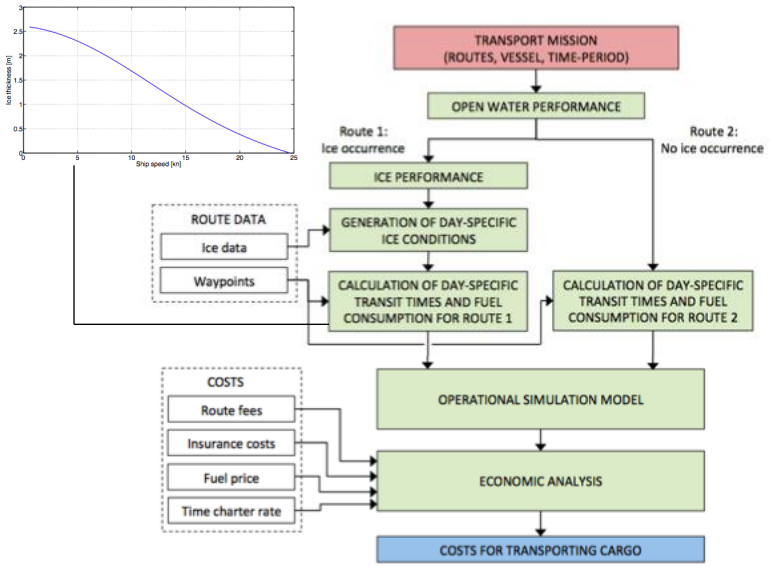
NSR profitability index

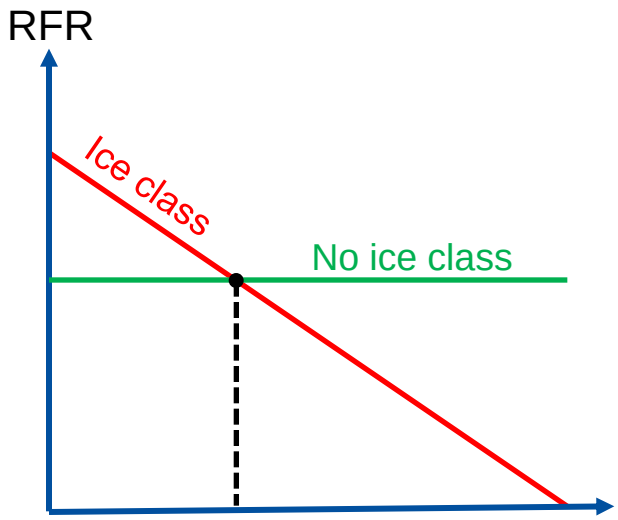
n_{NSR} = Number of operational days along NSR
IC = Vessel's ice class
DWT = Vessel size
$dist_{NSR/SCR}$ = Distance between ports
IB = Icebreaker fee
SC = Suez Canal fee
I_{SCR} = Insurance fees for SCR
I_{NSR} = Insurance fees for NSR
BP = Bunker price

Multi-variable regression analysis

$i = f (n_{NSR}, IC, DWT, dist_{NSR/SCR}, IB, SC, I_{SCR}, I_{NSR}, BP)$

Thank you for your attention!





$$i = f\left(n_{NSR}, IC, DWT, dist_{NSR/SCR}, IB, SC, l_{SCR}, l_{NSR}, BP \right)$$