European Commission

The EU Fleet Economic Database: Short-term forecasts and quota impact

Carvalho, N.
Guillen, J.
Carpenter, G.

2016

EUR 28476 EN

JRC Science Hub
https://ec.europa.eu/jrc

JRC104421

EUR 28476 EN

PDF	ISBN 978-92-79-65789-4	ISSN 1831-9424	doi:10.2760/584037
Print	ISBN 978-92-79-65788-7	ISSN 1018-5593	doi:10.2760/53794

Luxembourg: Publications Office of the European Union, 2016

How to cite this report: Carvalho, N., Guillen, J., Carpenter, G., *The EU Fleet Economic Database: Short-term forecasts and quota impact*, EUR 28476, doi:10.2760/584037

Title The EU Fleet Economic Database: Short-term forecasts and quota impact

Abstract
The Annual Economic Report on the EU Fishing Fleet (AER) provides a comprehensive overview of the latest information available on the structure and economic performance of EU Member States fishing fleets, being the reference used for policy support. The socio-economic data collected and submitted by Member States under the EU Data Collection Framework (DCF) comes with at least a two year time lag. Yet, up-to-date and reliable information on the economic performance of European fishing fleets is essential for policy makers and fisheries managers to make sound decisions. Currently, the Bio-Economic Model of European Fleets (BEMEF) is used to forecast the short-term economic performance of Member State fishing fleets operating in the Northeast Atlantic. Due to underlying model assumptions based on annual (or multi-annual) Total Allowable Catches (TACs), BEMEF is only able to provide estimates for Member State fleets operating predominately in FAO fishing area 27, where most fisheries are managed under a TAC and quota system. To address the imitations of BEMEF and complement results in the AER with short-term performance projections for Member State fleets fishing outside area 27, we further explored the JRC/DCF economic database projection model and developed an alternative simplified methodology that allows projecting data for all countries, including Member State fleets operating exclusively in the Mediterranean & Black seas, as well as MS fleets operating in distant-waters. Both methodologies are compared and future recommendations are provided.

Contents

Authors 2
Abstract 3
1 Introduction 4
2 Materials and Methods 6
2.1 BEMEF 6
2.1.1 Data 6
2.1.2 Data incorporation 6
2.1.3 Other model drivers 7
2.1.4 Coverage of fleets and member states 7
2.1.5 Coverage of economic variables 8
2.1.6 Model equations 8
2.2 Alternative method for Mediterranean & Black Sea fleets 15
2.2.1 Regression analyses 15
2.2.2 Data 15
2.2.3 Analysis of the different variables 16
2.2.4 Proposed inferences 22
3 Results 25
3.1 Comparison of both models 25
3.2 Final recommendations 26
4 Conclusions 28
References 29
List of abbreviations and definitions 30
List of tables 31

Authors

Carpenter, Griffin
New Economics Foundation,
10 Salamanca Place, SE1 7HB,
London, UK.

Carvalho, Natacha
European Commission, Joint Research Centre,
Directorate D – Sustainable Resources, Unit D.02 Water and Marine Resources,
Via E. Fermi 2749,
21027-Ispra, Italy.

Guillen, Jordi
European Commission, Joint Research Centre,
Directorate D – Sustainable Resources, Unit D.02 Water and Marine Resources,
Via E. Fermi 2749,
21027-Ispra, Italy.

Abstract

The Annual Economic Report on the EU Fishing Fleet (AER) provides a comprehensive overview of the latest information available on the structure and economic performance of EU Member States fishing fleets. The AER and the data used to produce are important tools and references for fisheries socio-economic analyses in support of policy.

It is very relevant for policy makers and fisheries managers to have the most recent and reliable data possible on which to base sound decisions. However, the economic data collect and submitted by Member States under the EU Data Collection Framework (DCF) carries at least a two-year time lag. In the 2016 Annual Economic Report on the EU Fishing Fleet, EU Member States submitted economic and transversal (e.g. number of vessels, days at sea) data up to 2014. Some Member States were also in a position to provide partial economic (income from landings) and transversal data for 2015. In order to provide up-to-date information on the economic performance of European fishing fleets, the BEMEF (Bio-Economic Model of European Fleets) model was used to estimate performance in 2015 and 2016. Projections for 2015 and 2016 were calculated for the 15 Member State fleets with significant fishing operations in the Northeast Atlantic (FAO area 27). Due to the importance of TACs (Total Allowable Catches) as external drivers, projections using BEMEF for EU Member States that do not operate in area 27 could not be calculated.

To address this imitation of BEMEF and complement results in the AER with short-term performance projections for Member State fleets fishing outside area 27, we further explored the JRC/DCF economic database projection model and developed an alternative simplified methodology that allows projecting data for all countries, including Member State fleets operating exclusively in the Mediterranean & Black seas, as well as Member State fleets operating in distant-waters. This alternative method uses regression analyses to find the best fit between two or more variables, through the calculation of the coefficient of correlation.

Both the BEMEF and the alternative methodology are described and compared in this report. This allows us to formulate recommendations for future projections in the AER.

1 Introduction

The Annual Economic Report (AER) on the European Union (EU) Fishing Fleet provides the most comprehensive overview of the structure and economic performance of EU Member State fishing fleets. The AER contains the latest available socio-economic scientific data on the EU fleet provided by Member States under the EU Data Collection Framework (DCF) and is the reference document and source of data for policy support. Some policy uses of the AER and its datasets include: Evaluating the socio-economic impacts of most Impact Assessments (IA) of policy proposals by DG MARE concerning the Common Fisheries Policy (CFP); Providing indicators to assess the balance between fleet capacity and fishing opportunities, which determine fleet segments that can benefit from EMFF support for fleet measures (e.g. scrapping or engine replacements); Support the socio-economic evaluations of some CFP conservation measures (e.g. TACs reductions) and provide evidence when assessing the impacts of structural policy or implementation of structural policies by the MS.

Under the DCF 2016 call, EU Member States (MS) submitted economic and transversal (e.g. number of vessels, days at sea, landings) data up to 2014 for the elaboration of the 2016 AER. Some Member States were also able to provide partial economic (income from landings) and transversal data for 2015. This is the common practice, taking place every year, where the submitted economic data have a 2 year time-lag and transversal data 1 year, in the best of the cases. This occurs because in order to have one year data (t), for example 2014, it is necessary to wait until the end of the year (i.e. in t+1, e.g. 2015) to collect it. The data are then aggregated, processed, and quality checked by Member States before submitting during the data call.

Yet, for policy reasons, it is relevant to have the most recent data possible. Hence, robust estimates of the economic performance of the EU fishing fleet for t+1 and t+2, (in this case for 2015 and 2016), are needed, i.e. projections for 2015 and forecast for 2016.

In order to provide this up-to-date information on the economic performance of European fishing fleets, the Bio-Economic Model of European Fleets (BEMEF) was used to estimate performance in 2015, where preliminary data has not been provided, and to forecast fleet performance in 2016. Projections for 2015 and 2016 were calculated for the fleets of 15 Member States with significant fishing operations in the Northeast Atlantic (FAO area 27). Projections were not calculated for EU Member State fleets that do not operate in area 27 due to the importance of TACs as an external driver, in particular 2016 forecasts.

The BEMEF model is based on the EIAA model and designed around the DCF data. It incorporates knowledge about key economic relationships in the fishing industry and timely information (2015 and 2016) from other sources, including:

— TACs for 2015 and 2016 (from relevant Council legislation, covering 25 quota species and 150 TACs);
— Changes in spawning stock biomass (ICES) to estimate catchability;
— Changes in capacity (EU Fleet register);
— Changes in import/export fish prices from the European Market Observatory for Fisheries and Aquaculture Products (EUMOFA);
— Changes in fuel prices by MS (EC weekly oil bulletin) and
— Interest rates by MS from the European Central Bank (ECB).

Due to the importance of TACs and fishing quotas as output constraints, the BEMEF model is structure 'backwards', that is, by first setting the TAC, using the TAC to determine landings, determining the amount of effort required to harvest those landings and then calculating the associated revenues and cost with the level of effort and landings. As the implementation of the landing obligation is expected to impact fleet performance, especially for fleets with high, historic, discard rates, these expected impacts were incorporated in the 2016 projections for demersal fisheries. The amount of expected discards for each fleet was calculated by using discard rates from the Effort DCF call and applying this rate (minus a 10% improvement in selectivity) to the expected catches in 2016. The BEMEF model is described in more detail documented in more detail in the next section of this report.

As BEMEF employs TACs and quotas as the main external driver, it is not well adapted to model the performance of fleets and fisheries that are managed under different systems, such as effort regimes, as is the case of the majority of the MS fishing vessels operating in the Mediterranean & Black seas. To project performance results in t+1 for these MS fleets, we developed an alternative approach to overcome some of the limitations imposed in BEMEF. This simplified approach is based on regression analyses to estimate the best inferences for projecting data, and hence, in the case of limited data availability, can increase the coverage of short-term projections for MS fleets in the AER.

In the results section, we compare both methodologies and provide some recommendations for future projections in the AER.

2 Materials and Methods

2.1 BEMEF

2.1.1 Data

BEMEF uses the most recent three years of verified data (2012-2014) as a baseline from which to model future performance. A three-year base period removes some of the year-to-year variance while ensuring that the data used for projections is current and relevant[1].

From this base period, projections for 2015 and 2016 are calculated using what is known about fleet performance in these years from non-DCF data sources and by using equations that approximate fleet behaviour on key economic relationships. These equations are documented at the end of this chapter.

Where data has already been provided for a fleet in 2015, this preliminary data is used. For many fleets and member states, this means that the 2015 figures are a mix of preliminary data where it is available and modelled data where no data has been provided. All data for 2016 is modelled as no preliminary data is available at the fleet level until the end of the year.

Additional data inputs for the projections are:

- Total Allowable Catches (2015 and 2016);
- changes in spawning stock biomass (2015 and 2016 for the Baltic stocks;
- changes in the number of registered vessels by member state and by length class (2015 and 2016);
- changes in import/export fish prices by member state and species (2015 and 2016 January-April);
- changes in fuel prices by member state (2015 and 2016 January-April);
- Interest rates by member state (2015 and 2016 January-April).

2.1.2 Data incorporation

The data 2015 and 2016 Total Allowable Catches comes from the relevant Council legislation and agreements with third countries. BEMEF uses the majority of these TACs as inputs, covering 25 quota species and 150 TACs. Each fleet's allocation of its member state TAC is determined based on its proportion of the member state landings in the base period.

The spawning stock biomass is published by the International Council for Exploration of the Sea (ICES) for most stocks in 2015 and for the Baltic stocks for 2016. This information is used to estimate changes in catchability.

The number of vessels comes from the EU Fleet Register. For integration in BEMEF this data is grouped by member state and by three length classes (0-12m, 12-24m, 24m+) using the 1 January registration. These figures are then compared to the average 1 January registration from 2012-2014 to calculate the relative change in vessel numbers for each fleet.

[1] Fleets that change clusters over this time period were aggregated to their 2014 clustering to harmonise data reporting with the rest of this report. A two-year base period is used for effort data from Estonia as there was a change in reporting methodology from 2012 to 2013.

Import/export fish prices come from the European Market Observatory for Fisheries and Aquaculture Products (EUMOFA). These prices may not directly reflect the price at first sale that vessels receive, but the relative change from the base period to 2015 and 2016 should approximate overall prices in the supply chain. Member state prices are calculated per species and then an average is taken between the import/export price for the member state of the fleet and the EU as a whole to account for landings to foreign ports.

Fuel oil prices are extracted from European Commission's Weekly oil bulletin and the change in price between periods is calculated for each member state as the price change is non-uniform between member states.

The interest rate by member state is provided by the European Central Bank and is used to calculate opportunity costs2.

2.1.3 Other model drivers

A level of technological change of 2% per annum is used to simulate the observed trend in EU fisheries of increasing catchability (measured as catch per unit of effort) due to gear improvement. The consequence of this driver is that fewer days at sea are required per unit of catch and thus a decrease in all variable costs. A further technological change factor of 2% per annum is used to simulate the substitution of labour for capital. As the 2015 projections are made from a three-year base period, these technological change factors are calculated as compounded over two years (as 2013 is the midpoint of the base period).

The implementation of the landing obligation is a significant policy change that is likely to impact fleet economic performance, especially for fleets with large, historic discard rates. The landing obligation is already in place in the Baltic Sea and pelagic fisheries, although the estimated economic impact is considered to be relatively small, especially in future forecasts, so it is not included in the BEMEF modelling.

There will be a noteworthy change in 2016 with the implementation of the landing obligation for a number of demersal fisheries. The amount of expected discards for each fleet is calculated by using discard rates from the effort data call and applying this rate (minus a 10% improvement in selectivity for 2016) to the expected catches in 2016.

There are expected to be impacts on the operating costs of vessels for increased labour to help with sorting fish, steaming costs when hold capacity is reached earlier due to discards, and processing costs to handle the discarded fish onshore. An estimate of €305 per tonne of landed discards is applied in BEMEF following a Dutch trial run by LEI Wageningen UR[3]. There are also expected to be impacts on fleet revenues as TACs may rise due to quota uplift, but some of this landed fish will have a much lower price as it cannot be sold for human consumption. The Dutch trial shows an expected price of €100 per tonne of landed discards. The amount of landed discards under the 2016 landing obligation is also used to adjust catchability to model hold capacity. No choke analysis was included in this modelling but is recommended for any projections to 2017 and beyond.

2.1.4 Coverage of fleets and member states

Projections for 2015 and 2016 have been calculated for the fleets of 15 Member States with significant fishing operations in the Northeast Atlantic (FAO area 27): Belgium, Germany, Denmark, Spain, Estonia, Finland, France, the United Kingdom, Ireland,

[2] In keeping with the rest of this report, the interest rate for Estonia is calculated as an average of interest rates for Lithuania and Latvia.

[3] Baarssen, J., Luchies, J., Turenhout, M., Buisman, F.C. (2015). Verkenning economische impact aanlandplicht op Nederlandse kottervloot. Flynth adviseurs en accountants & LEI Wageningen UR.

Lithuania, Latvia, the Netherlands, Poland, Portugal and Sweden. Projections for EU member states that do not operate in this area were not calculated due to the importance of TACs as an external driver – especially for the 2016 projections. Some of the Member States covered have fleets outside of the Northeast Atlantic and projections are made for these fleets. Although the projections for these fleets are more simplified, this approach allows member state performance to be projected by summing the performance of all fleets.

Economic performance is calculated in BEMEF at the fleet level and is then summed to member state totals. Some fleets have incomplete data, so the total figure at the member state level may have varying degrees of coverage4. This issue is mirrored in the 2016 AER's national chapters.

2.1.5 Coverage of economic variables

In the 2016 AER, BEMEF provides projections for 2015 and 2016 by fleet segment for a range of economic performance measures consistent with the data collection framework reporting:

- Active vessels (#)[5]
- Full time equivalent fishers (#)
- Total employed (person)
- Days at sea (day)
- Energy consumption (thousand litre)
- Live weight of landings (thousand tonne)
- Value of landings (thousand €)
- Income from landings (thousand €)
- Other income (thousand €)
- Wages and salaries of crew (thousand €)
- Unpaid labour value (thousand €)
- Energy costs (thousand €)
- Repair and maintenance costs (thousand €)
- Other variable costs (thousand €)
- Other non-variable costs (thousand €)
- Annual depreciation costs (thousand €)
- Opportunity cost of capital (thousand €)
- Tangible asset value (thousand €)
- Gross value added (GVA) (thousand €)
- GVA to revenue (%)
- Gross profit (thousand €)
- Gross profit margin (%)
- Net profit (thousand €)
- Net profit margin (%)
- GVA per FTE (thousand €)
- Return of fixed tangible assets (%)

2.1.6 Model equations

The following section covers the equations used to calculate the economic performance measures. The full model methodology and data sources for BEMEF can be found online at www.fisheriesmodel.eu. If preliminary data is available for 2015, the preliminary data is used instead of the calculations listed here.

Due to the importance of fishing quota as an output constraint, the model structure of BEMEF is 'backwards' by first setting the TAC, using the TAC to determine landings,

[4] The exception is Germany, where the DEU A27 TM40XX fleet is excluded in the calculation of total weight of landings due to incomplete data on other variables.
[5] This differs from the historic tables in this report which refer to total vessels.

determining the amount of effort required to harvest those landings, and then calculating the associated costs and revenues with that level of effort and landings.

Live weight of landings

The following equation is used to determine landings for a fleet:

$$L_{j,t,k} = \sum FSS_{j,k} RU_{j,k} RS_{c,k} Q_{t,k} + NQL_{t,j} \qquad \text{(eq. 1)}$$

Where:

- L - Quantity of landings
- j - Fleet segment
- k - TAC (species and area)
- c - Member state
- t - Time period
- FSS - Fleet segment share
- RU - Realised uptake
- RS - Relative stability
- Q – Quota
- NQL – Non-quota landings
- 0/t - Time period

For the fleet segment share (FSS) the default assumption is that quota is allocated to fleets within member states based on historic landings reported in the base period.

Not all of the quota that is allocated to a member state or fleet will actually be landed in a given year and model simulations account for this more likely outcome. The default level of uptake (RU) is calculated for each TAC and for each country using reported landings from the AER database and comparing this to the amount of quota allocated to a country through relative stability. This is calculated using the following equation:

$$RU_{j,k} = \frac{L_{0,j,k}}{FSS_{0,j,k} Q_{0,k}} \qquad \text{(eq. 2)}$$

Likewise, the relative stability of quota between member states is assumed to be fixed, but any quota trading between member states is captured by the realised uptake percentages.

Not all fleet landing will be covered by quota species. This amount of landings (NQL, in tonnes) is calculated from the base period and assumed to be constant in future periods:

$$NQL_{t,j} = L_{0,j} - QL_{0,j} \qquad \text{(eq. 3)}$$

Where:

- QL – Quota landings

Value of landings

The value of landings (LV) is determined by the price of quota species applied to the quantity of quota species:

$$LV_{t,j} = \sum_i P_{t,i,j} QL_{t,i,j} + NQLV_{t,j} \qquad \text{(eq. 4)}$$

Where:

- i – Species

The value of landings of non-quota species (NQLV) is calculated from the base period and assumed to be constant in future periods:

$$NQLV_{t,j} = LV_{0,j} - QLV_{0,j} \qquad \text{(eq. 5)}$$

Where:

- LV - Value of landings
- QLV – Value of landings under quota management
- NQLV - Value of landings not under quota management

For the majority of commercial fish species the EUMOFA database covers import/export prices by Member State. In these situations future prices by fleet and species are calculated as the average of the change in Member State and EU import/export prices. The adjustment factor is adjusted by inflation as the EUMOFA prices are nominal.

Where EUMOFA prices are used:

$$P_{t,i,j} = P_{0,i,j} * \frac{\left[\left(\frac{EUP_{0,i,m}}{EUP_{t,i,m}}\right)+\left(\frac{EUP_{0,i,eu}}{EUP_{t,i,eu}}\right)\right]}{2} \qquad \text{(eq. 6)}$$

Where:

- EUP – EUMOFA import/export price
- m – Member state
- eu – European Union average

Prices in the base period (P) are calculated using fleet level data:

$$P_{0,i,j} = \frac{LV_{0,i,j}}{L_{0,i,j}} \qquad \text{(eq. 7)}$$

Where species are not covered by the EUMOFA database a fish price flexibility is used. Fish price flexibilities (the inverse of a price elasticity) tend to follow an inverse demand model with a decrease in supply leading to an increase in price. The reference rates for a species' price flexibility largely come from academic literature and those used in other bio-economic models.

Where price flexibility is required:

$$P_{t,i,j} = P_{0,i,j} * \left(\frac{Q_{t,i,j}}{Q_{0,i,j}}\right)^{e} \qquad \text{(eq. 8)}$$

Where:

- e - Price flexibility by species

For 2016 the value of landings is extended to include some potential impacts of the landing obligation on fleet performance

$$LV_{t,j} = \sum_i P_{t,i,j} QL_{t,i,j} + NQLV_{t,j} - \left(DR_{t,j,k} * sc * \frac{L_{t,j,k}}{(1- DR_{t,j,k})} * \left(P_{t,i,j} - dp\right)\right) \qquad \text{(eq. 9)}$$

Where:

- DR – discard rate
- sc – selectivity change of 90% (a 10% change)
- dp – landed discard price of €100/tonne

Income from landings

$$LI_{t,j} = LV_{t,j} * \left(\frac{LI_{0,j}}{LV_{0,j}}\right) \qquad \text{(eq. 10)}$$

Where:

- LI – income from landings

Other income

$$OI_{t,j} = OI_{0,j} * \left(\frac{V_{t,j}}{V_{0,j}}\right) \quad \text{(eq. 11)}$$

Where:

- OI – Other income
- V – Number of vessels

Energy costs

$$EC_{t,j} = EC_{0,j} * A_{t,j} * \left(\frac{V_{t,j}}{V_{0,j}}\right) \quad \text{(eq. 12)}$$

Where:

- EC – Energy costs
- A – Activity coefficient

An activity variable is calculated and used in the model to adjust variable costs. These changes are calculated within a fleet segment, rather than between fleets.

This calculation takes the form of an inverse Cobb-Douglas production function to isolate for the effort change variable.

$$A_{t,j} = \sum\left(L_{0,i,j} P_{t,i,j} \theta_{t,i,j}\right) * \left(\frac{SSB_{t,i,j}}{SSB_{0,i,j}}\right)^{\Upsilon_{i,j}} * \left(\frac{Q_{t,i,j}}{Q_{0,i,j}}\right)^{\chi_{i,j}} \quad \text{(eq. 13)}$$

Where:

- θ - Effort driver
- SSB - Spawning stock biomass
- ϒ - Activity-stock flexibility rate (β/ɑ)
- χ - Activity-landing flexibility rate (1/ɑ)
- ɑ - catch-effort coefficient
- β - stock-catch coefficient

Other variable costs

$$OVC_{t,j} = OVC_{0,j} * A_{t,j} * \left(\frac{V_{t,j}}{V_{0,j}}\right) \quad \text{(eq. 14)}$$

For 2016 variable costs are extended to include some potential impacts of the landing obligation on fleet performance

$$OVC_{t,j} = \left(OVC_{0,j} * A_{t,j} * \left(\frac{V_{t,j}}{V_{0,j}}\right)\right) + \left(DR_{t,j,k} * sc * \frac{L_{t,j,k}}{(1 - DR_{t,j,k})} * dc\right) \quad \text{(eq. 15)}$$

Where:

- OVC – other variable costs
- θ - Effort driver
- SSB - Spawning stock biomass
- ϒ - Activity-stock flexibility rate (β/ɑ)
- χ - Activity-landing flexibility rate (1/ɑ)
- ɑ - catch-effort coefficient
- β - stock-catch coefficient
- dc – discard processing costs of €305/tonne

Repair and maintenance costs

$$RC_{t,j} = RC_{0,j} * \left(\frac{V_{t,j}}{V_{0,j}}\right) \quad \text{(eq. 16)}$$

Where:

- RC – repair and maintenance costs

Other non-variable costs

$$NVC_{t,j} = NVC_{0,j} * \left(\frac{V_{t,j}}{V_{0,j}}\right) \quad \text{(eq. 17)}$$

Where:

- NVS – Other non-variable costs

Wages and salaries

$$LC_{t,j} = MAX\left[\left(\left(LI_{t,j}\right) * \left(\frac{LC_{0,j}}{LI_{0,j}}\right)\right| \left(\frac{LC_{0,j}}{FTE_{0,j}}\right) * FTE_{t,j} * 0.5\right)\right] \quad \text{(eq. 18)}$$

Where:

- LC – Labour costs (wages and salaries)

Unpaid labour value

$$ULC_{t,j} = ULC_{0,j} * \left(\frac{V_{t,j}}{V_{0,j}}\right) \quad \text{(eq. 19)}$$

Where:

- ULC – unpaid labour costs

Annual depreciation costs

$$D_{t,j} = D_{0,j} * \left(\frac{V_{t,j}}{V_{0,j}}\right) \quad \text{(eq. 20)}$$

Where:

- D – Depreciation costs

Tangible asset value

$$TAV_{t,j} = TAV_{0,j} * \left(\frac{V_{t,j}}{V_{0,j}}\right) \quad \text{(eq. 21)}$$

Where:

- TAV – Tangible asset value

Opportunity cost of capital

$$O_{t,j} = TAV_{t,j} * r_{t,m} \quad \text{(eq. 22)}$$

Where:

- O – Opportunity cost
- r – real interest rate

The opportunity cost of capital uses a real interest rate (r) which is calculated as:

$$r_{t,m} = \frac{1+i_{t,m}}{1+\pi_{t,m}} - 1 \qquad \text{(eq. 23)}$$

Where:

- i – interest rate
- π – inflation rate

Gross value added

$$GVA_{t,j} = LI_{t,j} + OI_{t,j} - EC_{t,j} - OVC_{t,j} - RC_{t,j} - NVC_{t,j} \qquad \text{(eq. 24)}$$

Where:

- GVA – Gross value added

GVA to revenue

$$(GVA/TR)_{t,j} = \frac{GVA_{t,j}}{TR_{t,j}} \qquad \text{(eq. 25)}$$

Total revenue includes landing income (LI) and other income (OI):

$TR_{t,j} = LI_{t,j} + OI_{t,j}$

Where:

- TR – Total revenue

Gross profit

$$GCF_{t,j} = GVA_{t,j} - LC_{t,j} \qquad \text{(eq. 26)}$$

Where:

- GCF – Gross cash flow (gross profits)

Gross profit margin

$$GPM_{t,j} = \frac{GCF_{t,j}}{TR_{t,j}} \qquad \text{(eq. 27)}$$

Where:

- GPM – Gross profit margin

Net Profit

$$P_{t,j} = GCF_{t,j} - D_{t,j} - O_{t,j} \qquad \text{(eq. 28)}$$

Where:

- P – Net profit

Net profit margin

$$NPM_{t,j} = \frac{P_{t,j}}{TR_{t,j}} \qquad \text{(eq. 29)}$$

Where:

- NPM – Net profit margin

GVA per FTE

$$(GVA/FTE)_{t,j} = \frac{GVA_{t,j}}{FTE_{t,j}} \quad \text{(eq. 30)}$$

Where:

- FTE – Full time equivalent (national) employees

Return of fixed tangible assets

$$RoFTA_{t,j} = \frac{P_{t,j}+O_{t,j}}{TAV_{t,j}} \quad \text{(eq. 31)}$$

Where:

- RoFTA – Return on fixed tangible assets

Full time equivalent fishers

$$FTE_{t,j} = \frac{FTE_{0,j}}{SD_{0,j}} * SD_{t,i,j} * \frac{1}{1+LS^t} \quad \text{(eq. 32)}$$

Where:

- ɑ - catch-effort coefficient
- β - stock-catch coefficient
- SD - Sea days
- LS – Labour substitution of 2% per annum

Total employed

$$TE_{t,j} = TE_{0,j} * \left(\frac{V_{t,j}}{V_{0,j}}\right) \quad \text{(eq. 33)}$$

Where:

- TE – Total employed

Days at sea

$$SD_{t,i,j} = L_{t,i,j} CPUE_{t,i,j} \quad \text{(eq. 34)}$$

The number of sea days in future periods uses a measure of catachability, measured as catch per unit of effort (CPUE):

$$CPUE_{0,i,j} = \frac{L_{0,i,j}}{SD_{0,j}} \quad \text{(eq. 35)}$$

Where

- CPUE - Catch per unit of effort

Then future catchability using a Cobb-Douglas productions function

$$CPUE_{t,i,j} = CPUE_{0,i,j} * \left(\frac{L_{t,i,j}}{L_{0,i,j}}\right)^{1-\left(\frac{1}{\alpha_{i,j}}\right)} * \left(\frac{SSB_{t,i,j}}{SSB_{0,i,j}}\right)^{\frac{\beta_i}{\alpha_{i,j}}} * TI^t \quad \text{(eq. 36)}$$

Where:

- TI – Technological improvement of 2% per annum

Energy consumption

$$EC_{t,j} = EC_{0,j} * \frac{SD_{t,j}}{SD_{0,j}} \qquad \text{(eq. 37)}$$

Where:

- EC – Energy consumption

2.2 Alternative method for Mediterranean & Black Sea fleets

The main aim of this exercise is to complement the BEMEF model, which is tailored for fisheries managed under TACs and quotas, to provide projections for Mediterranean & Black Sea fleets and fisheries managed under effort or other regimes in general. This will further improve the projecting and forecasting capabilities of the JRC/DCF models and AER outputs. We further investigate the various explanatory capacities that the different transversal variables (e.g. number of vessels, days at sea and value of landings) have when trying to infer the values of other variables, generally termed the 'economic' variables, such as employment, income and costs.

For this, two approaches are considered. The first infers values for a variable in year t+1 when the economic data for year t and transversal data for year t+1 are available as explanatory variables. The second approach attempts to explain the value of a variable in year t+1 based only on the values of that variable in year t.

In this way, for example in the case of the 2016 AER, the first approach would allow to estimate 2015 variables, and the second one would allow to project 2016 data.

2.2.1 Regression analyses

We use regression analysis to estimate the relationship between variables.

In the second approach, when a variable "A" at year t+1 is explained by the same variable "A" at year t, the following equation characterisation is used to run the regression:

$$A_{t+1} = \alpha A_t \qquad \text{(eq. 38)}$$

The regression coefficient is the constant (α) that represents the rate of change of one variable (A_{t+1}) as a function of change in the other (A_t).

While in the first approach, when a variable "A" in year t+1 is explained by the same variable "A" in year t and another variable "B" with a known value in year t+1, then the following equation is used:

$$A_{t+1} = \alpha \left(A_t \frac{B_{t+1}}{B_t} \right) \qquad \text{(eq. 39)}$$

The R-square of the regression indicates the proportion of variance in the dependent variable that is predictable from the independent variable, that is, it informs how well one variable can explain the other.

2.2.2 Data

For this exercise, data submitted by Member States under the 2016 DCF fleet economic data call for the period 2008-2014 were used. Only data from fleet segments with reported values for all the main variables and years of analysis were considered. By main variables we mean the variables necessary to estimate the economic performance (net profits) of a fleet segment. The dataset used comprised 184 fleet segments that reported main variables for the years 2008-2014 (download date: 12/05/2016).

Data were paired by years: t and t+1 (e.g. 2008 and 2009, 2009 and 2010, and so on). Hence, six year groups could be achieved, multiplied to the 184 fleet segments led to a total of 1104 observations for each variable.

The variables investigated for year t+1 were:

- Number of vessels
- Days at sea
- Income from landings
- Unpaid labour
- Wages and salaries
- Energy consumption
- Energy costs
- Repair and maintenance
- Depreciation costs
- Other variable costs
- Other non-variable costs
- Value of tangible assets
- Total employment
- Full Time Equivalents
- Other income

2.2.3 Analysis of the different variables

Number of vessels

The *number of vessels* in year t+1 can be well explained by the *number of vessels* in year t, or by the *number of vessels* in year t multiplied by the change in *days at sea* in year t+1 compared to year t.

Table 1: Potential relations for number of vessels

Dependent variable	Explanatory variable	Coefficient	R-square
(number of vessels)$_{t+1}$	(number of vessels)$_t$	0.99	0.99
(number of vessels)$_{t+1}$	$(number\_of\_vessels)_t \dfrac{(days\_at\_sea)_{t+1}}{(days\_at\_sea)_t}$	0.99	0.99

Days at sea

The *days at sea* for year t+1 can be robustly explained by *days at sea* in year t, and by the *days at sea* in year t raised by the change in the *number of vessels*.

Table 2: Potential relations for days at sea

Dependent variable	Explanatory variable	Coefficient	R-square
$(\text{Days at sea})_{t+1}$	$(\text{Days at sea})_t$	0.98	0.99
$(\text{Days at sea})_{t+1}$	$(Days\_at\_sea)_t \dfrac{(number\_of\_vessels)_{t+1}}{(number\_of\_vessels)_t}$	0.98	0.99

Income from landings

From the regression outcomes, the best way to estimate *income from landings* at year t+1 is by using the *value of landings* in t+1. As one would expect, both figures should match.

When *value of landings* in year t+1 is not available, then *income from landings* or *value of landings* in year t can be used (the R-square in both cases are very similar).

Other options for estimating *income from landings* in t+1 include raising the *income from landings* in the previous year by the change in the *number of vessels*, or by raising *income from landings* in the previous year by the change in the *days at sea*. These options provide only slightly better results than simply using the previous year's *income from landings* or *value of landings*.

Table 3: Potential relations for income from landings

Dependent variable (t+1)	Explanatory variable	Coefficient	R-square
$(\text{Income from landings})_{t+1}$	*(Income_from_landings)*$_t$	0.99	0.94
$(\text{Income from landings})_{t+1}$	$(Income\_from\_landings)_t \dfrac{(days\_at\_sea)_{t+1}}{(days\_at\_sea)_t}$	1.02	0.95
$(\text{Income from landings})_{t+1}$	$(Income\_from\_landings)_t \dfrac{(days\_at\_sea)_{t+1}}{(days\_at\_sea)_t} \dfrac{(number\_of\_vessels)_{t+1}}{(number\_of\_vessels)_t}$	0.92	0.84
$(\text{Income from landings})_{t+1}$	$(Income\_from\_landings)_t \dfrac{(number\_of\_vessels)_{t+1}}{(number\_of\_vessels)_t}$	1.03	0.96
$(\text{Income from landings})_{t+1}$	$(Income\_from\_landings)_t \dfrac{(value\_of\_landings)_{t+1}}{(value\_of\_landings)_t}$	1.00	0.99
$(\text{Income from landings})_{t+1}$	(Value_of_landings)t+1	1.00	0.99
$(\text{Income from landings})_{t+1}$	(Value_of_landings)t	0.99	0.95

Wages and salaries

Results indicate that the best way to estimate *wages and salaries* for year t+1 is either (i) by multiplying *wages and salaries* at year t by the increase in *value of landings* from year t to t+1, or (ii) by multiplying *wages and salaries* in year t by the increase in *value of landings* minus the *fuel costs* from year t to t+1.

For simplicity, the former approach may be chosen. If *value of landings* is missing, *income from landings* could be used as a robust proxy.

Table 4: Potential relations for wages and salaries

Dependent variable	Explanatory variable	Coefficient	R-square
$(\text{Wages\_and\_salaries})_{t+1}$	$(\text{Wages\_ and\_salaries})_t$	0.95	0.87
$(\text{Wages and salaries})_{t+1}$	$(Wages\_and\_salaries)_t \dfrac{(number\_of\_vessels)_{t+1}}{(number\_of\_vessels)_t}$	1.00	0.91
$(\text{Wages and salaries})_{t+1}$	$(Wages\_and\_salaries)_t \dfrac{(value\_of\_landings)_{t+1}}{(value\_of\_landings)_t}$	0.99	0.93
$(\text{Wages and salaries})_{t+1}$	$(Wages\_and\_salaries)_t \dfrac{(value\_of\_landings)_{t+1} - (Fuel\_\cos ts)_{t+1}}{(value\_of\_landings)_t - (Fuel\_\cos ts)_t}$	0.97	0.93
$(\text{Wages and salaries})_{t+1}$	$(Wages\_and\_salaries)_t \dfrac{(days\_at\_sea)_{t+1}}{(days\_at\_sea)_t}$	1.00	0.90

Unpaid labour

Unpaid labour value in year t+1 can be explained by the *unpaid labour* value in year t raised by the increase in the *number of vessels*, even if the explanatory power (r-square) is relatively low.

Table 5: Potential relations for unpaid labour

Dependent variable	Explanatory variable	Coefficient	R-square
$(\text{unpaid labour})_{t+1}$	$(\text{unpaid labour})_t$	0.89	0.79
$(\text{unpaid labour})_{t+1}$	$(unpaid\_labour)_t \dfrac{(number\_of\_vessels)_{t+1}}{(number\_of\_vessels)_t}$	0.91	0.79
$(\text{unpaid labour})_{t+1}$	$(unpaid\_labour)_t \dfrac{(days\_at\_sea)_{t+1}}{(days\_at\_sea)_t}$	0.83	0.72
$(\text{unpaid labour})_{t+1}$	$(unpaid\_labour)_t \dfrac{(wages\_and\_salaries)_{t+1}}{(wages\_and\_salaries)_t}$	0.71	0.68

Energy consumption

Energy consumption in year t+1 can be well explained by the *energy consumption* in year t raised by the increase in the *days at sea* or the *number of vessels*. Raising by the change in *days at sea*, explains slightly better than by raising by the change in the *number of vessels*, as shown in the annex tables.

Table 6: Potential relations for energy consumption

Dependent variable	Explanatory variable	Coefficient	R-square
$(\text{Energy consumption})_{t+1}$	$(\text{Energy consumption})_t$	0.94	0.96

(Energy consumption)$_{t+1}$	$(Energy\_consumption)_t \dfrac{(number\_of\_vessels)_{t+1}}{(number\_of\_vessels)_t}$	0.99	0.97
(Energy consumption)$_{t+1}$	$(Energy\_consumption)_t \dfrac{(days\_at\_sea)_{t+1}}{(days\_at\_sea)_t}$	0.98	0.97

Energy costs

Energy costs in year t+1 can be better explained by the *energy costs* in year t raised by the increase in the *number of vessels*.

Table 7: Potential relations for energy costs

Dependent variable	**Explanatory variable**	**Coefficient**	**R-square**
(Energy costs)$_{t+1}$	(Energy costs)$_t$	0.93	0.93
(Energy costs)$_{t+1}$	$(Energy\_\cos ts)_t \dfrac{(number\_of\_vessels)_{t+1}}{(number\_of\_vessels)_t}$	0.97	0.94
(Energy costs)$_{t+1}$	$(Energy\_\cos ts)_t \dfrac{(days\_at\_sea)_{t+1}}{(days\_at\_sea)_t}$	0.96	0.93

However, energy consumption can be explained better than energy costs. This implies that there is more uncertainty when forecasting energy costs than energy consumption. This is because (volatile) fuel price variations add uncertainty to this variable. Therefore, if fuel prices for t+1 are available, fuel consumption for the year t+1 can be projected, and then multiplied by the fuel price to obtain the fuel costs.

Repair and maintenance costs

Repair and maintenance costs in year t+1 can be better explained by *repair and maintenance costs* in year t multiplied by the change in the *number of vessels*, or by the *repair and maintenance costs* in year t alone.

Table 8: Potential relations for repair and maintenance costs

Dependent variable	**Explanatory variable**	**Coefficient**	**R-square**
(repair and maintenance)$_{t+1}$	(repair and maintenance)$_t$	0.96	0.89
(repair and maintenance)$_{t+1}$	$(repair\_and\_ma\text{int}enance)_t \dfrac{(number\_of\_vessels)_{t+1}}{(number\_of\_vessels)_t}$	0.99	0.90
(repair and maintenance)$_{t+1}$	$(repar\_and\_ma\text{int}enance)_t \dfrac{(days\_at\_sea)_{t+1}}{(days\_at\_sea)_t}$	1.00	0.89

Depreciation costs

Depreciation costs at year t+1 can be either explained by the *depreciation costs* in year t or the *depreciation costs* in year t multiplied by the change in the *number of vessels* from year t to t+1.

When the *number of vessels* is available, we consider that the best option is to use the *depreciation costs* at year t multiplied by the change in the *number of vessels* from year t to t+1, because it helps to capture significant changes in vessel numbers that a fleet segment may suffer, which would have an important effect on depreciation costs.

Table 9: Potential relations for depreciation costs

Dependent variable	**Explanatory variable**	**Coefficient**	**R-square**
$(\text{depreciation})_{t+1}$	$(\text{depreciation})_t$	0.93	0.92
$(\text{depreciation})_{t+1}$	$(depreciation)_t \dfrac{(number\_of\_vessels)_{t+1}}{(number\_of\_vessels)_t}$	0.96	0.92
$(\text{depreciation})_{t+1}$	$(depreciation)_t \dfrac{(days\_at\_sea)_{t+1}}{(days\_at\_sea)_t}$	0.95	0.90

Other variable costs

Other variable costs in year t+1 can be better explained by the *other variable costs* in year t multiplied by the change in the *number of vessels*, or by the *other variable costs* in year t alone.

Table 10: Potential relations for other variable costs

Dependent variable	**Explanatory variable**	**Coefficient**	**R-square**
$(\text{other variable costs})_{t+1}$	$(\text{other variable costs})_t$	0.93	0.87
$(\text{other variable costs})_{t+1}$	$(other\_variable\_costs)_t \dfrac{(number\_of\_vessels)_{t+1}}{(number\_of\_vessels)_t}$	0.98	0.90
$(\text{other variable costs})_{t+1}$	$(other\_variable\_costs)_t \dfrac{(days\_at\_sea)_{t+1}}{(days\_at\_sea)_t}$	0.98	0.90

Other non-variable costs

Similarly, *other non-variable costs* in year t+1 can be better explained by the *other non-variable costs* in year t multiplied by the change in the *number of vessels*, or by the other *non-variable costs* in year t alone.

Table 11: Potential relations for other non-variable costs

Dependent variable	**Explanatory variable**	**Coefficient**	**R-square**

(other non-variable costs)$_{t+1}$	(other non-variable costs)$_t$	1.04	0.90
(other non-variable costs)$_{t+1}$	$(other\_non\_variable\_costs)_t \dfrac{(number\_of\_vessels)_{t+1}}{(number\_of\_vessels)_t}$	1.05	0.90
(other non-variable costs)$_{t+1}$	$(other\_non\_variable\_costs)_t \dfrac{(days\_at\_sea)_{t+1}}{(days\_at\_sea)_t}$	1.00	0.86

Total value of tangible assets

The total *value of tangible assets* in year t+1 can be well explained by the total *value of tangible assets* in year t raised by the increase in the *number of vessels*.

Table 12: Potential relations for value of assets

Dependent variable	Explanatory variable	Coefficient	R-square
(value of assets)$_{t+1}$	(value of assets)$_t$	0.98	0.96
(value of assets)$_{t+1}$	$(Value\_of\_assets)_t \dfrac{(number\_of\_vessels)_{t+1}}{(number\_of\_vessels)_t}$	1.00	0.96
(value of assets)$_{t+1}$	$(Value\_of\_assets)_t \dfrac{(days\_at\_sea)_{t+1}}{(days\_at\_sea)_t}$	0.98	0.95
(value of assets)$_{t+1}$	(value of assets + investments – depreciation)$_t$	1.02	0.95
(value of assets)$_{t+1}$	((value of assets)$_t$ + (investments)$_{t+1}$ – (depreciation)$_{t+1}$)	1.02	0.95
(value of assets)$_{t+1}$	(value of assets + investments)$_t$	0.92	0.95
(value of assets)$_{t+1}$	(value of assets – depreciation)$_t$	1.11	0.95
(value of assets)$_{t+1}$	$(Value\_of\_assets + investments - depreciation)_t \dfrac{(number\_of\_vessels)_{t+1}}{(number\_of\_vessels)_t}$	1.04	0.95

Total employment

Outcomes from this analysis show that *total employment* in year t+1 can be well explained by the *total employment* in year t raised by the increase in the *number of vessels*.

Table 13: Potential relations for total employment

Dependent variable	Explanatory variable	Coefficient	R-square
(total_employment)$_{t+1}$	(total_employment)$_t$	0.97	0.96
(total_employment)$_{t+1}$	$(total\_employment)_t \dfrac{(number\_of\_vessels)_{t+1}}{(number\_of\_vessels)_t}$	1.00	0.97

$(\text{total\_employment})_{t+1}$	$(total\_employment)_t \dfrac{(days\_at\_sea)_{t+1}}{(days\_at\_sea)_t}$	0.98	0.95

Full Time Equivalents (FTE)

Full time equivalents in year t+1 can be better explained by the *full time equivalents* in year t raised by the increase in the *days at sea*.

Table 14: Potential relations for full time equivalent

Dependent variable	**Explanatory variable**	**Coefficient**	**R-square**
$(\text{FTE})_{t+1}$	$(\text{FTE})_t$	0.94	0.93
$(\text{FTE})_{t+1}$	$(FTE)_t \dfrac{(number\_of\_vessels)_{t+1}}{(number\_of\_vessels)_t}$	0.99	0.95
$(\text{FTE})_{t+1}$	$(FTE)_t \dfrac{(days\_at\_sea)_{t+1}}{(days\_at\_sea)_t}$	0.97	0.96

Other income

Other income in year t+1 can be better explained by the *other income* in year t raised by the increase in the *number of vessels*. However, the explanatory power (R-square) is relatively low.

Table 15: Potential relations for other income

Dependent variable	**Explanatory variable**	**Coefficient**	**R-square**
$(\text{Other income})_{t+1}$	$(\text{Other income})_t$	0.56	0.25
$(\text{Other income})_{t+1}$	$(Other\_income)_t \dfrac{(number\_of\_vessels)_{t+1}}{(number\_of\_vessels)_t}$	0.62	0.26
$(\text{Other income})_{t+1}$	$(Other\_income)_t \dfrac{(days\_at\_sea)_{t+1}}{(days\_at\_sea)_t}$	0.54	0.21

2.2.4 Proposed inferences

From the outcomes of the regression analysis presented in the results section, we propose two different sets of relationships between variables. The first set of relations (see Table 16) contains as explanatory variables economic data for year t and transversal data (i.e., vessels, days at sea and value of landings) for year t+1; while the second (see Table 17) explains the value of a variable based on values of that variable at year t.

This implies that forecasts obtained using the first approach are more dynamic, and better adapt significant changes in the fleets (e.g. significant reductions in the number of vessels). Hence, it can be used to forecast national totals but also fleet segments when year t+1 transversal data are available.

Table 16: Proposed relations and coefficients with available number of vessels, days at sea and value of landings for year t+1

Dependent variable (t+1)	Explanatory variable	Coefficient
Number of vessels	$(number\_of\_vessels)_t \dfrac{(days\_at\_sea)_{t+1}}{(days\_at\_sea)_t}$	0.994505
Days at sea	$(Days\_at\_sea)_t \dfrac{(number\_of\_vessels)_{t+1}}{(number\_of\_vessels)_t}$	0.982749
Income from landings	$(Value\_of\_landings)_{t+1}$	1.004850
Wages and salaries	$(Wages\_and\_salaries)_t \dfrac{(value\_of\_landings)_{t+1}}{(value\_of\_landings)_t}$	0.987513
Unpaid labour	$(unpaid\_labour)_t \dfrac{(number\_of\_vessels)_{t+1}}{(number\_of\_vessels)_t}$	0.908128
Energy consumption	$(Energy\_consumption)_t \dfrac{(days\_at\_sea)_{t+1}}{(days\_at\_sea)_t}$	0.983948
Energy costs	$(Energy\_\cos ts)_t \dfrac{(number\_of\_vessels)_{t+1}}{(number\_of\_vessels)_t}$	0.968203
Repair and maintenance	$(repair\_and\_ma\text{int} enance)_t \dfrac{(number\_of\_vessels)_{t+1}}{(number\_of\_vessels)_t}$	0.993386
Depreciation costs	$(depreciati on\_\cos ts)_t \dfrac{(number\_of\_vessels)_{t+1}}{(number\_of\_vessels)_t}$	0.960893
Other variable costs	$(other\_\text{var} iable\_\cos ts)_t \dfrac{(days\_at\_sea)_{t+1}}{(days\_at\_sea)_t}$	0.983389
Other non-variable costs	$(other\_non\_\text{var} iable\_\cos ts)_t \dfrac{(number\_of\_vessels)_{t+1}}{(number\_of\_vessels)_t}$	1.054063
Value of assets	$(Value\_of\_assets)_t \dfrac{(number\_of\_vessels)_{t+1}}{(number\_of\_vessels)_t}$	1.000162
Total employment	$(total\_employment)_t \dfrac{(number\_of\_vessels)_{t+1}}{(number\_of\_vessels)_t}$	0.996790
Full Time Equivalents	$(FTE)_t \dfrac{(days\_at\_sea)_{t+1}}{(days\_at\_sea)_t}$	0.966415
Other income	$(Other\_income)_t \dfrac{(number\_of\_vessels)_{t+1}}{(number\_of\_vessels)_t}$	0.615508

On the other hand the second approach (only using year t data) can be useful when t+1 transversal data are not available to forecast national totals or main fleet segments, which have not suffered significant changes.

Table 17: Proposed relations and coefficients when no data is available for year t+1

Dependent variable (t+1)	Explanatory variable (t)	Coefficient
Number of vessels	Number of vessels	0.988152
Days at sea	Days at sea	0.975595
Income from landings	Income from landings	0.987188
Wages and salaries	Wages and salaries	0.952661
Unpaid labour	Unpaid labour	0.893002
Energy consumption	Energy consumption	0.938895
Energy costs	Energy costs	0.926686
Repair and maintenance	Repair and maintenance	0.960783
Depreciation costs	Depreciation costs	0.934462
Other variable costs	Other variable costs	0.932176
Other non-variable costs	Other non-variable costs	1.035438
Value of assets	value of assets	0.983364
Total employment	Total employment	0.971199
Full Time Equivalents	Full Time Equivalents	0.944226
Other income	Other income	0.564783

The R-square of all the proposed relations were higher than 90%, with the exception of *wages and salaries* (87%), *unpaid labour* (79%), *repair and maintenance* (89%), *other variable costs* (87%), and *other income* (25%).

The explanatory power (R-square) for the estimation of *other income* is low, especially when compared to other relationships analysed in this exercise. This is because *other income* is not related to the main operational activity and can be quite volatile. So, projections for *other income* should be considered with even more caution, even if the low coefficient (below 1) implies that forecast are relatively conservative (will not lead to significant increases that may alter the economic performance). In this sense, all other regression coefficients estimated (see Tables 16 and 17) are between 0.89 and 1.05, so this makes us believe that the projection models estimated in this exercise are robust.

3 Results

The 2016 call for economic data on the EU fishing fleet requested, in addition to the economic and transversal data for the period 2008-14, transversal data (effort, landings and capacity) from MS for 2015, as well as income from landings, to be used for projecting fleet economic performance indicators in 2015. As 2015 data are only preliminary, results should be considered with caution.

Hence, economic performance of the EU fishing fleets could be estimated for the period 2008-14 based on the data submitted by MS. Economic performance projections using the BEMEF model were made for 2015 and 2016 covering the 15 EU member states with fishing activity in the Northeast Atlantic. This selection of member states was due to greater data on performance drivers and the management of fisheries using TACs. Projections were made based on fleet segment level data and then aggregated to the MS level.

Projected BEMEF results for 2015 suggest that all MS analysed generated gross profits and with the exception of Finland and Lithuania, all MS analysed generated net profits as well. In 2016 all MS are projected to have positive gross and net profits.

In 2015 the highest gross profit margins are projected for Denmark (42.5%), Spain (36.3%) and Portugal (32.5%) and the highest net profit margins are projected for Spain (30.6%), the United Kingdom (22%), and Denmark (20.4%). In 2016 the highest gross profit margins are in Denmark (44.9%), Sweden (41.5%) and Latvia (36.0%). The highest net profit margins are for the same three member states (24.9%, 28.0% and 30.9% respectively).

However, as the BEMEF model is centred on TACs and quotas, it currently cannot be used for Member State fleets and fisheries managed under effort regimes. This includes the majority of all Mediterranean & Black Sea Member State fleets. To overcome the BEMEF limitations, we investigated an alternative approach based on regression analyses to enable projecting results for Mediterranean & Black Sea fleets, and in turn, increase the coverage of short-term forecasts.

3.1 Comparison of both models

Based on the outcomes of this exercise, we note some similarities between the BEMEF (currently used in the AER) and the regression model. Outcomes from this comparative analysis confirm the following common procedures:

- *Other non-variable costs* in year t+1 are better explained by the *other non-variable costs* in year t multiplied by the change in the *number of vessels*.
- *Total employment* in year t+1 are better explained by the *total employment* in year t raised by the increase in the *number of vessels*.
- *Depreciation costs* at year t+1 are better explained by *depreciation costs* in year t multiplied by the change in *number of vessels* from year t to t+1.
- *Value of tangible assets* (or *fleet depreciated replacement value*) in year t+1 are better explained by the total *value of tangible assets* in year t raised by the increase in the *number of vessels*.
- *Full time equivalents* in year t+1 are better explained by the *full time equivalents* in year t raised by the increase in the *days at sea*.
- *Energy consumption* in year t+1 are better explained by the *energy consumption* in year t raised by the increase in the *days at sea*.
- *Energy costs* in year t+1 can be estimated when fuel price for year t+1 is available by multiplying the estimated fuel consumption for the year t+1 by the fuel price at year t+1.

However, we note the following divergences:

- BEMEF uses the average of the last 3 years while in the alternative method, the latest year value of the variable is used (i.e. at year t) as the explanatory variable.
- In the alternative method, we consider and estimate the regression coefficients. These coefficients explain the rate of change of the dependent variables (the one we are trying to infer) as a function of the explanatory variable. Hence, it is important to incorporate this coefficient in the projections whenever it is different than one.
- In BEMEF, *wages and salaries* and *unpaid labour costs* for year t+1 are estimated by raising them by the increase in *days at sea* from year t to t+1. When *days at sea* at year t+1 are unavailable, *wages and salaries* were estimated by raising them by the increase in *value of landings*. Results from the alternative method recommend estimating *wages and salaries* in year t by the increase in *value of landings* from year t to t+1, and estimating *unpaid labour* in year t by the increase in *number of vessels* from year t to t+1 predict better the values of *wages and salaries* and *unpaid labour costs* for year t+1.
- In BEMEF model, *variable costs* are projected using the change in days at sea; while the alternative method shows that *other variable costs* in year t+1 are better explained by the *other variable costs* in year t multiplied by the change in the *number of vessels*.
- In BEMEF, *repair and maintenance costs* are projected using the change in days at sea; while the alternative method shows that *repair and maintenance costs* in year t+1 can be slightly better explained by *repair and maintenance costs* in year t multiplied by the change in the *number of vessels*.

3.2 Final recommendations

We intend to further investigate the feasibility of the following changes to the methodology used in future AERs:

- Re-estimate the regression coefficients including the most updated data by fleet, country or group of relevant countries (e.g. Mediterranean countries).
- Incorporate the regression coefficients (when different from 1) in all projections.
- It is not a major difference to use the average of the last 3 years or only the last year as explanatory variables when the variables values are relatively stable. However, significant differences can appear when variables exhibit some trend or are volatile. When looking at the national level, we recommend using the last year’s value. At fleet segment level, it would depend on the stability of the fleet in terms of capacity and effort as well as the variable analysed.
- Analyse the feasibility in the BEMEF model to estimate *wages and salaries* in year t+1 by multiplying *wages and salaries* in year t by the increase in *value of landings* from year t to t+1.

$$(Wages\_and\_salaries)_{t+1} = 0.9875 * (Wages\_and\_salaries)_t \frac{(value\_of\_landings)_{t+1}}{(value\_of\_landings)_t}$$

- Analyse the feasibility in the BEMEF model to estimate *unpaid labour* in year t+1 by multiplying *unpaid labour* in year t by the increase in *number of vessels* from year t to t+1.

$$(unpaid\_labour)_{t+1} = 0.9081 * (unpaid\_labour)_t \frac{(number\_of\_vessels)_{t+1}}{(number\_of\_vessels)_t}$$

- Analyse the feasibility in the BEMEF model to estimate *other variable costs* in year t+1 by multiplying *other variable costs* in year t by the change in the *number of vessels* from year t to t+1.

$$(other\_variable\_costs)_{t+1} = 0.9834 * (other\_variable\_costs)_t \frac{(number\_of\_vessels)_{t+1}}{(number\_of\_vessels)_t}$$

- Analyse the feasibility in the BEMEF model to estimate *repair and maintenance costs* in year t+1 by the *repair and maintenance costs* in year t multiplied by the change in the *number of vessels* from year t to t+1.

$$(repar\_and\_maintenance)_{t+1} = 0.9934 * (repair\_and\_maintenance)_t \frac{(number\_of\_vessels)_{t+1}}{(number\_of\_vessels)_t}$$

4 Conclusions

The Annual Economic Report (AER) on the European Union (EU) fishing fleet provides a comprehensive overview of the latest information available on the structure and economic performance of EU Member States fishing fleets. It is the reference in policy support in fisheries socio-economic issues.

The 2016 call for economic data on the EU fishing fleet requested, in addition to the economic and transversal data for the period 2008-14, transversal data (effort, landings and capacity) from MS for 2015, as well as income from landings, to be used for projecting fleet economic performance indicators in 2015.

Economic performance projections were made in the 2016 AER using the BEMEF model for 2015 and 2016 that cover the 15 EU member states with fishing activity in the Northeast Atlantic. Projected results for 2015 and 2016 suggest that economic performance continues to improve. Because of the uncertainty that carry projections and that 2015 data are only preliminary, results should be considered with caution.

However, BEMEF model could not be used for those countries managing their fisheries using effort regimes. Hence, all Mediterranean countries had to be excluded from the projections. To overcome the BEMEF limitations, we developed a simplified alternative approach to be able to project performance results for MS fleets operating in FAO fishing area 37. Regression analysis was used to estimate the best inferences for projecting data.

When comparing both methodologies, we find they are quite similar. It is thus, important to investigate the existing divergences between the methodologies in order to provide more accurate projections in future AERs.

References

Scientific, Technical and Economic Committee for Fisheries (STECF) – The 2016 Annual Economic Report on the EU Fishing Fleet (STECF 16-11); Publications Office of the European Union, Luxembourg; EUR 27758 EN; doi:10.2788/805055

List of abbreviations and definitions

AER	Annual Economic Report on the EU Fishing Fleet
BEMEF	Bio-Economic Model of European Fleets
EU	European Union
MS	Member State

List of tables

Table 1: Potential relations for number of vessels 16

Table 2: Potential relations for days at sea 17

Table 3: Potential relations for income from landings 17

Table 4: Potential relations for wages and salaries 18

Table 5: Potential relations for unpaid labour 18

Table 6: Potential relations for energy consumption 18

Table 7: Potential relations for energy costs..19

Table 8: Potential relations for repair and maintenance costs 19

Table 9: Potential relations for depreciation costs 20

Table 10: Potential relations for other variable costs 20

Table 11: Potential relations for other non-variable costs...20

Table 12: Potential relations for value of assets..21

Table 13: Potential relations for total employment 21

Table 14: Potential relations for full time equivalent..22

Table 15: Potential relations for other income 22

Table 16: Proposed relations and coefficients with available number of vessels, days at sea and value of landings for year t+1 23

Table 17: Proposed relations and coefficients when no data is available for year t+1 24

KJ-NA-28476-EN-N

JRC Mission

As the science and knowledge service of the European Commission, the Joint Research Centre's mission is to support EU policies with independent evidence throughout the whole policy cycle.

EU Science Hub
ec.europa.eu/jrc

@EU_ScienceHub

EU Science Hub - Joint Research Centre

Joint Research Centre

EU Science Hub

Publications Office

doi:10.2760/584037

ISBN 978-92-79-65789-4