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Optimal Baltic Fleet in the Transferable Fishing Concessions System

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Research motivation:

- Poor condition of fish stocks around the globe with 32% stocks overexploited, depleted or recovering from depletion (FAO, 2010)
- Significant Baltic Sea fishing fleet overcapacity leading to poor prosperity of the sector (Döring and Egelkraut, 2008)
- Potential to increase the profitability in the sector through management tools
- Common Fishery Policy reform proposing Transferable Fishing Concessions

GREEN/BLUE GROWTH as efficient utilization of capital potential

HARVEST DATA

Source: Polish Fisheries Monitoring under the Ministry of Agriculture and Rural Development
Time horizon: 2004-2009
Segments:
S1: demersal trawlers of length 12-24 m including vessels using as main gear otter trawls (OTB) and pair trawls (PTB) (8% in 2009)
S2: pelagic trawlers trawlers of length 24-40 m including vessels using as main gear otter trawls (OTM) and pair trawls (PTM) (7% in 2009)
S3: vessels using passive gears of length 0-12 m including vessels using as main gear pots (FPO), set gillnets (GNS), driftnets (GND) and trammel nets (GTR) (63% in 2009)

	S1	S2	S3
Observations	944	333	3781
Harvest: cod	30748	25121	3377
Harvest: herring	19149	286621	3997
Harvest: sprat	56284	1106238	0
Harvest: other	32588	18286	9185
Tonnage	64,5	153,6	4,6
Effort	82,0	120,9	86,2

most commercially important species (cod, herring, sprat)
86% of total catch
74% of total value

ECONOMIC DATA

Source: The 2011 Annual Economic Report on the European Fishing Fleet 2011

Assumptions:

- total segment cost distributed evenly between vessels according to their effort days and tonnage
- cost shares of inputs (energy, labor and maintenance)
- input prices for each of defined segments
- energy consumption according to power and effort
- labour input according to tonnage

MODEL ASSUMPTIONS

- Vessels attempts to minimize variable cost of harvesting given the quota (Bjorndal and Gordon, 2001)

- Vessel is minimizing variable cost while being constrained by quasi-fixed factors (capital) (Kulatilaka, 1985)

- The long-run equilibrium implies partial adjustment of quasi-fixed factors over time (Kulatilaka, 1985)

$$\ln C = \alpha_0 + \sum_{i \in I} \alpha_i \ln w_i + \sum_{j \in J} \alpha_j \ln h_j + \alpha_T \ln T$$

$$+ \frac{1}{2} \sum_{i \in I} \sum_{i' \in I} \alpha_{ii'} \ln w_i \ln w_{i'} + \sum_{i \in I} \sum_{j \in J} \alpha_{ij} \ln w_i \ln h_j + \sum_{i \in I} \alpha_{iT} \ln w_i \ln T +$$

$$+ \frac{1}{2} \sum_{j \in I} \sum_{j' \in J} \alpha_{jj'} \ln h_j \ln h_{j'} + \sum_{j \in J} \alpha_{jT} \ln h_j \ln T + \frac{1}{2} \alpha_{TT} (\ln T)^2$$

$$S_i = \alpha_i + \sum_{i' \in I} \alpha_{ii'} \ln w_{i'} + \sum_{j \in J} \alpha_{ij} \ln h_j + \alpha_{iT} \ln T$$

Short-run restricted cost function

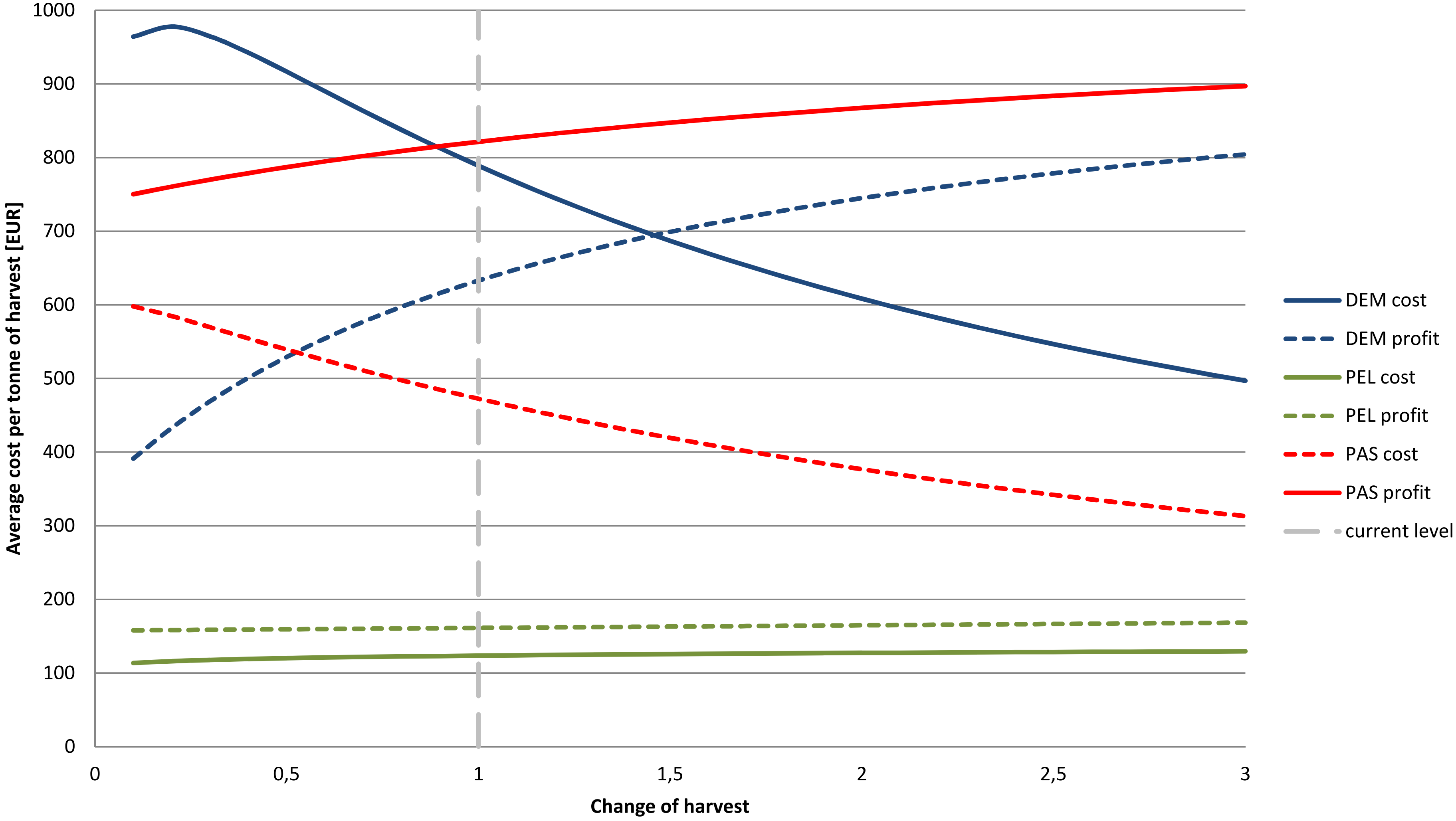
estimated jointly with SUR (Zellner, 1962)

w_i - vector of factor prices
h_j – vector of outputs (harvest)
T – quasi-fixed factor (vessel's tonnage)

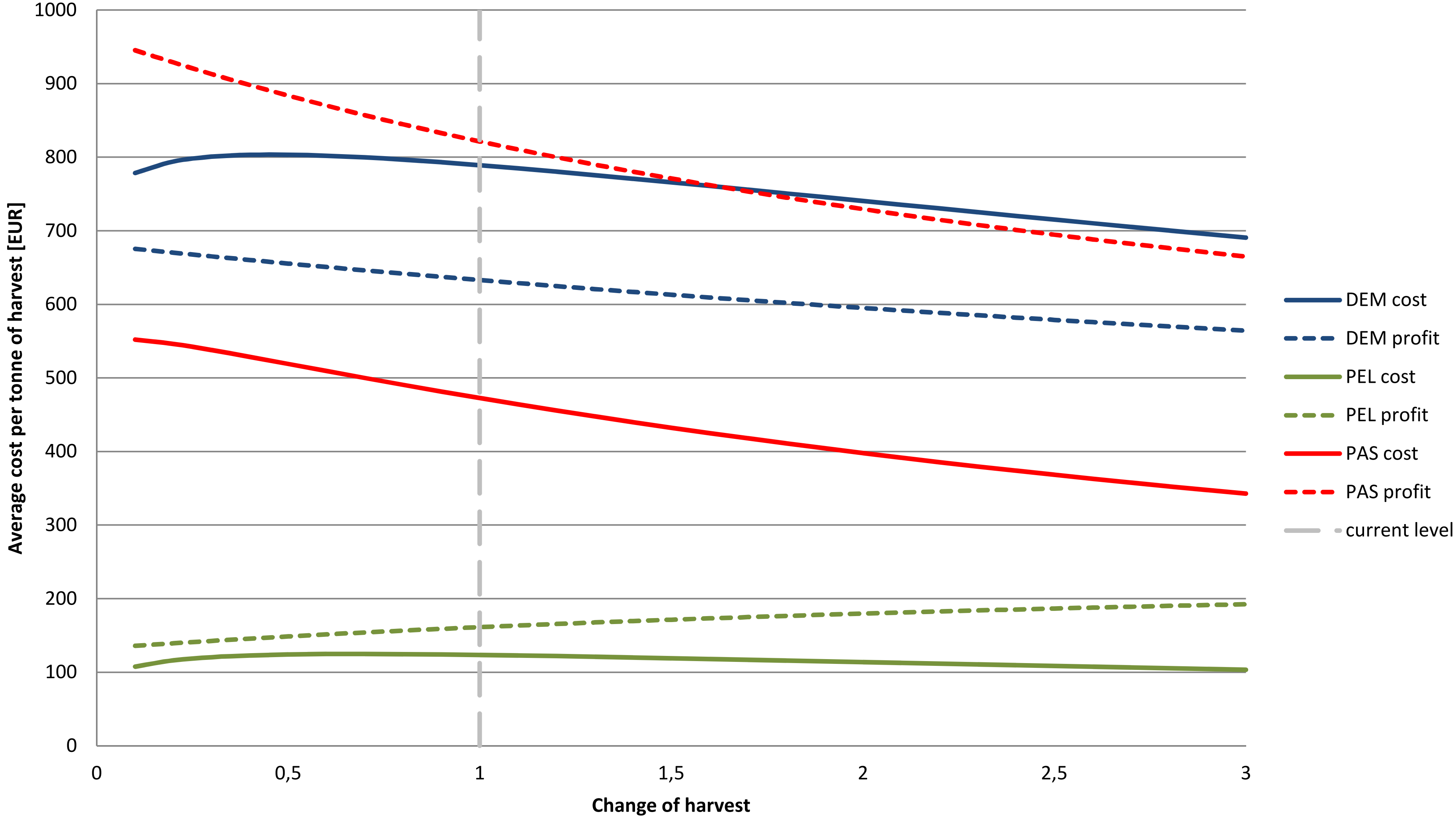
(Segerson and Squires, 1990)

	S1						S2						S3				
vl	0,437	*	xee	0,106	*	vl	0,415	*	xee	0,098	*	vl	0,690	*	xeo	0,001	*
vv	0,114	*	xec	0,008	*	vv	0,147	*	xec	0,003	*	vv	0,074	*	xet	0,172	*
ve	0,448	*	xeh	0,004	*	ve	0,438	*	xeh	-0,002	*	ve	0,236	*	xcc	0,004	*
vc	0,145	*	xes	0,002		vc	0,050	*	xes	0,000		vc	0,027	*	xch	-0,001	*
vh	0,065	*	xeo	0,003	*	vh	0,166	*	xeo	0,001		vh	0,028	*	xco	-0,007	*
vs	0,032		xet	0,105	*	vs	0,133	*	xet	0,039		vo	0,109	*	xct	0,006	*
vo	0,081	*	xcc	0,014	*	vo	0,013	*	xcc	0,007	*	vt	0,820	*	xhh	0,003	*
vt	0,789	*	xch	-0,003	*	vt	0,668	*	xch	0,000		xll	0,000		xho	-0,001	
xll	-0,001		xcs	0,002		xll	-0,038	*	xcs	-0,001		xlv	-0,011	*	xht	0,000	
xlv	-0,002		xco	-0,005	*	xlv	0,012	*	xco	-0,001	*	xle	0,012	*	xoo	0,011	*
xle	0,003		xct	0,028	*	xle	0,026	*	xct	0,003		xlc	0,002	*	xot	-0,002	
xlc	-0,010	*	xhh	0,007	*	xlc	-0,002	*	xhh	0,009	*	xlh	0,001	*	xtt	0,161	*
xlh	-0,004	*	xhs	0,000		xlh	0,002	*	xhs	-0,001		xlo	-0,003	*	con	2,650	*
xls	-0,004	*	xho	-0,001		xls	-0,001		xho	0,007	*	xlt	-0,066	*			
xlo	-0,004	*	xht	-0,017	*	xlo	-0,001	*	xht	-0,006		xvv	0,081	*			
xlt	-0,069	*	xss	0,003		xlt	-0,027		xss	0,013	*	xve	-0,069	*			
xvv	0,110	*	xso	0,000		xvv	0,112	*	xso	-0,001	*	xvc	-0,001	*			
xve	-0,109	*	xst	0,022		xve	-0,124	*	xst	-0,076	*	xvh	-0,001	*			
xvc	0,002	*	xoo	0,008	*	xvc	-0,001	*	xoo	0,001		xvo	0,002	*			
xvh	0,000		xot	0,010		xvh	0,000		xot	-0,004		xvt	-0,106	*			
xvs	0,002		xtt	-0,117		xvs	0,001	*	xtt	-0,157		xee	0,058	*			
xvo	0,001		con	11,046	*	xvo	0,001		con	12,298	*	xec	-0,001	*			
xvt	-0,036					xvt	-0,012					xeh	-0,001	*			

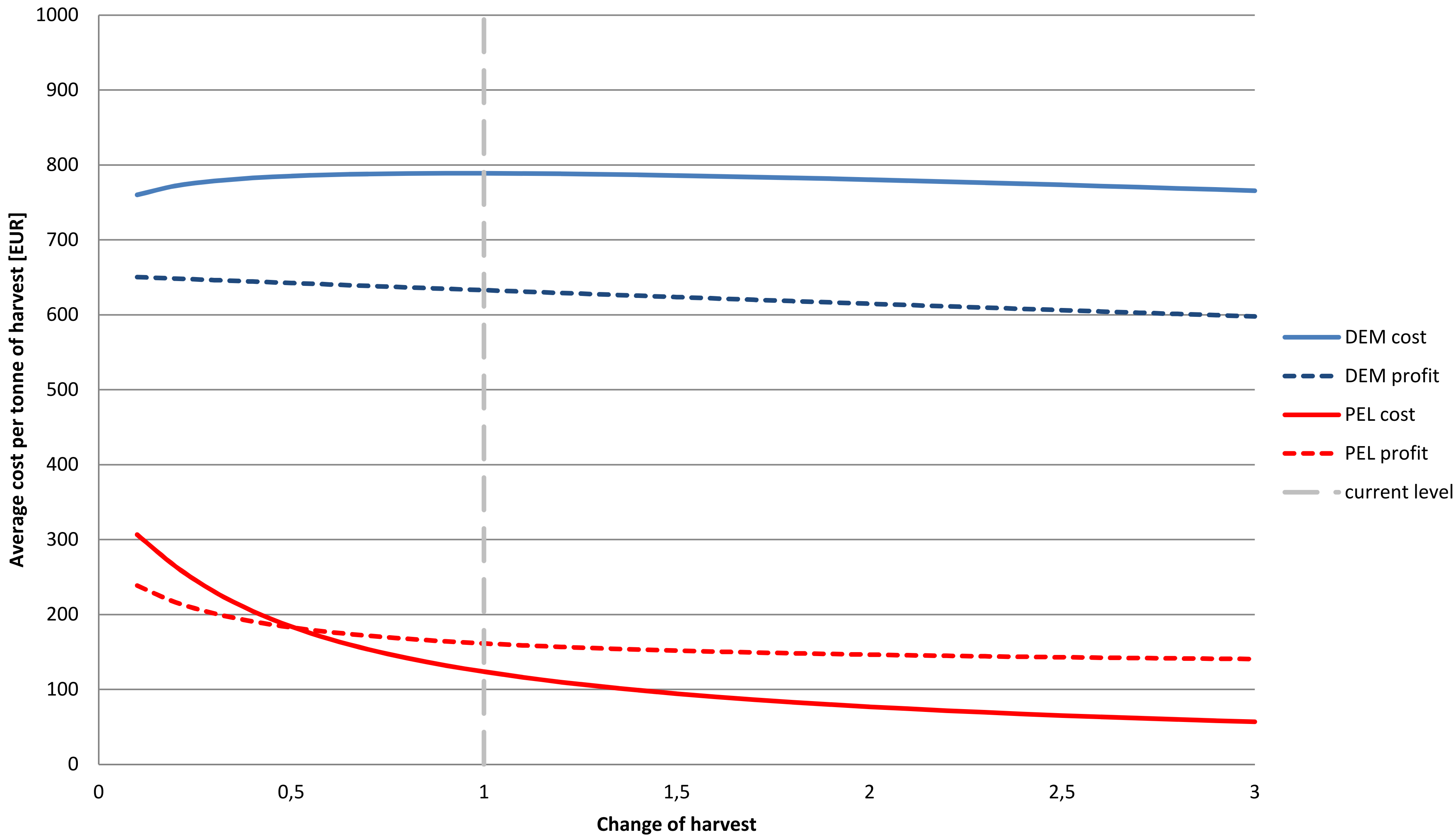
Estimated average cost of harvesting cod by segment at 2009 levels



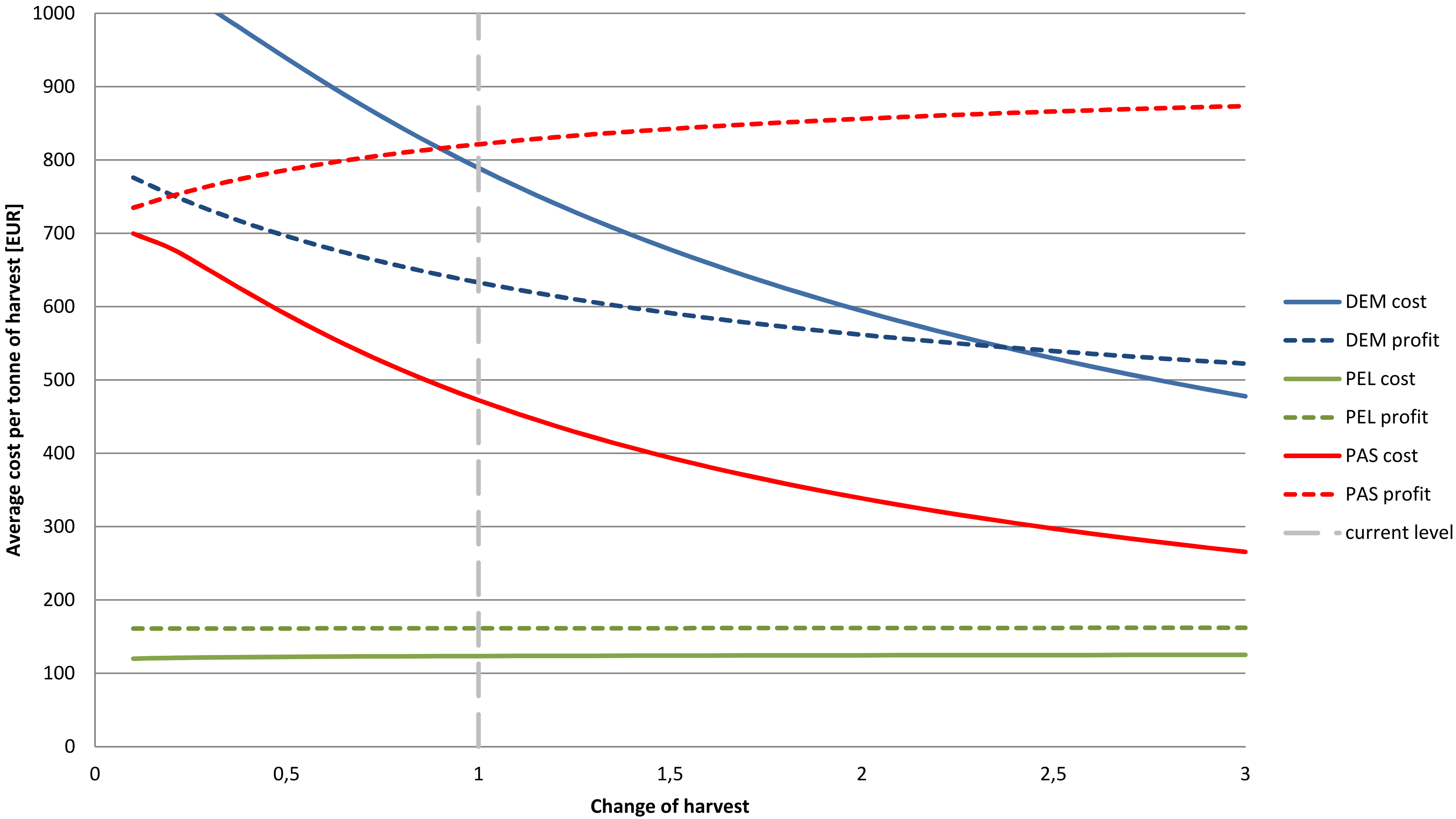
Estimated average cost of harvesting herring by segment at 2009 level



Estimated average cost of harvesting sprat by segment at 2009 level



Estimated average cost of harvesting other species by segment at 2009 level



Calculating the equilibrium capital

$$TC = C(w_i, y_j, T) + w_T \cdot T$$

$$C^* = \min_T TC$$

$$\frac{\partial TC}{\partial T} = \frac{\partial C}{\partial T} + w_T = 0$$

dC/dT is the reduction in variable cost for a unit increase in the level of quasi-fixed factors, therefore –dC/dT can be thought of as the shadow value of the quasi-fixed input (Kulatilaka, 1985)

$$w_T^* > w_T$$

Over-capitalization
firm would utilize capital at lower level but stickiness of capital prevents from imidiate adjustment

data assumes constant utilization rates for capital, thus over-capitalization may be overestimated (Kulatilaka, 1985)

$$w_T^* < w_T$$

Under-capitalization
adjustment costs or other restrictions are preventing from imidiate increase of the capital

eqilibrium condition for the whole fleet

$$\underbrace{\frac{\partial \ln C}{d \ln T} \cdot \frac{\overline{C}}{\overline{T}}}_{w_T^*} \cdot \underbrace{\overline{T} \cdot K}_{\text{Sum of capital}} = w_T \cdot \overline{T} \cdot K$$

$$K^* = \frac{w_T \cdot \overline{T} \cdot K}{\frac{\partial \ln C}{d \ln T} \cdot \overline{C}}$$

Summary of findings

	S1	S2	S3
w_T	473	372	608
w_{T*}	905	877	1614
K	67	46	393
K*	35	18	148
change in K	48%	61%	62%

CONCLUSIONS

- Significant overcapacity in Polish fishing fleet
  - (results consistent with other estimations saying that reasonable efficiency in fishery sector requires decrease of fleet potential, e.g. Garcia and Newton, 1997)
- Potential to decrease costs by accumulating quotas
  - (revealed motivation for introducing Transferable Fishing Concessions)

IDEAS FOR FUTURE RESEARCH

- Necessity to combine biological and economic aspects of stocks exploitation in order to ensure stability of the ecosystem while maintaining prosperity of the fishing sector (extension to include in form of cost of fishing - fish stock abundance dependence)
- Comparing results with other Baltic fleets to asses potential economic incentives to trade quotas between countries, e.g. on annual basis (comparison with Danish database)

Thank you for your attention