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Support to fisheries

LEVELS AND IMPACTS

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SUPPORT TO FISHERIES: LEVELS AND IMPACTS

The OECD Fisheries Support Estimate (FSE) database collects and classifies information on budgetary transfers to the fisheries sector in 31 countries that together account for 35% of global fisheries landings. In 2015, the most recent year, it inventories policies and programmes totalling USD 7 billion. Most of this support is found to be directed towards general services to the fishing sector, mainly in the form of fisheries management costs, but also for, *inter alia*, infrastructure, research and stock enhancement. Approximately USD 500 million per year is used for programmes that deliver funds directly in the hands of fishers. The share of this form of support has been decreasing over time. Payments based on the use of variable inputs are found to be the most likely to provoke increased fishing effort, while payments based on fixed capital formation are most likely to encourage increased capacity levels. Payments based on fishers income are less likely to increase effort or capacity and may be more effective at improving the welfare of fishers. Payments to general services for the sector are least likely to increase effort or fishing capacity.

Key words: Fisheries support, subsidies, overcapacity, overfishing

JEL codes: Q22, H23, H53, H54

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Executive summary

Various bodies, including the OECD, have been calling for more transparency and better understanding of the effects of fisheries support since the 1980s. These calls have been motivated by concerns that some forms of support may complicate sustainable fisheries resources management by promoting overcapacity and overfishing. Currently, negotiations are taking place at the WTO and countries are working to implement the UN Sustainable Development Goal 14.6, with the aim to eliminate all such harmful fisheries subsidies.

Over the entire period of discussions at the WTO, there has never been a complete inventory of the subsidies under discussion or a common understanding of their impacts. This information vacuum has largely been filled by broad assumptions and estimates that may be more misleading than helpful. OECD expertise in policy measurement and evaluation can bridge this gap by providing a process through which authoritative information can be developed and disseminated.

This report describes the latest OECD inventory of support policies in participating countries. These are defined as policies that generate a transfer from taxpayers to fishers. It also provides a review of the past literature on the nature and effects of support to the fisheries sector, including a preliminary analysis to identify the factors that determine how support can affect overcapacity and overfishing, including illegal fishing, along with their likely benefits.

The OECD Fisheries Support Estimate (FSE) database contains information on support policies implemented in 31 countries, including four outside the OECD. These countries represent 35% of global fisheries landings by volume. This database currently contains data from 2009 to 2015, and is updated annually. This database will expand to cover 37 countries representing more than half of global landings by the end of 2017.

The total value of support provided by these policies was USD 7 billion in 2015, an amount that has been mostly stable over time, with some decline over the review period as share of the gross value of landings. The majority of reported support is in the form of general services to the fishing sector, not payments directed to fishers individually. Of this general support, the majority is to cover the costs of fisheries management, monitoring and control, infrastructure and research. The amount of GSSE support is quite substantial, amounting to around 20 percent of the landed value of fisheries in countries participating in the FSE. The relative share of support to general services in the FSE has been increasing over time, with the relative importance of transfers to individual fishers gradually decreasing.

Three categories—beneficial, harmful, and ambiguous—are often used to describe the effects of support on capacity and fishing effort. A better conceptual model considers relative degrees of impact. The relative degree of impact is estimated using an economic analysis of the case where fishers can flexibly increase their use of purchased inputs like fuel or bait in response to price changes but have only limited opportunity to adjust physical capital such as vessels in the short to medium term. Future OECD work will connect the FSE data to an empirical model to better understand and quantify these impacts, but some observations on the likely effects are already possible from the evidence in the literature and economic analysis.

Preliminary findings

- Most reported budgetary support is for general services to the sector, such as fisheries management, infrastructure and R&D. Cost recovery charges to recuperate the costs of management are not widely applied.

- Reported budgetary support targeted directly at fishers is usually in the form of payments for input use, to supplement income, or reduce fleet capacity. Less than USD 500 million of this type of support is reported in the FSE database in 2015. This does not include non-budgetary forms of support such as market price support nor does it include fuel tax concessions.

- Support, even when completely decoupled from effort or capacity, if it puts capital in the hands of entrepreneurs with a history of investing in the fisheries sector, could result in added capacity in the long run.

- The effect of support on capacity and fishing effort is conditioned on, but not entirely mitigated by, the quality of the management system in place. For example, management that limits total catch will prevent overfishing but will not reduce the incentive for excess capacity to build up in a fishery.

- Even if a support policies' marginal impact on overfishing or overcapacity is small, it can still have a large impact if the amount of support provided is large. Economic analysis suggests that for a similar rate of support provided to the different categories of support in the FSE:

  - Support directed at the use of variable inputs (such as for equipment, fuel or bait) is the most likely to increase fishing effort and the potential of overfishing, and the least likely to deliver real income benefits to fishers.

  - Support directed at the use of fixed inputs (vessels and other durable investments) is the most likely to encourage expansion of capacity as this lowers the cost of investment. The benefits of this support disperses into factor values and benefits only factor owners at the time the support is initially put in place.

  - Support based on fisher's income appears to provide the greatest benefit to fishers and is relatively less likely to increase capacity or fishing effort.

  - Support to management, enforcement, infrastructure investments and R&D, appears to be the least likely to increase capacity or fishing effort.

Fisheries subsidies are suspected of having important trade and environmental impacts

Various bodies, including the OECD, have been calling for more transparency and understanding of the impact of fisheries support since the 1980s. These calls have been motivated by concerns that some forms of support may complicate sustainable fisheries resources management by promoting overcapacity and overfishing.

WTO members began work to clarify the rules regarding subsidies to the fishing sector in 2002 (Box 1). This was motived by the view that often commercial fisheries are exploited, potentially exploited by more than one nation, either because fishermen from more than one country operate in the same area or because the fish migrate from one jurisdiction to another. As a result, fisheries subsidies may not have just an impact on trade, but an additional effect of hindering a trading partner's ability to produce fish products if one country subsidises its fisheries to the extent that the resource is diminished. Three implications are noted:

- For shared or migratory stocks, countries that do not subsidise and that restrain total catch to maintain resources at a biologically sustainable level lose the extra catch to countries that subsidise and do not restrain total catch.
- Competition from subsidised distant water fleets can make it economically unviable for developing countries to develop their own fisheries and therefore to realize the benefits of their own 200-mile zones of fishery jurisdiction.
- Subsidies can contribute to stock depletion and ecosystem impoverishment, with negative economic, trade and environmental effects for other countries that have an interest in the stock (Shrank, 2003).

There has been some debate on whether subsidies to fishing or deficiencies in fisheries management (which typically aims to ensure sustainable exploitation of the resource) are the more important contributor to overfishing and overcapacity. Achieving effective fisheries management and sustainable fisheries will require making progress in both areas. The management system can address the negative effects of certain subsidies (e.g. setting a total allowable catch and allocating individual transferable quotas limits overfishing and excessive capital investment), but only when it is effective, enforced and provides the right incentive to fishers to operate at an optimal level of capital investment and effort. Subsidies in turn can put pressure on the management system by giving incentives to increase desired effort above allowed levels, encouraging both IUU fishing and lobbying to increase allowed effort.

Box 1. Fisheries subsidies in WTO negotiations

Fishery and aquaculture products are excluded from the WTO Agreement on Agriculture, instead being treated as an industrial sector or product. This classification, and the way they are subsequently handled within the definitions, concepts, and thresholds established in the 1994 Agreement on Subsidies and Countervailing Measures has meant that managing fisheries subsidies through multilateral trade regulations at the WTO has been difficult to date.

Early work on fisheries subsidies in the WTO was primarily undertaken in the Committee on Trade and Environment (CTE) where, from 1996, work was undertaken to investigate the environmental benefits of removing trade restrictions and distortions, and the case for examining fishing subsidies and their relation to WTO from both a trade and an environment perspective. Negotiations to clarify and improve disciplines on fisheries subsidies were then formally started at the Doha Ministerial Conference in 2001 and, following the Hong Kong Ministerial Conference of 2005, text proposing an entirely new set of sector-specific disciplines for fisheries subsidies within the Agreement on Subsidies and Countervailing Measures was proposed by the Chairman of the Negotiating Group on Rules in 2007. Disagreement within the group over many issues resulted in a systematic revision process being undertaken in 2009 but there has been no further progress.

Since the middle of 2016, there has been new activity on fisheries subsidies at the WTO. A number of proposals are currently being worked on by member countries; these include disciplines focusing on subsidies in respect of IUU fishing and overfished stocks, those that contribute to overcapacity, and to an approach similar to that used by the Trade Facilitation Agreement to phased adoption of disciplines

Better evidence can help advance progress

Making progress towards more sustainable and productive fisheries worldwide, through negotiations at the WTO, or at a regional level with negotiation of trade agreements that include fisheries disciplines such as the TPP, or efforts decided in the framework of the UN Sustainable Development Goals, requires supporting information and analysis. Without a better understanding of the prevalence, scale, and effect of different types of fisheries policies and a common appreciation of which programmes would be implicated by proposed disciplines, the costs and benefits to fishers, the effect on the environment and sustainability, and the net benefit of an agreement to the parties to it cannot be known.

Over the entire period of discussions at the WTO, there has never been a complete inventory of the subsidies under discussion or a common understanding of their impacts. WTO notifications, the process by which WTO members officially list and describe their support policies, are incomplete and out of date in most cases. As of October 2016, a total of 89 members have not yet notified their fisheries subsidies for 2015. Sixty-three members still have not made their notification for 2013 and 57 members still have not submitted their 2011 notifications, which were due five years ago. Many of these members "either have never notified or have done so only in the distant past," according to the chair of the WTO's Committee on Subsidies and Countervailing Measures (WTO, 2016a).

OECD expertise in policy measurement and evaluation can bridge this gap, as evidenced by the role it played in the Uruguay Round Agreement on Agriculture (URAA). This expertise can be applied to the fisheries sphere in a similar way and with similar benefits. OECD work to improve the transparency of fisheries support policies catalogues the current situation, provides orientations for beneficial reform, and establishes a means to take stock of progress. More specifically:

- **A good understanding of existing fisheries support policies is an essential start**. An inventory of the programmes currently in place along with details of their design and implementation criteria is an opportunity for peer learning and establishes the initial conditions for discussions.
- **Better understanding on the impacts of support to fisheries provides a basis for progress**. It is easy to agree to eliminate subsidies that are "harmful"; it is another thing entirely to agree on exactly which subsidies fall in this category. Progress towards a more precise understanding requires a solid foundation of analysis.
- **Monitoring the evolution of support over time demonstrates progress against goals**. The UN Sustainable Development Goals (SDG) 14.6 commits governments, by 2020 to prohibit certain forms of fisheries subsidies that contribute to overcapacity and overfishing. Goals such as these benefit from effective means to measure progress and success.

This report takes stock of existing information on fisheries support and presents the OECD Fisheries Support Estimate (FSE) database, which provides official statistics on support to the fisheries sector structured around a standardised questionnaire. This database is built in a collaborative process with participating countries and economies. The report also reviews the existing literature, including investigating the mechanisms through which different fisheries support programmes operate.

Fisheries support policies are in place to help achieve government objectives for fishers and fishing communities. This report also investigates how the benefits of different categories of fisheries support are distributed to help inform about what kinds of support may be relatively more effective at delivering benefits to fishers.

Future work will deepen understanding of how support affects the decision-making of fishers and outcomes in the fisheries sector by modelling the impact of FSE data on trade flows of fish products and income generation for fishers.

Measurement of support to fisheries

Previous studies and their limitations

OECD work

The OECD has published data on support to fisheries intermittently since 1965 and the Fisheries Committee has expressed explicit interest in fisheries subsidies at least since 1987, setting the goal of establishing "transparency on economic assistance measures, direct as well as indirect, and to develop an analytical framework to help understand how these measures affect the industry" (OECD 1987). The OECD next published an inventory of government assistance programmes in 1992, part of a package of inventories that included tariff and non-tariff barriers as well as an inventory of fisheries management systems (OECD, 1992a; OECD, 1992b).

The early OECD perspective on support to fisheries was strongly founded in economic theory. The report of the expert group convened by the OECD Fisheries Committee (COFI) in 1993 concluded that "The concept of assistance to the fishing industry in a country should be defined as government intervention or lack of government intervention which distorts the allocation of resources in that country relative to an efficient allocation. This implies, for example, that lack of efficient management of the fish resources, restrictions on free trade in fish, fish products and fishing services, restrictions on migration of fishermen and on foreign investment in the fishing industry, constitute assistance". This early work encompassed support as well to the processing sector and included border measures such as tariffs and non-tariff barriers.

Later OECD work moved the point of central concern away from efficient allocation of resources to ensuring that government support was compatible with sustainable levels of harvest. A major study of "Government Financial Transfers" to fisheries titled *Transition to Responsible Fisheries* was published in 2000. The most recent OECD study of support to fisheries was in 2006, entitled *Financial Support to Fisheries--Implications for Sustainable Development.*

The main limitation of past OECD work has been its partial geographical coverage. The 1992 reports covered 22 countries, 24 were covered in 2000 and 24 in the 2006 *Financial Support to Fisheries* report. The latest version of the fisheries support estimate database covers more countries than ever before, with a goal of eventually including the majority of global support to fisheries provided by governments (Table 1).

Table 1. Past OECD work measuring support to fisheries

Report	Number of countries	Reporting year	Transfers to individual fishers	Transfers to general services	Total transfers	Value of landings	Transfers as % value of landings
Transition to Responsible Fisheries (2000)	24	1996	1 629	5 171	6 799	37 646	18%
Financial Support to Fisheries (2006)	24	2003	1 721	4 771	6 472	31 725	20.4%
This report	27+4	2015	433	6 497	6 780	33 188	20%

Note: Definitions of transfers to individual fishers and transfers to general support vary slightly in the different reports. This report presents data on 27 OECD members but the FSE database covers four additional countries (Argentina, Indonesia, Chinese Taipei and Colombia). Coverage in some participating countries may be incomplete.

Non-OECD work

To date, only a handful of estimates of the total value of global fisheries subsidies have been made. The main ones are Millazo (1998), FAO (1993), APEC (APEC region only) (2000) and the work led by the UBCs Institute for Oceans and Fisheries that is reported online as part of the *Seas Around Us* project at www.seaaroundus.org/ (Sumaila U. et al., 2010; Sumaila, Lam, Manach, Swartz, & Pauly, 2016). Of these, the *Seas Around Us* project is the most recently updated, reporting data for 2003 and 2009.

The *Seas Around Us* data have by default become the most cited source of information on subsidies, but this work has only a limited empirical basis. Half of all the observations in the database are estimated based on extrapolations from other countries—30% of all observations in developed countries and over 60% of all developing country data are estimated using "subsidy intensity" factors derived from available observations in other countries.

The report by Milazzo was ground-breaking and is still influential in terms of defining fisheries subsidies and their impacts. However, the estimate produced (USD 14-20 billion in global subsidies) is flawed and limited in many ways. It is made up of the following components:

- **Direct budgetary support**. Six case studies (Japan, the European Union, Norway, the United States, Russian Federation, and the People's Republic of China) are extrapolated to find a global total. Policies are included following the WTO definition of subsidy (specific, actionable). The extrapolation to the global total is roughly estimated with no analytical basis.
- **Lending and tax policies** — based on anecdotal information and the assumption that capital subsidies are equivalent to 10% of the value of loans.
- **Untaxed resource rents**—assumed to be between 5% and 10% of landed value (this range is behind the USD 14-20 billion range in the overall estimate).
- **Budgeted and unbudgeted shipbuilding and infrastructure subsidies**—rough estimates.

Asia-Pacific Economic Cooperation (APEC) produced a study in 2000 that inventoried and classified support policies in the APEC region.[1] The authors of the study obtained responses to questionnaires for ten participating economies and used other sources and direct contacts to ultimately report on 19 participating economies, finding the total value of support equal to USD 12.6 billion. The report's method of classification drew heavily on the work of the OECD at that time, as well as from Milazzo (1998).

One of the objectives of the APEC study was to assess the risk of challenge under WTO rules for the support policies identified. Applying the WTO definitions of prohibited and actionable subsidies and using a subjective evaluation based on past experience in the dispute resolution mechanism, the authors found that of the 162 distinct subsidies identified, 29 were likely non-actionable, 133 were conceivably actionable, and 10 were of medium to high risk of challenge.

What constitutes support to fisheries?

There has been considerable debate regarding what constitutes a fisheries subsidy, dating back at least to 2001 when the subject was first taken up by the WTO. The major studies mentioned above helped to clarify some terms of the debate, but have not definitively answered the primary questions of what is a subsidy to fisheries, what is the total amount of these subsidies globally and what are their impacts.

OECD work prefers and uses exclusively the term "support" rather than subsidies to refer to the contents of the FSE database, at least in part to avoid becoming entangled in the debate over subsidy definitions. Not

1. The participating APEC economies are: Australia, Brunei Darussalam, Canada, Chile, the People's Republic of China, Hong Kong-China, Indonesia, Japan, Korea, Malaysia, Mexico, New Zealand, Papua New Guinea, Peru, Philippines, Russian Federation, Singapore, Chinese Taipei, Thailand, United States, and Viet Nam.

every support policy in the FSE would be considered a subsidy in the WTO sense. When the term subsidy is used in this report, it is in reference to other research or the content of global discussions on that subject.

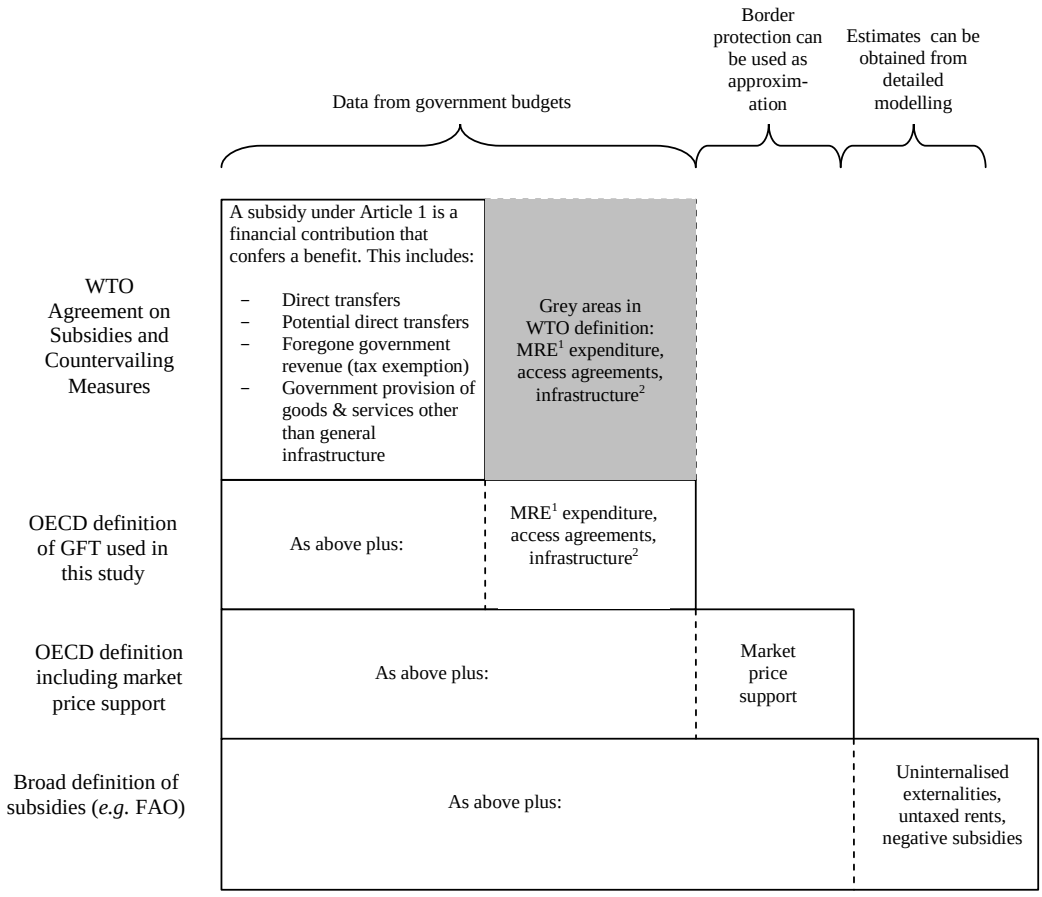
The 2006 OECD report *Financial Support to the Fisheries Sector* contains a useful schematic of the different possible dimensions of a definition of fisheries support (Figure 1). This starts with the WTO definition as a basis and shows how this can be expanded. Some of these elements and the reasons for their inclusion or exclusion are discussed in the following subsections.

Budgetary transfers

Budgetary transfers are the most visible form of policy support. They are most easily measured as they are observed and do not need to be estimated as is the case with the tax exemptions and price support. Budgetary information mainly comes from the government institution responsible for fisheries. The most common exception for this is enforcement expenditures made as part of coast guard activities.

The main emphasis of the FSE is on budgetary transfers, though some countries do report non-budgetary policies such as fuel tax exemptions or market price support. The concept is based on the transfer of funds from taxpayers or consumers to fishers, with a support policy being a programme that generates such a transfer. This includes general services which provide a benefit to fishers, something which is discussed in more detail below, but not the administrative costs of government itself.

Figure 1. Schematic representation of alternative definitions of fisheries support



Note: GFT=Government Financial Transfers are now reported in the FSE, Fisheries Support Estimate, database and the term GFT is no longer used. 1. MRE refers to management, research and enforcement. 2. Infrastructure is a grey area and is included in both the WTO and OECD definitions for reasons of inclusiveness.

Source: OECD (2006).

Tax expenditures related to fuel use

The impact of policies related to the price paid for fuel (mainly diesel) by fishers is often highlighted by those involved in the global subsidies debate, and they feature prominently in the work by Sumaila—USD 20 billion of the USD 35 billion global subsidies total estimated in his work are fuel supports (Sumaila, Lam, Manach, Swartz, & Pauly, 2016). The high share of fuel costs in total costs of fishing makes government policies influencing these costs potentially highly relevant to their objectives for preserving and promoting the fishing sector.

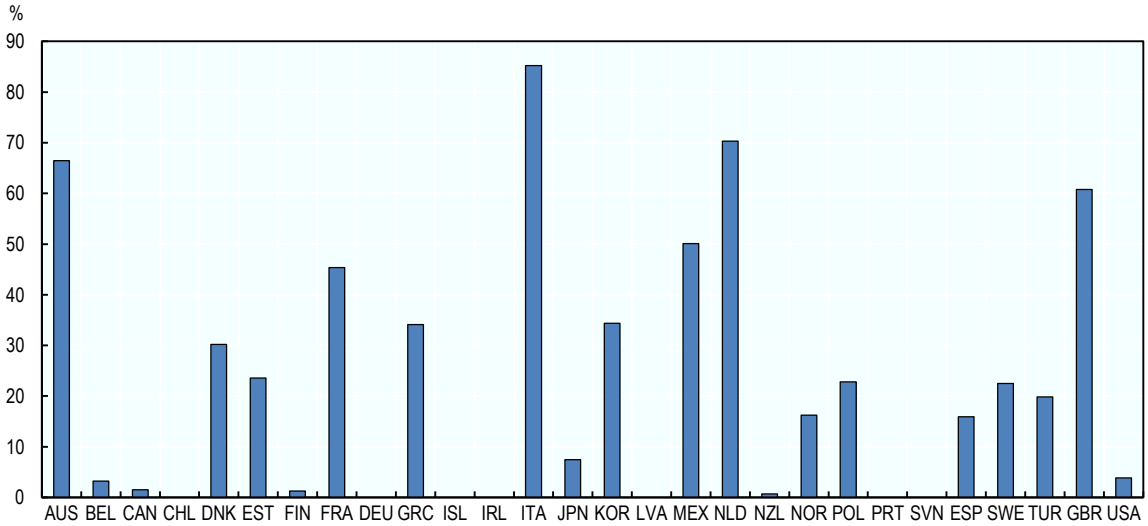
For example, the World Bank report *The Sunken Billions* (2006) in its discussion of the impact of subsidies also pays particular attention to fuel subsidies, using Sumaila's data as a basis. The report states that "By reducing the cost of harvesting, for example through fuel subsidies or grants for new fishing vessels, subsidies enable fishing to continue at previously uneconomic levels" (World Bank and FAO 2009, section 2.4).

Previous OECD work estimated the amount of fuel-tax concessions (FTCs) present in OECD fisheries as USD 2 billion in 2008 (Martini, 2012). This work showed that FTCs affect the price of fuel for fishers in almost every OECD country and that the level of support provided was comparable in many cases to the level of budgetary support directed at the fisheries sector (Figure 2). The total FSE in the OECD region (excluding support to fuel) was USD 6.7 billion in 2015.

The EU reports fuel consumption and fuel efficiency of the fleet as part of its Annual Economic Report on the EU Fishing Fleet (the most recent edition is STECF 2016). This reports a decline in fuel consumption of 16% between 2008 and 2014. A study on the value of fuel support to the fisheries sector (Borrello, Motova and Dentes De Carvalho, 2013) estimates the value of the transfer generated by fuel tax exemptions in EU member states to be EUR 1.05 billion over the period 2002-2011.

The OECD FSE database does not systematically collect data on fuel tax concessions, as one criterion for inclusion is that a policy be primarily directed at the fisheries sector, an evaluation that is left to participating countries. Most EU countries report FTCs in their data submissions to the OECD FSE, though few other countries outside the European Union do so.

Figure 2. FTC transfer value as % of reported FSE, 2008



Note: Data for 2008 except as noted: 2007 for Australia and Japan; New Zealand fuel consumption estimate 2005; GFT estimate for Mexico and Poland from 2007.

Source: Martini, R. (2011).

Meanwhile, discussions regarding support to fuel use across sectors have been taken up in a broader context. Elimination of fossil fuel subsides is an objective of the G20; the Leader's Statement from the 2009 Pittsburgh Summit (G20, 2009) sets an objective:

> To phase out and rationalize over the medium term inefficient fossil fuel subsidies while providing targeted support for the poorest. Inefficient fossil fuel subsidies encourage wasteful consumption, reduce our energy security, impede investment in clean energy sources and undermine efforts to deal with the threat of climate change.

The G7 Ise-Shima Leaders' Declaration (2016) revisits this pledge, noting "We remain committed to the elimination of inefficient fossil fuel subsidies and encourage all countries to do so by 2025."

Market price support and other trade barriers

Market price support occurs when, as a result of government policy, the domestic price of a product is greater than the world market price. This support is normally created by trade restrictions and import or export duties. An attempt to assess whether market price support, as a broad concept, could be meaningfully estimated in the OECD GFT was undertaken in the early 1990s using cod as a case study. The conclusion was that the inherent technical problems in estimating a producer support estimate proved too great an obstacle. The primary problem concerned the heterogeneous nature of the fisheries commodity market and the consequent difficulty in establishing a world reference price from which price gaps can be measured[2]. The current FSE does not systematically collect market price support data, but maintains it as part of the classification. A small number of countries provide this data, but it is not used in overall reporting or indicators.

One of the complicating factors when evaluating the trade distortions introduced by support is that the fisheries management system already represents a de facto output control system. This confounds estimation of price and trade effects of other policies and leaves an unclear counter-factual for the condition that would prevail absent support. Munk and Motzfeldt (1993) enumerate in detail the difficulties in measuring trade distortions related to fisheries policies. They summarise the situation as follows:

> The measurement of trade distortion is particularly difficult in the case of the fishing industry for the following three reasons: Firstly, the occurrence of market failure in the fishing industry implies that an efficient allocation cannot be obtained without government intervention. The benchmark against which to measure trade distortion does, therefore, in the case of the fishing industry, unlike in other industries, require government intervention in the form of a management scheme. Secondly, restrictions on the free flow of services in the form of restrictions on the access of foreign vessels to national fishing grounds and to ports and port facilities constitute an important distortion to trade which needs to be taken into account. Thirdly, it is particularly difficult to establish a model of the fishing industry due to the complexity of the production function (Munk & Motzfeldt, 1993).

Resource rents

Resource rents are the profits above normal economic profits earned by fishers. These are usually generated as a consequence of certain management systems and more generally defined as the shadow price of access to the resource. Whether untaxed resource rents are considered support remains controversial. The view of the OECD COFI in *Economic Assistance to the Fishing Industry: Observations and Findings* was: "If the management regime does not require fishermen to take into account the full social costs of the fish they harvest, then fishermen can be considered to be receiving an implicit subsidy on the use of the fish resources. This also applies when fishermen are provided access to foreign waters when the access fees are paid by the Government" (OECD, 1991). In *Financial Support to the Fisheries Sector* (OECD 2006), a more classical economic view of resource rents was taken, considering only economic rents generated by the management

2 . See OECD (2006) for more of a discussion on this.

system: "If the management instruments do not create conditions for the generation of resource rent to begin with, … it is hard to justify counting that foregone revenue as support to the industry."

Current OECD estimates of support in the FSE make no attempt to calculate untaxed resource rents. On the other hand, *taxed* resource rents are considered to be "cost recovery" and enter the FSE with a negative value. This leads for example to the case where Iceland reports a negative FSE in 2014, as resource rents are excluded but their recovery through taxation is included as a negative. Milazzo (1998) included resource rents (assumed to be between 5 and 10% of landed value), pointing out that in other natural resource industries artificially low resource access charges have been successfully subject to challenge at the WTO (See the Canada-US softwood lumber dispute for a long-running example).

Summary of the state of measurement of global support to fisheries

Except in the case of EU reporting of support under the European Fisheries Fund (EFF) and the European Marine Fisheries Fund (EMFF), and the OECD FSE database, there is little in the way of recent comparable international data on fisheries support. OECD work on measuring fisheries support is the only sustained effort based mainly on direct data collection, but remains limited in its global coverage and completeness with respect to different types of support.

The FSE database and indicators of policy support to fisheries

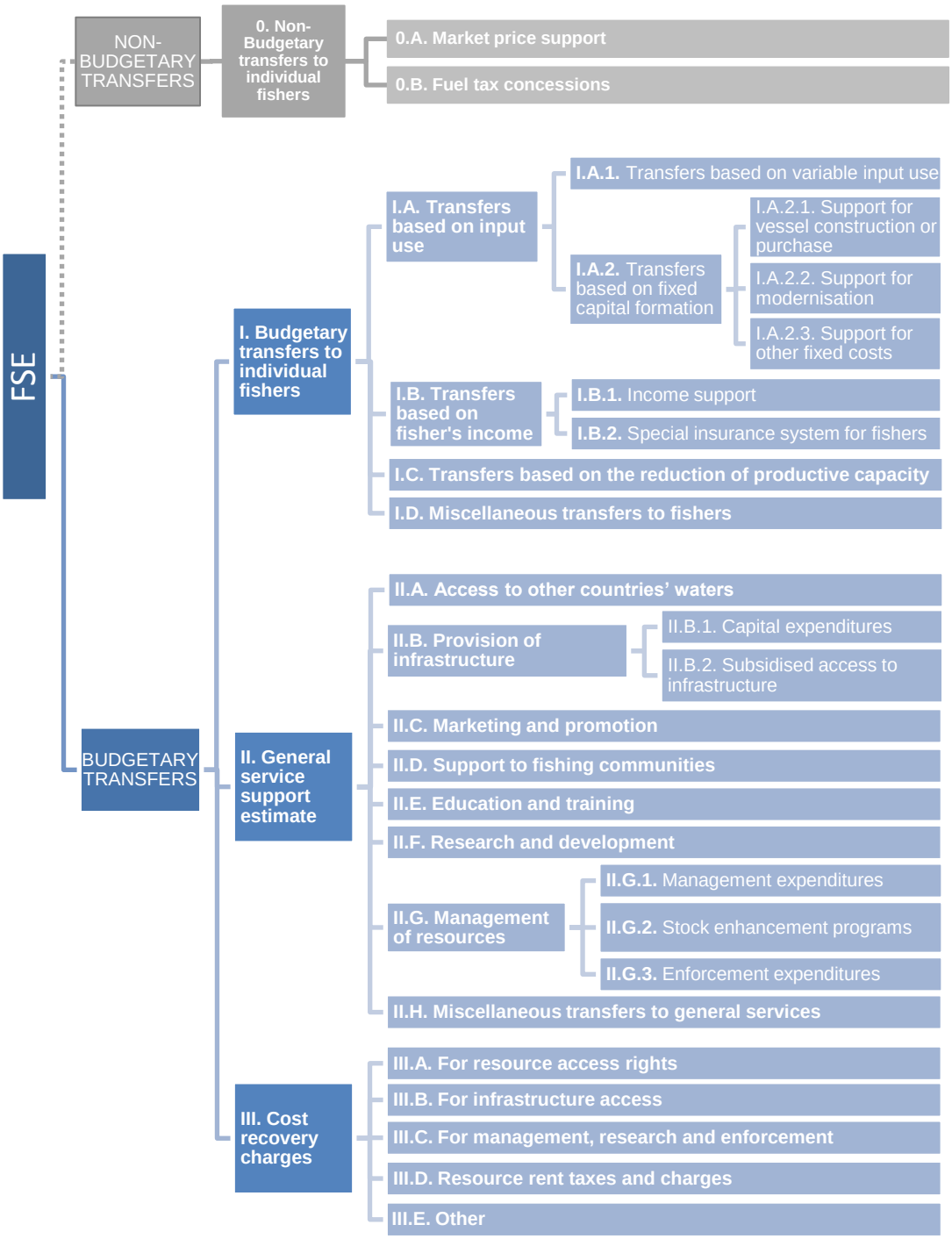
The FSE is a global database of support to fishers. It conveys two kinds of information necessary to understand support. First, the FSE indicates the level of, and changes over time in the level, monetary transfers from taxpayers to fishers resulting from fisheries support policies. Second, support estimates are classified according to criteria regarding the implementation of the associated policy measure, thereby highlighting the 'initial incidence' of the support measure for analytical purposes. The format for reporting fisheries support has been revised since *Financial Support to Fisheries* (OECD 2006) was released. This revision clarifies definitions and provides a more useful organisation of the data.

The FSE is a collaborative effort among governments to improve the transparency and accountability of fisheries support policies. This is based on an agreed set of definitions and criteria for the reporting and classification of support (OECD 2016) (Figure 3 and Box 3).

The objectives and priorities of fisheries policies in OECD countries cover a wide range of issues, including managing fish stocks, preserving traditional communities and ways of life and securing production of food. Policy instruments are equally varied, reflecting changes in domestic political priorities and economic settings and developments in the international economic arena. Despite this diversity, policy measures applied in a country within a certain period of time can be brought together and expressed in one or several simple numbers – called support indicators – which are comparable across time and between countries. The utility of doing this is three-fold:

- Measuring and classifying support can be used to monitor and quantify developments in fisheries policy.
- Closely related to this, the data establish a common basis for policy dialogue by using a consistent and comparable method to evaluate the nature and incidence of policies. The international comparability of the data and wide country coverage makes it a useful tool for policy makers as well as research institutions and other interested organisations.
- Finally, the database is used in further research on policy impacts. The data can potentially serve as inputs into modelling to assess the effectiveness and efficiency of policies in delivering the outcomes for which they were designed and to understand their effects on production, trade, income, the environment, etc. While the data cannot by themselves quantify these impacts, the economic information upon which they are based is an important building block for further analysis.

Figure 3. Components of the FSE



Box 2. Indicative list of transfers in the FSE by category

Management, research and enforcement expenditure	
Management expenditure	Research expenditure
Enforcement expenditure	Funding of information dissemination
Expenditure for information collection and analysis	Expenditure on the protection of marine areas
Payments to support community based management	Payments to producer organisations
Expenditure to promote international fisheries cooperation	Support to improve the management of cooperatives
Fisheries infrastructure expenditure	
Support to build port facilities for commercial fishers	Reduced charges for use of government provided infrastructure
Fisheries enhancement expenditure	Support to improve fishing villages
Support to enhance the fisheries community environment	Regional development grants
Expenditure on exploratory fishing	Support for artificial reefs
Aid for restocking of fish resources	
Payments for reductions in productive capacity	
Vessel decommissioning schemes	Buyouts of licences and permits
Buyouts of quota and catch history	
Income support and unemployment insurance	
Income support	Unemployment insurance
Price support payments to fishers	Grants to small fisheries
Direct aid to participants in particular fisheries	Grants for the temporary withdrawal of fishing vessels
Temporary grants to fishers and vessel owners	Compensation for closed or reduced seasons
Compensation for damage from predators on fish stocks	Disaster relief payments
Retirement grants for fishers	Income guarantee compensation
Grants for retraining of fishers into other activities	Vacation support payments
Grants to set up temporary or permanent joint ventures in other countries	Income tax deductions for fishers
Payments based on variable input use	
Support for crew insurance	
Reduced charges for government services	Provision of bait services
Underwriting of insurance costs	Low cost insurance
Payments to reduce accounting costs	Support for development of deep-sea fisheries
Interest subsidies for the purchase of machinery and equipment for fishing vessels	
Payments based on fixed capital formation	
Low cost loans to young fishers	Low cost loans to specific fisheries
Interest rebates	Loan guarantees
Contributions to match private sector investments	
Tax exemptions for deep-sea vessels	
Grants for new vessels	Grants for modernisation
Subsidised loans for vessel construction	Subsidised loans for vessel modernization
Loan guarantees for vessel construction	Loan guarantees for vessel modernisation
Grants for purchase of second-hand vessels	Interest subsidies for the purchase of second hand vessels

Fisheries support policies may provide direct payments to fishers, or they may support the sector in general through management, harbours and other infrastructure. The common element to all these policies is that they generate a transfer. The concept of "transfer" presumes both a source of the transfer and the existence of a recipient. In the present method, fishers are the recipient of policy transfers and taxpayers are the source, i.e. the group bearing the cost of fisheries support. The term "fisheries" designates fishers as an economic group. Fishers are viewed from two perspectives – as individual entrepreneurs, and collectively (i.e. as a sector). These distinctions underlie the key dimensions in which fisheries support is measured and the basic structure of the indicators.

Scope and content of the FSE database

The fishing sectors of OECD members accounted for 27% of world capture fisheries landings by volume (24.8 million tonnes) in 2015 (FAO 2017), and the FSE database contains data on most OECD member economies with significant marine fisheries. The current version of the FSE contains data for 2009 to 2015, with some earlier data available for certain programmes.

Budgetary policy support to the capture fisheries sector in OECD countries resulted in net transfers totalling a reported USD 6.74 billion in 2015. The total support reported in the FSE database including the four non-OECD countries currently participating is almost USD 7 billion. The vast majority of this was provided in the form of support to general services (GSSE) which, after accounting for cost recovery charges of USD 0.16 billion, are estimated to have totalled USD 6.30 billion. The remaining USD 0.43 billion of support was provided in the form of transfers to individual fishers (TIF). Support considered as falling within the category of general services includes: access to other EEZs, infrastructure, marketing and promotion, community support, education and training, research and development, management of resources. Transfers that support fishers individually include support that: reduces variable or fixed costs, maintains income, and payments to reduce capacity (Figure 4).

Instances of non-reporting have left some gaps, particularly for categories relating to support in the form of management and enforcement expenditures. Under the assumption that all fisheries systems face costs associated with management and enforcement, and to ensure that non-reporting did not result in aggregate levels of support being incomplete, these gaps are currently filled with estimates. The missing values for management and enforcement support were estimated by deriving the average ratio of support to value of landings observed in reporting countries and applying this to the value of landings in non-reporting countries. Again, the secretariat is working with reporting countries to fill these gaps and eliminate the need for estimates[3].

Support as a proportion of the value of landings has decreased at the OECD level

Care needs to be taken when assessing how absolute levels of support to fisheries have changed over time at the OECD level as the number of countries for which data is available in the FSE database is not constant and has recently increased, and reporting from participating countries is not comprehensive in all years; under-reporting may skew trends in the data.

Moreover, and in particular at the country level, the delivery of support can vary considerably from year-to-year in the context of a multi-year programme. Wherever possible the base period when considering

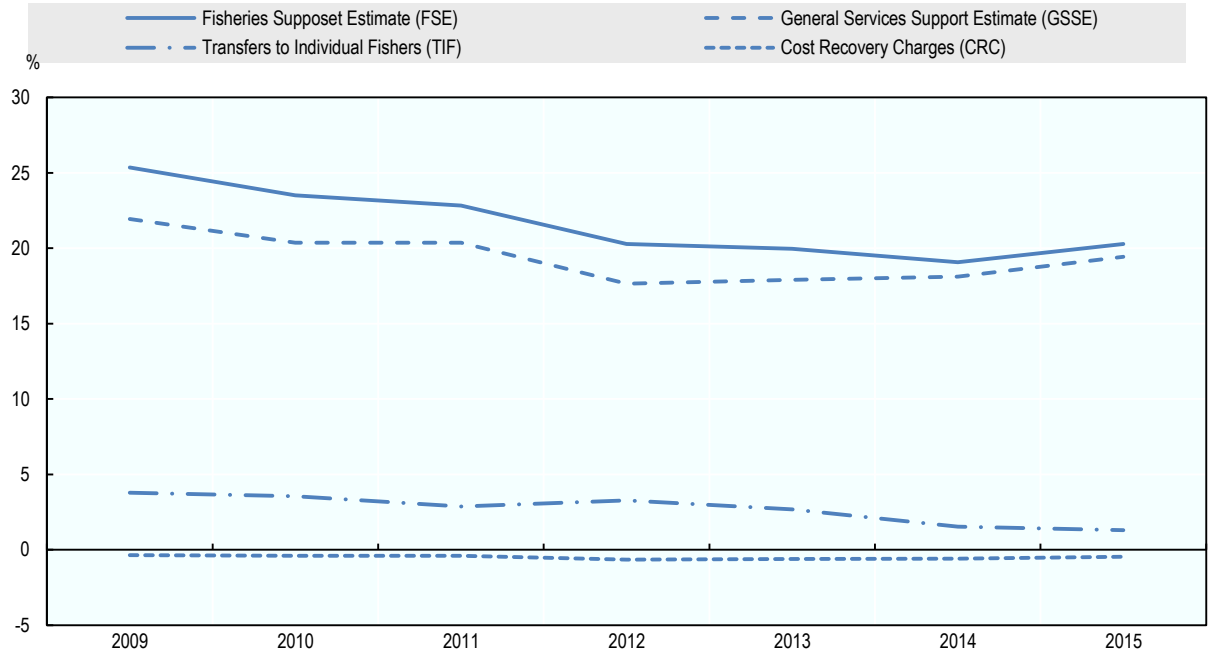
3. Data on the value of landings is currently only available up to the year 2014, whilst the FSE database contains data on support up to and including 2015. Estimated management and enforcement expenditures in 2015 were therefore calculated using the value of landings for that country in 2014 and indicators where the value of landings is used to contextualise the level of support also use value of landings from 2014 under the assumption that this will have not changed significantly from one year to the next. In all cases, if the data used in an indicator or associated figure is not for 2015 this is stated in the text or in a note appended to the figure. Following this approach the indicators presented here provide the most up-to-date and complete picture currently possible of support to fisheries over the period 2009-15.

individual country data has been set as the annual average of 2009-11 and the reference period the annual average of 2014-15. This means that changes in support are currently being assessed over a period of time that may be too short to accurately discern trends. This situation will improve as additional data is collected and a longer time series develops.

When the component parts of the FSE are considered it can be seen that the majority of budgetary policy support has always been provided to the fishing industry in the form of GSSE, TIF only ever making up a relatively small proportion of budgetary support (Figure 4). Missing from this picture though are non-budgetary transfers to individual fishers, forms of support that include fuel tax concessions and market price support, which are not currently reported by many countries. Because of this inconsistent reporting, and because of disagreements regarding the status of fuel tax concessions as a form of support, these components of the FSE are not included in indicators or figures, though they are available in the database.

Figure 4. Evolution of the Fishery Support Estimate, OECD countries, 2009-15

Percentage of gross value of landings



Note: When not reported value of landings data for EU countries have been obtained from the STECF 2016 Annual Economic Report on the EU Fishing Fleet (STECF 2016) (Belgium, France, Ireland, Latvia, Netherlands, Slovenia, United Kingdom), in other cases value was estimated by carrying over the value of the previous year. Where necessary the GSSE numbers reported here include estimates of management and enforcement expenditures based on rates of intensity observed in reporting countries.

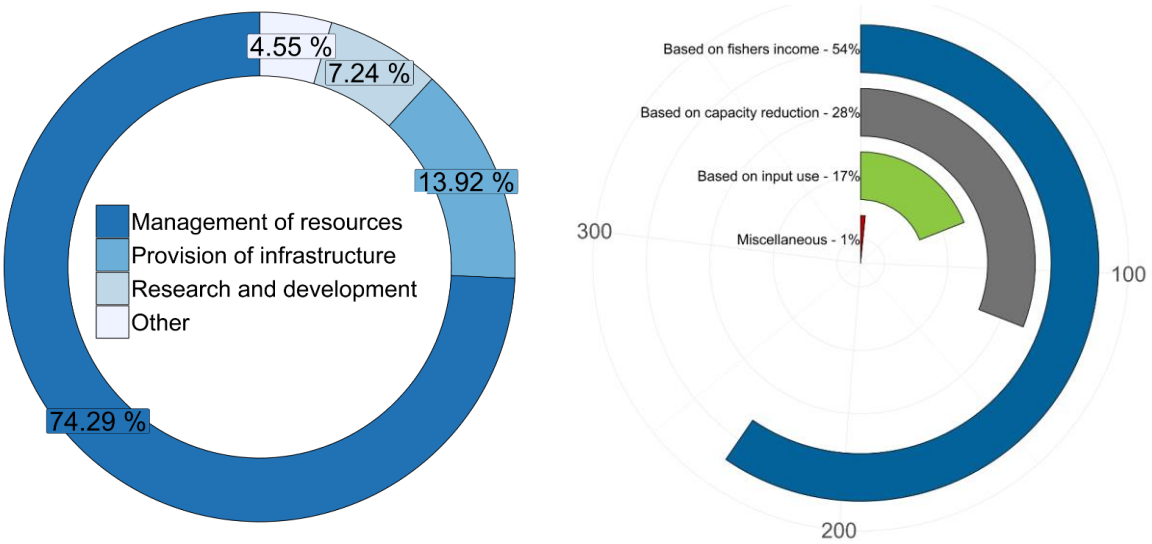
Considered as a proportion of the gross value of landings, net reported support to fisheries (FSE) fell consistently over the period 2009-14 before increasing slightly in 2015 (Figure 4). All references to total FSE in this report are net of costs recovered, unless otherwise stated. The average rate of change in FSE to value of landings at the OECD level was -3.8% per year, over the period 2009-11 to 2014-15. The ratios for transfers to individual fishers (TIF) fell by -16.0% per year and support to general services (GSSE) by -2.1% per year over the same period.

By 2014 transfers of public money accounted for USD 0.19 in every dollar of gross revenue generated by the fisheries sector, a substantial (25%) decrease from the USD 0.25 observed in 2009. The subsequent increase in 2015 (to USD 0.20) may represent a change in the trend but it is currently too soon to tell. An increase in the absolute level of GSSE appears to have contributed to the observed change in this year but as the 2015 indicator uses estimated landings values this may have also influenced the indicator for this year; these values will be revised once value of landings data for 2015 becomes available.

The importance of policies that support fishers collectively (in the form of general services or GSSE) have increased

How support is provided has changed over time. The relative importance of transfers to individual fishers has gradually decreased, partly as a consequence of total spending in this area tending to fall but also because of overall increases in the amount spent on support to general services. The proportion of total FSE coming from policies supporting GSSE has been increasing since 2009. After taking cost recovery charges into account, GSSE support made up 94% of total FSE transfers at the OECD level in 2015, up from 85% in 2009.[4]

Figure 5. GSSE is mainly directed to resource management and TIF is mainly based on income



Note: Where necessary the GSSE numbers reported here include estimates of management and enforcement expenditures based on rates of intensity observed in reporting countries.

Forms of support categorised as falling within general services include: access to other EEZs, infrastructure, marketing and promotion, community support, education and training, research and development, management of resources. Fisheries management, which includes expenditure on management programmes, surveillance and enforcement, and stock enhancement, accounts for the greatest part of general services support and accounted for 74% of the value of OECD level GSSE in 2015 (Figure 5, left panel). Provision of infrastructure (14%) and research and development (7%) accounted for most of the remaining reported GSSE. The last 5%, assigned to the 'Other' category, includes support for: Miscellaneous transfers to general services, Support to fishing communities, Access to other countries' waters, Education and training and Marketing and promotion. Of these, miscellaneous transfers to general services was the largest (2.2%).

4. Improved policy coverage in both the TIF and GSSE components of the FSE could change this picture.

Support to individual fishers (TIF) is mainly directed at income

As the relative contribution of support to general services has increased in the FSE the relative contribution of transfers to individual fishers has consequently declined (from 15% in 2009 to 6% in 2015) (Figure 4). The TIFs reported in the FSE database are classified according to their implementation criteria, and cover forms of support that depend on input use (reducing variable or fixed costs), those that maintain incomes, and payments to reduce productive capacity. Transfers based on fisher income, e.g. income support or insurance, accounted for the majority (54%) of direct support to individual fishers in 2015, followed by capacity reduction (28%) and then transfers based on input use (17%) (Figure 5, right panel).

Cost recovery charges are small and not widely applied

Cost recovery charges (CRC) are typically levied in the context of offsetting the costs of providing GSSE support. As a proportion of the annual value of landings, these have fluctuated at an average of 2-3% in the countries that utilise CRC over the period 2009-15, in absolute terms they have fallen by 14% per year. Of the 27 OECD economies represented in the FSE database at some point between 2009 and 2015 only nine reported the use of cost recovery charges.

Annual average rates of change in total FSE are mixed and uneven at the country level

Country level-annual average rates of FSE change over the period 2009-11 to 2014-15 are mixed and uneven (Figure 6). The majority have reduced reported support and in all but two countries the absolute change is less than 10% per year. The smallest changes have generally occurred in the largest fisheries. The largest proportional increase took place in New Zealand (+21% per year) and the largest decrease in Slovenia (-23% per year). The numbers for New Zealand and Slovenia are affected by their relatively small bases and have some of the smallest measured rates of support as a share of landed value. Large capital expenditures by Slovenia on the provision of infrastructure in 2010-11 inflated the base period (2009-11) values above what appears to be their normal level, most likely due to European Fisheries Funding (EFF) which ran 2007-13, and resulted in the large subsequent fall in annual growth rate once this stopped (also visible in Figure 6). Support to research and development in New Zealand is not currently included in their support data prior to 2012 and has contributed to the sharp increase in their reported annual rate of change over the period considered; this data is in the process of being revised.

It should be noted that a lack of reported FSE data for the period 2009-11 resulted in several countries, some with major fisheries, having to be excluded from Figure 6 (Australia, Czech Republic, Germany, Ireland, Japan and Latvia).

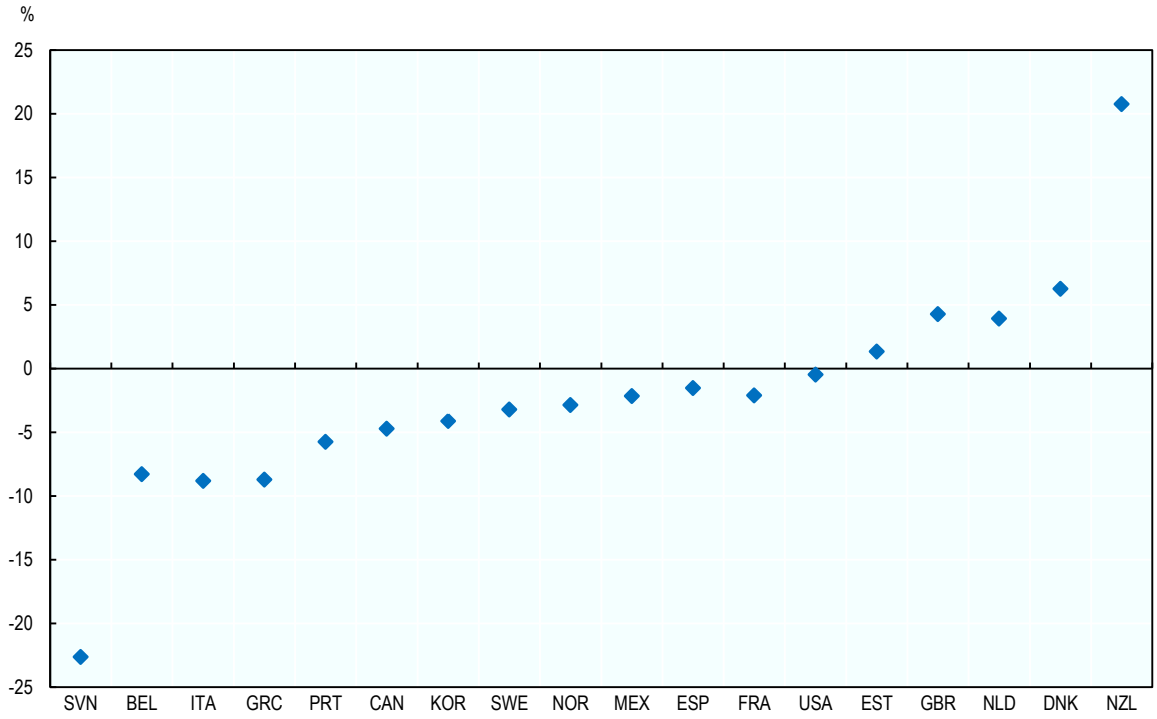
When the absolute level of policy support is considered as a proportion of the value of landings, all with respect to their 2014-15 averages, the extent of country level support is contextualised (Figure 7). Again, a high degree of variability is seen between countries when the extent of fishery support is assessed in these terms, with FSEs ranging from as low as 3% of the total value of landings (Iceland) to as high as 66% (Sweden). The proportionally high level of support seen in Sweden is the result of it having one of the smaller fishery sectors in terms of absolute value of production (a small denominator) while at the same time maintaining a well-developed set of GSSE polices to manage the sector.

Assessing support in the context of landings value overcomes some of the scale problems associated with using absolute values, where members with large fisheries will be more likely to make larger transfers in absolute terms, but interpreting the results still requires caution. Countries with relatively low-value fisheries may be required to assign proportionally larger levels of support to their fisheries, particularly in terms of GSSE, if there is a minimum fixed cost associated with management or management is highly developed. This appears to be the case for Sweden, Latvia and Slovenia, whose values of landings were amongst the five lowest of the group in 2014 whilst their FSE to landings ratios were the three highest. These three countries also had the highest ratios of GSSE to landings.

The ratio of FSE to value of landings also puts the outcome of the high growth rate observed for New Zealand (Figure 6) into context. Despite the recent growth in its FSE, it continues to have one of the lower FSE to value of landings ratios of all OECD economies in the most recent period reported (11th out of 25).

Figure 6. Evolution of total support to fisheries (total FSE) by country, 2009-11 to 2014-15

Average annual growth rate



Note: for Turkey 2009-11 is replaced by 2012. For Italy 2014-15 is replaced by 2013-14. Australia, Czech Republic, Germany, Ireland, Japan and Latvia are omitted as FSE data is only available for 2014 and 2015. Data includes estimated values for enforcement expenditures for some countries. Percentage changes as shown can vary strongly if the initial level of support is small, as is the case for New Zealand and Slovenia.

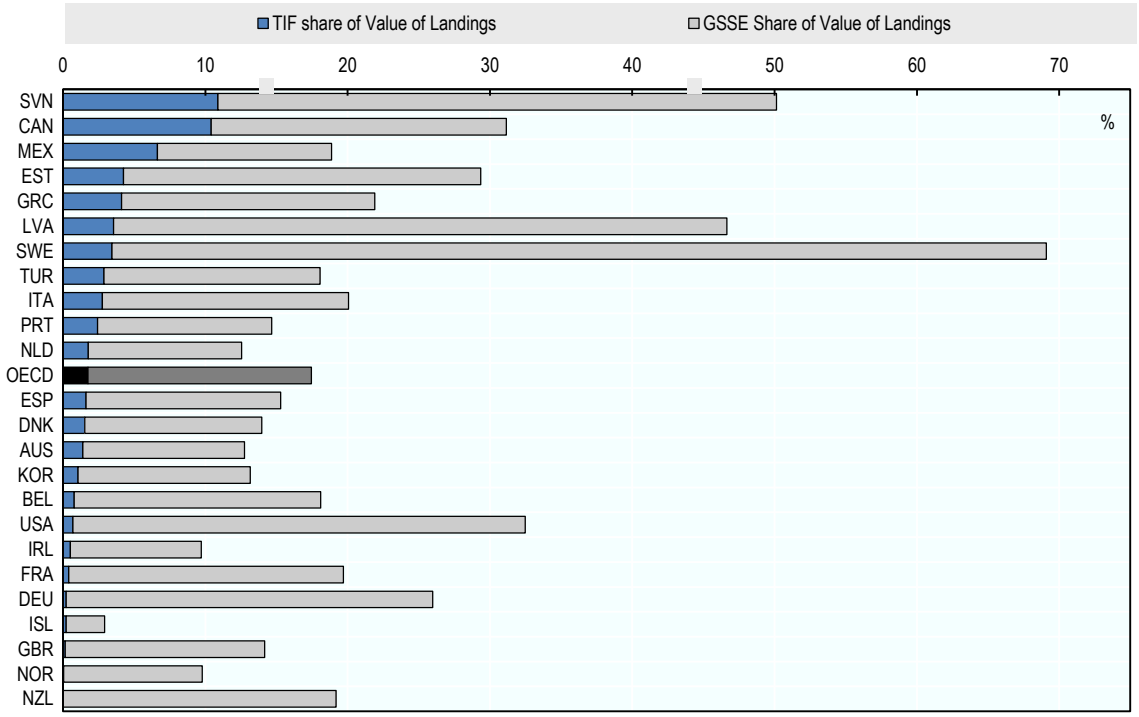
Transfers to individual fishers represented a relatively small proportion of total budgetary support in 2014-15

Policy support at the country level is predominantly supplied in the form of GSSE by all countries. Transfers to individual fishers accounted for between 0% and 11% of a country's value of landings in 2014-15 but were below 5% in most cases (Figure 7).[5] TIF to value of landings ratios of less than 1% are seen in nine countries (36%), this includes New Zealand who reported not having any budgetary transfers that accrued directly to individual fishers.

5 . EU Member States support is heavily influenced in scope and volume by EU structural support (EFF, EMFF).

Figure 7. Total policy support to commercial fisheries as a share of value of landings, selected countries, 2014-15

Disaggregated into Transfers to Individual Fishers (TIF) and General Services Support Estimates (GSSE)



Notes: Missing figures for value of landings have been estimated using data from *The 2016 Annual Economic Report on the EU Fishing Fleet* (Belgium, France, Ireland, Latvia, Netherlands, Slovenia, United Kingdom) or in some cases simply carrying over the value of the previous year. The GSSE numbers reported here include estimations for management and enforcement expenditures, where missing.

Most countries have reduced support to fishers while increasing general services

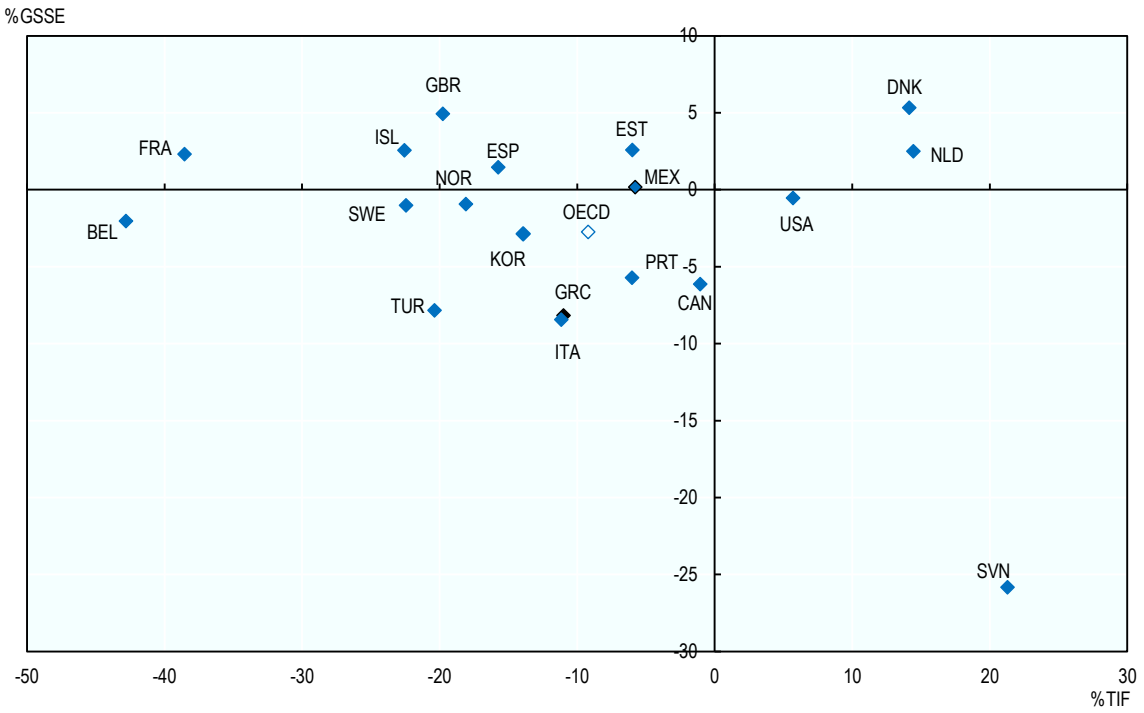
Over time, the quantities of money countries spend on GSSE and TIF have changed. Figure 8 decomposes the FSE movements reported in Figure 6 in terms of how absolute spending on GSSE and TIF has changed, providing greater insights into what has driven these changes and if shifts in policy focus have taken place. The annual average rates of change indicate that, whilst not all countries have moved in the same direction, the majority (nine countries, including the OECD as a whole) have reduced spending on both TIF and GSSE. This is represented by them appearing in the bottom left (SW) quadrant of Figure 8. Reductions in TIF have also generally been proportionally larger than those in the GSSE, illustrated by the points in Figure 8 being more closely grouped along the x-axis than along the y-axis, but this is largely driven by the relative difference in the absolute sizes of the two forms of support.

The next most common change in budgetary allocation to fisheries support (five countries) has been to reduce TIF but increase spending on GSSE, a shift into the upper left quadrant (NW). Only four countries are seen to have increased spending on TIF over the period reported and only two of these also increased spending on GSSE (Denmark and Netherlands).

When the major components making up TIF are looked at in greater detail the average annual growth rates are all negative on average at the country level; transfers based on input use (-3% per year), transfers based on fishers income (-8% per year), and transfers based on the reduction of productive capacity (-6% per year). The degree of deviation around these means is high in all cases except for the reduction of productive capacity, where negative rates of growth were seen in all reporting countries other than Mexico (7.2% per year).

Figure 8. Patterns of change in the FSE, 2009-1 to 2014-15

Average annual changes in the absolute contributions of TIF and GSSE



Note: for Turkey 2014 vs 2013, Czech Republic, Germany, Ireland, Japan, Latvia, New Zealand, Poland and Australia not included due to lack of data. Data includes estimations for management and enforcement expenditures for some countries.

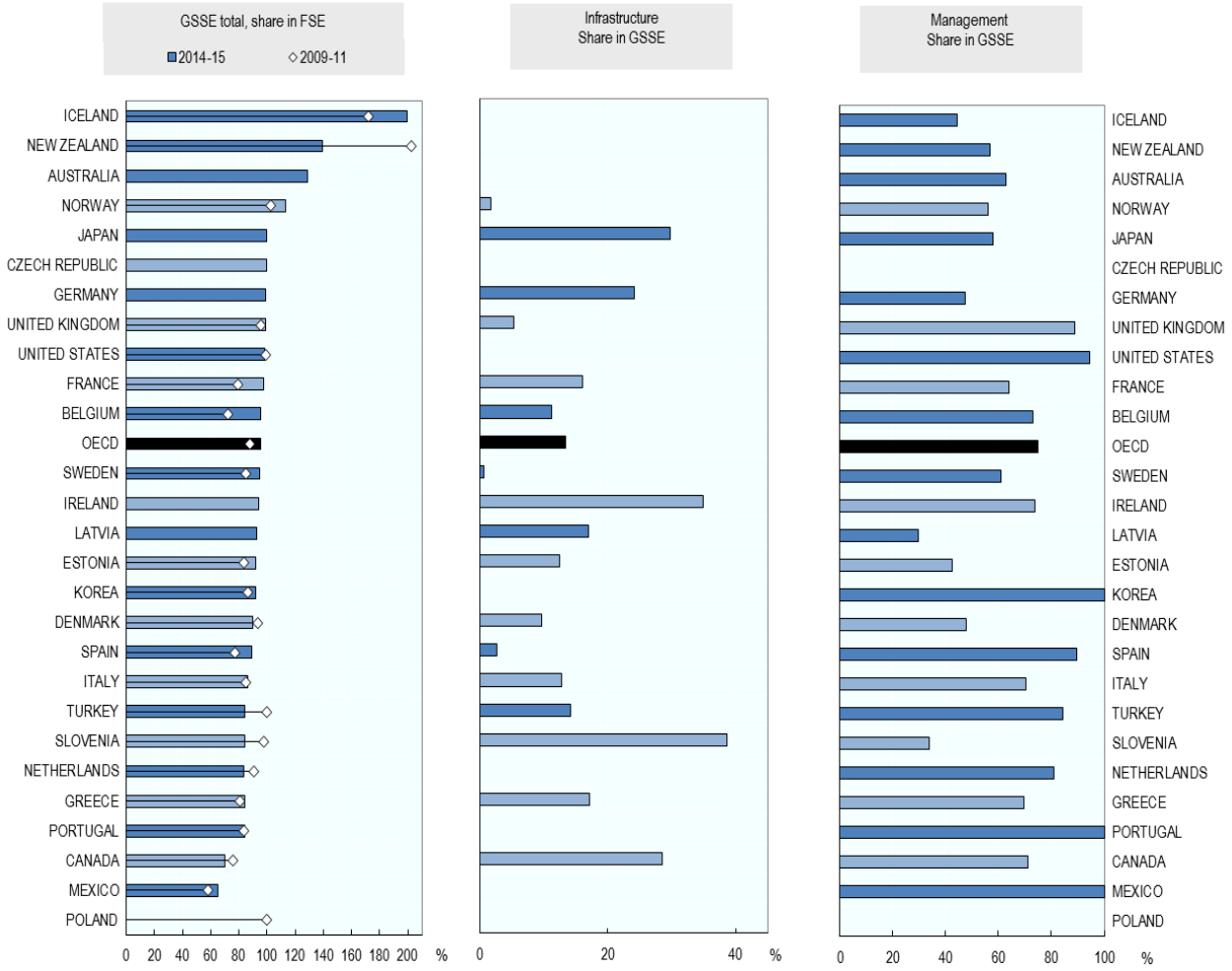
The influence of different policy approaches is again apparent when considering the breakdown of TIF. Transfers based on input use are mainly used in Mexico and the United States, who accounted for 86% of the OECD total in 2013, the last year for which data was made available to the OECD by the United States. In contrast, based on information provided, Canada appears to be the only country that makes significant use of transfers based on income, and accounted for 96% of all transfers of this kind within the OECD in 2015.

Support to general services is mostly used in the management of resources, which predominantly fund enforcement

The proportion of GSSE that goes into supporting the management of resources is large in general, accounting for just over 75% of GSSE spending at the OECD level (Figure 9). Transfers to the management of resources include funding for activities relating to management, stock enhancement, and enforcement of management measures. The last of these three accounts for the majority of spending (Figure 10) and in the majority of countries enforcement costs accounted for around 70% of spending on management of resources in 2014-15. Australia and Canada appear to be the exceptions to this, where the opposite was seen with around 70% of their expenditures on the management of resources being allocated to management programmes.

In 2014-15 an average of 61% of all FSE spending at the country level was attributed to a combination of management expenditures and the enforcement of management measures (this figure increases to 69% if Iceland is excluded as cost recovery charges resulted in them having a negative FSE in 2014). That such a high proportion of fishers support is allocated to management and the enforcement of management measures is indicative of the highly developed management systems that are in place in most countries and the desire to achieve good outcomes.

Figure 9. GSSE share and composition, 2009-11 to 2015

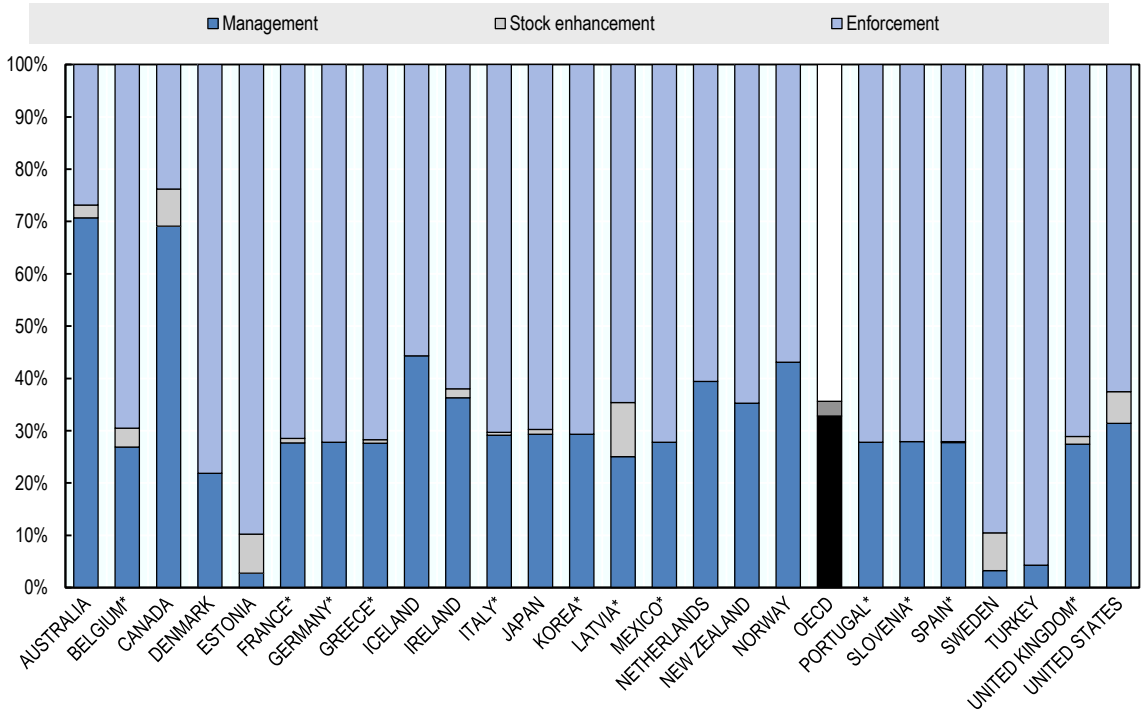


Note: Turkey: Change in GSSE is 2014-15 vs 2012.

Data for management and enforcement expenditures have been estimated for some countries.

Low or zero values for specific GSSE categories may reflect under-reporting rather than an absence of support. It is likely that, for OECD countries at least, some policy spending takes place under most GSSE categories.

Figure 10. Decomposition of management of resources, 2014-15



Note: Countries with estimations of management or enforcement expenditures have been highlighted with an asterisk.

Estimating impacts of support to fisheries

Past conceptual work

> It would appear that subsidies generally have the effect of aggravating an existing natural resource management problem. Simply stated, with subsidies, participation is encouraged and exit is discouraged. Even more disconcerting is the possibility that environmentally harmful subsidies in fisheries act independently as self–standing causal factors. (Milazzo 1998).

The FAO's work to estimate fishing costs and profitability in 1992 and 1993 and its conclusions regarding the impact of subsidies to fisheries, summed up in the above quote from Milazzo, had a powerful impact. The conclusion that fishers were generally operating at a loss was believed and subsidies were seen as the means by which fishers remained in business (Milazzo 1998).

FAO's work on costs and revenues in fisheries helped move subsidies discussions away from trade harm in the form of price effects and towards the negative consequences on fishing opportunities in third countries, conservation and sustainability. As a result, fisheries subsidies discussions no longer deal exclusively or even largely with trade injury, but with their impact on overcapacity of fishing fleets, encouragement of IUU fishing and overfishing itself.

The existing body of work generally agrees that many fisheries subsidies may be at odds with the sustainability and profitability objectives of governments. The consensus is that some forms of support can contribute to overfishing and overcapacity of fishing fleets, with the result of worsening profitability, maintaining a state of crisis, and adding risk to the long-term prospects of the resource and sector.

Some studies take the view that effective management can moderate or eliminate the negative impacts of subsidies (Hannesson, 1991; Porter, 2004). The argument in this case is that binding Total Allowable Catch (TAC) controls prevent an increase in effort in response to subsidies, eliminating any overfishing effects.

Porter (2004) takes the perspective that, even if management is not fully effective, subsidies are still not harmful if there is less than full capacity in the fishery--though Porter (2001) warns that "it would be unwise … to base the international policy toward the fisheries subsides regime on the theoretical proposition that well-managed fisheries can neutralize the negative impacts of subsidies."

Munro and Sumaila (2002) reject this perspective, finding that under the right circumstances, applying a subsidy to a "well-run" fishery could lead to the collapse of the resource if, for example, the intrinsic growth rate of the stock is low. They further argue more specifically that if fisheries capital cannot easily enter and exit the sector, many of the conclusions of the standard management model do not hold. Using a model where capital investment depreciates but may not be sold, they find that subsidies can lead to overcapacity. This is true in particular for decommissioning schemes that are anticipated by fishers, who increase investment prior to the policy to better take advantage of them.

Discussions regarding fisheries subsidies are motivated by their potential negative consequences on overcapacity and overfishing (and thereby on resource sustainability). These negative effects interact with but are not entirely overcome by regulatory actions related to fisheries management. The OECD last made a broad investigation of this in 2006, finding that support to fisheries in OECD countries are significant in scale and could benefit from well-designed reform (Box 3).

Box 3. Key Findings of *Financial Support to the Fisheries Sector*

The OECD produced a major report on financial support to the fisheries sector in 2006. This was based on in-depth case studies as well as an assessment of government financial transfers to the sector. It found that OECD countries transferred at least USD 6 billion per year in support of the fishing sector, divided approximately evenly between management, infrastructure, and direct payments to fishers. The key findings of that report were:

- **Transfers have an important, but limited, role to play in fisheries management policy**. They are an important part of the government's policy toolbox for managing fisheries as they are used to provide fisheries services (research, management and enforcement) that otherwise may not necessarily be supplied by the market. However, this is best limited to a subset of fisheries services, the benefits of which flow to the community in general.
- **There are shortcomings in the transparency of fisheries support programmes in many OECD countries**. Much of the data and information on the programmes are difficult to access and analyse, and there remain significant gaps in the data. Particular areas of concern that have been raised cover the extent of sub-national transfers (at regional and local levels) and the cost of off-budget items such as tax concessions, loan guarantees and interest subsidies.
- **An integrated approach to assessing support programmes is required.** Financial support to the fisheries sector has a wide range of impacts, often reaching beyond the intended target(s) of the programmes and it is necessary to ensure that the full range of effects of particular programmes on the environmental, economic and social dimensions is taken into account when the programmes are designed and implemented.
- **The effectiveness of the management regime and its enforcement is critical in determining the effects of transfer programs**. Importantly, it is the effectiveness of the management regime in enforcing rules and securing rights that is a key factor, just as much as the type of management regime itself. Anything less than perfect enforcement will generally result in adverse impacts on all dimensions and under all management regimes.
- **Financial support for the sector should be de-coupled from fishing activity** in order to ensure that fisheries management policy tools are not used as the primary means to achieve social and regional development objectives.
- **Reduction of financial support does not necessarily spell doom and gloom for the industry** and have generally resulted in increased profitability and reduced dependence on government assistance over the medium to longer term from reducing financial support.
- **Imposing time limits on support programmes will improve their effectiveness and increase community and individual resilience**. One of the major concerns over the provision of financial support to the fisheries sector is that expectations of government assistance tend to become embedded in the decision making processes of fishers.

Source: OECD (2006), *Financial Support to the Fisheries Sector*, OECD, Paris.

Empirical studies of the effects of support

While the large global studies discussed earlier contain some conclusions regarding the impact of different types of studies, these are based largely on a first-principles rather than empirical analysis. There have been a relatively small number of empirical studies investigating the impact of supports to fisheries, and these are usually done on a more regional or local basis. The general consensus is that support can have negative consequences for sustainability, and it is often hard to effectively target chosen beneficiaries and achieve intended outcomes.

Ramírez-Rodríguez, and Almendárez-Hernández (2013), use an expert-driven model to investigate the impacts of fuel tax concessions and VAT exemptions in a Mexican squid fishery. They find that these supports differentially benefit larger vessels and act to keep vessels in the fishery who would otherwise exit. Larger vessels primarily target shrimp and use the squid fishery as an off-season activity. Diesel accounts for more than half of their costs and so tax exemptions for fuel are strongly influential on profitability. Smaller boats have a higher share of costs in crew wages and so fuel policies have a smaller impact on profits for operations.

Carvalho et al. (2011) use a CGE model to estimate the impact of elimination of all fisheries subsidies on the fishing sector in the Azores. They find that subsidies have a net negative welfare effect at the macroeconomic level, though they will benefit the fisheries sector as a whole. Their model does not allow for considering the fisheries sector as other than a single unit, so they do not investigate changes in sector composition or activity due to subsidies.

Tuong et al. (2009) use a combination of structured stakeholder interviews and expert consultations to investigate the impact of the set of subsidies in place in Viet Nam on resources and trade. They found that a credit program to encourage offshore fishing increased overall effort without the intended reduction of pressure on inshore fisheries. Fuel subsidies were found to maintain vessels in operation that would otherwise be scrapped, and to increase the number of total vessels in operation, small vessels in particular. Eliminating a resource tax reduced fishers' concern for resource conservation. Infrastructure investments had a marginal impact on entry into the sector, and also helped raise food safety and hygiene standards. Programs to promote exports led to overcapacity in the processing sector and increase demands on the resource. The overall conclusion calls for reduced and better-targeted subsidies, while acknowledging that open-access management is the main cause of overcapacity and overfishing.

Islam et al. (2016), using a sample of 246 Malaysian fishers interviewed via questionnaire, found that fuel subsidies disproportionately benefitted larger commercial vessels and had unequal benefits in favour of larger operations. Smaller vessel owners were able to benefit from an income support programme providing a monthly stipend. The authors conclude that while existing subsidies have a negative impact on sustainability, their elimination will not solve problems of overfishing.

A Spanish study investigating factors influencing exit of fishing operations from the sector found that decommissioning schemes hastened exit of purse seine vessels, but not by a great deal (Cordón Lagares & García Ordaz, 2015). Another study of decommissioning schemes in Scotland found two different effects: Owners expecting profitable operation considered how to use government grants to enable fresh investment in the fishery. For vessels with poor expected performance, owners' principal concern was whether the payment would be sufficient to clear outstanding debt (Curtis & Jones, 2016). Their responses indicate that decommissioning schemes have a more complicated impact than simply an effect on the entry-exit decision at the margin.

Accounting-based models of the effect of subsidies can show tremendous impacts on profitability resulting from subsides, especially for fuel (see for example Ziegler and Hornburg 2013), which often imply a strong and sudden drop in capacity (and loss of jobs) if subsides are reduced or eliminated. These ignore the dynamic effects of fishers' capacity to adjust input mix and technology in response to price changes as well as the overall effects of entry and exit (especially in situations of existing overcapacity) (see for a counter-example Stouten et al., 2007).

Economic analysis of impacts of fisheries supports

Work by Sumaila and his collaborators or based on it typically classify the impacts of subsidies as either harmful, beneficial or ambiguous – sometimes termed “good, bad and ugly”. (Sumaila, Lam, Manach, Swartz, & Pauly, 2016; Sumaila U. , et al., 2010; Carvalho, Rege, Fortuna, & Isidro, 2011; Cullis-Suzuki & Pauly, 2010; Sharp & Sumaila, 2009; Sumaila U. , Khan, Watson, Munro, & Zeller, 2007) (Table 2). While part of the reason for the popularity of this approach is its practicality for discussing subsidies, the "ambiguous" category is not entirely helpful and would benefit from more refinement. This simple classification is sometimes contradicted by more specific research (Munro & Sumaila, 2002; Arnason, 2000).

Table 2. Classification of subsidies following Sumaila et al.

Beneficial	Ambiguous	Harmful
• Fisheries management	• Fisher assistance programmes	• Fuel Subsidies
• R&D	• Vessel buyback programmes	• Vessel construction, renewal and modernisation
• Marine protected areas	• Community development programmes	• Port construction and renovation
		• Price and marketing support
		• Fishery development projects
		• Foreign access agreements

Source: Sumaila et al. (2010)

There have been other attempts to provide a coherent perspective on the likely impact of support, taking into account the management system in place (Hannesson, 1991; Hannesson, 2001; Porter, 2004, OECD 2006) (see Table 3 for an example). These are useful summaries of structured thinking about the problem, but again may be contradicted by specific studies with more flexible assumptions (Munro & Sumaila, 2002; Clark, Munro, & Sumaila, 2005). The authors of these reports recognise that actual effects are likely to be less clear cut than their stylised analyses suggest and more work is needed to arrive at more detailed and comprehensive conclusions.

The role and effectiveness of the management system is a main factor in the results shown by Hannesson, Porter and the OECD cited in the previous paragraph. These studies generally assume that the management system is either absent (open access) or entirely effective at enforcing effort or catch limits.

The existence of IUU fishing bears witness to the fact that management systems, while ubiquitous today, are not universally effective. These systems imperfectly control fishing catches and effort and may not always provide the proper incentives to maintain optimal capacity levels.

To account for this in the investigation of the potential impact of support policies, it can be considered that there may be a difference between the amount of fishing effort allowed by the management system and the desired level of effort of fishers. The desired level of effort is a function of several factors, the most important of which may be marginal profitability of fishing effort, defined as the difference between marginal benefit and marginal cost of additional effort. A similar situation may be defined for desired fleet capacity levels.

Table 3. Long-term effects of cost-reducing or revenue-enhancing subsidies

Management regime→ **Status of fish stock↓**	**Property rights**		**No property rights**		**No property rights** **No controls**
	Catch controls	Effort controls	Catch controls	Effort controls	
Overfished	No effect on catch or stock No effect on effort Higher value of fish quotas	Same effects as with no property rights except that the value of effort rights will increase.	No effect on catch or stock Greater effort and more boats Same revenue or lower Higher costs and lower industry profits Negative resource rent	No effect on effort, if it is effectively controlled. Higher revenues Higher profits Incentive to expand uncontrolled components of effort. If effort expands smaller stocks lower catches less increase in revenue higher costs less increase in profits lower resource rent	Greater effort and more boats Smaller fish stocks Lower fish catch Lower revenue Higher costs Higher intra-marginal rents Negative resource rent
Underfished	Same as for overfished stocks	Same effects as with no property rights except that the value of effort rights will increase.	Same as for overfished stocks	No effect on effort, if it is effectively controlled. Higher revenues Higher profits Incentive to expand uncontrolled components of effort. If effort expands smaller stocks larger catches higher revenue higher cost less increase in profits lower resource rent	Greater effort and more boats Smaller fish stocks Greater fish catch Higher revenue Higher costs Higher intra-marginal rents Negative resource rent

Source: OECD (2006).

Support policies, inasmuch as they may alter the marginal benefits or costs of fishing, could therefore alter the desired level of fishing effort. If the management system effectively constrains this to the allowed effort level, there will be no effect on effort. If the management system is imperfect, the difference between desired and allowed effort defines the incentive to fish outside management limits, i.e. IUU fishing.

Relative effect of support on desired fishing effort—degree of impact

In this section the consequences of the initial incidence of support are considered. This analysis is an adaptation of work by Floyd (1965) as further elaborated by Gardner (1979) and used in OECD (2001) and Martini (2011). The initial incidence refers to which market activity is directly affected by the support. For example, a payment to replace fishing gear effectively reduces the supply price of gear and so has its initial incidence in the supply function for fishing gear, a variable input. The importance of the initial incidence of support motivates the FSE classification system, which is organised to identify the economically-relevant aspects of the implementation of support policies.

Support will be expansive of fishers' desired effort and fleet capacity when it either increases revenue or reduce costs of operations, whether fixed or variable. Conditionality of support designed to minimise this, such as restrictions related to decommissioning schemes, are unlikely to be perfectly effective in the long term (OECD, 2009; Clark, Munro, & Sumaila, 2005).

In terms of induced effort (the desired change in output resulting from a support policy), the policies with the largest impact are, in descending order:

- Payments based on variable inputs
- Payments based on output
- Payments based on fixed input use
- Payments based on fishers' income
- Payments based on general services

This rank ordering is derived from the work of Dewbre, Antón and Thompson (2001), Hertel (1989) and has been confirmed in OECD (2001) and Martini (2011). The logic behind this ordering is based on the observation that the supply elasticity for the fishing firm can be thought of as a weighted average of the supply elasticities of the factors of production, with the weights being a function of the factor shares and the elasticity of substitution between factors. An annex to this document provides more detail regarding the relevant derivations.

Providing support to variable inputs where supply is more elastic causes a price change focussed on the part of production most able to respond to it. While demand for all factors will increase, the supported input will increase more, and the substitution effect means that relatively more of it will be used in production.

Support based on output, on the other hand, effectively spreads the effect across more factors, and reduces the substitution effect significantly. The fact that some of the support effectively accrues to inelastic factors mutes the total supply (effort) response such that the induced increase in effort is smaller for the same amount of support provided when compared to support to variable inputs.

This logic extends as well to supports directed at fixed inputs; the inelastic supply response means that more of the support goes to an increased factor price than it does to the factor quantity response. Factor returns are higher, and the change in desired effort lower than is the case for output support.

Income-based payments are less distorting of effort still. Like any transfer, the value becomes capitalised in the most-fixed asset that is most closely associated with the entitlement. If the entitlement is closely connected to fishing activity (such as when recipients must be active fishers in the year the income payment is made) the effect is similar to a payment based on fixed inputs. However, income payments are usually imperfectly connected to fishing activity, and the value of the support may accrue in part to assets outside the

fishing sector, such as when the payments are based entirely on historical characteristics of the recipient and not their current activity.

Support to general services, fisheries management in particular, is often categorised as a beneficial subsidy that has the effect of reducing effort and improving sustainability (Sumaila, Lam, Manach, Swartz, & Pauly, 2016). However, the clear and necessary regulatory benefits of management may be considered separately from the effects of policy support made to enable them.

Evidence from the FSE database suggests that expenditures on management and enforcement can amount to more than 25% of sector revenue in many cases, and more than half of all revenue for some (Figure 7). This is certainly enough to affect the profitability of the sector. Even if one considers that private costs of management would be fixed (as opposed to variable costs like fuel), the impact of public management and enforcement support would be larger investment in the sector, with implications for potential overcapacity.

Porter (2004) argues that even if private financing of management is possible, the quality of government-provided management is likely to be higher. By this reasoning, government provision of management services can be beneficial.

On the other hand, if government allocation of resources to fisheries management is limited by the opportunity cost of public funds spending will be below the optimal amount that a private system could achieve. The New Zealand experience with private funding of stock assessments hints that if investment in management is made to the point where its marginal benefit equals its marginal cost, actual spending would be higher in private systems than in public (Harte, 2000; Sinclair, Valdimarsson, & Food and Agriculture Organization of the United Nations., 2003).

Whether government funding of fisheries management constitutes a beneficial subsidy has to do with the definition of the counterfactual. Under the assumption that the alternative is no management control at all, government provision of management is almost certainly beneficial. On the other hand, if it amounts to government funding of a service that would exist in any case, then it could increase capacity and optimal effort, as it eliminates a substantial cost that fishers would otherwise bear (Arnason, 2000).

Two polar cases for the counterfactual are (1) without government provision of these services, they would be wholly absent, and (2) without government payments, the identical services would be provided, paid for by sector participants themselves. The truth likely lies somewhere in between, with the probability of private provision of management positively linked to the quality of property rights in the fishery.

In case (1), the impact of general services support is not separable from the benefits of the associated regulatory activity and public goods. These aren't properly the effects of support *per se*, but are commonly viewed as such. In case (2), support to general services is essentially a payment based on sector revenue, with effects similar to payments based on income. In Table 4 general services is shown as having the least impact on overcapacity and overfishing because it is likely that some of the policies in this category—which includes not only management but research and education—are closer to public goods or that their incidence is at some distance from production activity and therefore would have a lesser impact than would management.

A final note on output impacts: Thinking of different fish stocks as a portfolio of activities among which a fisher may choose based on relative returns, the scope of a subsidy will bear upon its (desired) output impact. Broad-based subsidies covering all fish stocks affect only the supply response — reducing input costs does not change the relative attractiveness of any particular fish stock.[6] Subsidies targeting a specific stock or gear type will have an additional substitution effect as fishers re-allocate effort towards the subsidised fishery or gear. The more specific a subsidy is to a particular stock, the greater the potential impact on that stock. In

6 . This is true only when differential gears are not relevant. It has frequently been noted that support to fuel makes more distant stocks more attractive, or the use of active gears. The general supply impact is separate from any induced technological change.

some cases however, specific targeting of support to particular stocks is done in order to divert effort away from fisheries that cannot tolerate it. Such support would have effects strongly conditioned by the management system and hard to determine in a general manner and may reduce pressure on specific stocks.

The degree of impact on capacity is closely related to the effect of support on the use of fixed inputs, which in this analysis represents capacity investments in the production system. In this case, payments to fixed inputs have the strongest effect, followed by payments on output, income, variable inputs and general services (Table 4).

The degree of impact on income is usually inverse to the degree of impact on desired effort. More induced effort means greater deadweight losses from market distortions, which equates to lost value. If a distinction is maintained between benefits that accrue to active fishers versus payments that accrue to incumbents (those active in the sector at the time the support policy is introduced), then payments based on fixed input use can be less effective, depending on other conditions associated with the policy transfer.

Payments based on income are, not surprisingly, the most effective at supporting income and, whist they can result in effort remaining in a fishery when it otherwise may not, are less likely than other more common policies to promote overcapacity and overfishing. If government objectives are to support fishers in order to make their incomes more comparable with those in other sectors, this may be the best sectoral-based approach. One problem with explicit income payments is that in the context of existing social programmes, it can be hard to justify a separate system for a specific sector. As well, these programmes may not be well-received by fishers if they are seen as “hand-outs”; fishers prefer to believe that they are earning their way fairly and that assistance policies are only there to help overcome factors out of their control.

The prevailing concept of the impact of support uses three categories—beneficial, harmful, and ambiguous. This is an imprecise view of the effects of support. A better conceptual model has to do with degree of impact, which recognises that different categories of support will have different effects on overcapacity or overfishing, as well as different benefits for fishers and other sector participants.

The degree of impact on any particular outcome depends on implementation details, many of which are captured in the FSE database which is designed for that purpose. It is also strongly conditioned on the set of management regulations and rules in place that set the rules of the game for fishers. Many forms of support are likely to reduce costs, raise revenue or income, or put capital in the hands of sector participants. Associated constraints are unlikely to be perfectly effective at offsetting these effects.

The scale of support can be just as important as the decree of impact. A large amount of support that is minimally distorting can still add up to an important impact. Even support that has no effect on marginal cost but that amounts to a large percentage of the value of landings will influence the long-term entry-exit choices of fishers, and thereby tend to promote overcapacity.

Table 4. Summary of results on degree of impact of policies

Support type payment based on…	Effect on desired effort, rank	Effect on capacity, rank	Effect on income, rank	Main beneficiaries
Variable inputs	1	4	5	Input suppliers, fishers
Output	2	2	4	Fishers, input suppliers
Fixed inputs	3	1	2	Incumbents, fishers
Income	4	3	1	Fishers
General Services	5	5	3	Fishers, incumbents

Source: Adapted from Dewbre, et al. (2001); OECD, 2001 and Martini (2011).

Expenditures on general services to the sector (the majority of which are for management) often amount to a substantial proportion of the total value of landings for a fishery. For this reason, cost-recovery of management expenditures serves as a useful check on the economics of fishing in a region, helping ensure that the fishery is a net economic contributor to the economy as a whole.

There is concern that some fisheries would be abandoned without support. Many fisheries operations have fuel costs that approach or exceed half of all costs, and in some cases fuel can account for 80% of all costs (Martini, 2012; Borrello, Motova and Dentes De Carvalho, 2013). It is often assumed that these are dependent on support for survival. The objective of maintaining effort in specific fleets and metiers may conflict with other objectives having to do with preventing overcapacity and overfishing (in addition to broader environmental objectives such as reducing CO_2 emissions, bycatch or habitat damage). It is a very difficult task for a support policy to have a knife's-edge goal of promoting effort without causing overfishing.

It is probably not the case that a valuable fishery will go unexploited absent support, but it is likely that reforming support can change the way these stocks are pursued and by whom; there is relatively little risk of leaving too many fish in the sea. If it is part of the objectives of a government to maintain traditional fishing activities in certain regions, then it is important to consider the impacts of support on the overall quality of life of fishers and in the fishing community as a whole. Policies targeting gears, vessels or activities are usually inferior mechanisms for improving this, and the associated environmental externalities can make them counterproductive in the long-run.

It has been demonstrated here that many forms of support can be expected to do a poor job of increasing the income of fishers, because a large share of the value of the transfer generated goes to non-fishers--such as input suppliers, shipyards or “armchair fishers”—non-fishing license holders or vessel owners. For this reason, when choosing policies to meet their objectives, governments should consider not only whether they are susceptible to provoking overcapacity and overfishing, but also their transfer efficiency and the scale of support required to achieve their objectives.

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Annex

Some supporting analysis

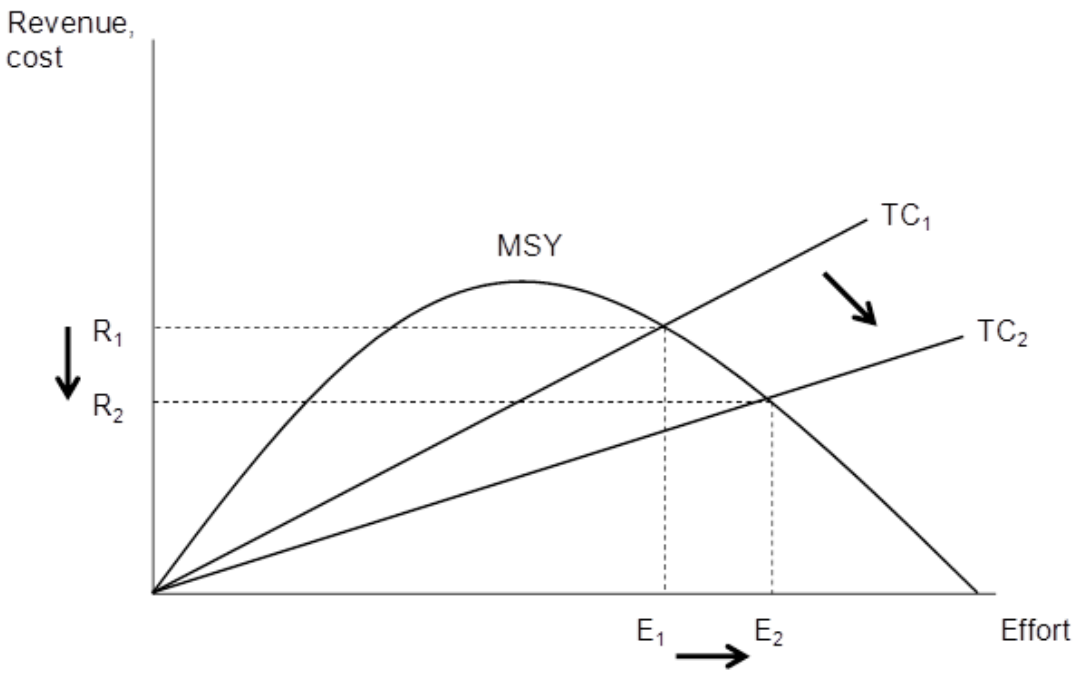
Analysis using bionomic equilibrium

The effect of reduced unit costs as a result of support can be complex. Open access leads to profits being exhausted through expansion of effort lowering catch per unit effort (CPUE) through lower stocks. When a TAC is enforced, profits will still be exhausted through capital stuffing which reduces capital efficiency or racing to fish which lowers operational efficiency. This means that support does not have a long-term impact on profits in most cases. It can, however, change desired and actual effort and fleet size, and factor returns for fishers and input suppliers.

The classic analysis of the impact of support uses the concave yield function representing the long-term equilibrium between effort and output (Figure A1). This is combined with a total cost of effort function (TC), the intersection of which with the yield curve identifies the open-access equilibrium of the fishery.

In this analysis, support lowers the cost of effort, leading to more effort and a smaller fish stock in equilibrium. The figure shows a shift in the slope of the total cost (TC) function from TC_1 to TC_2, indicating a reduction in marginal cost. Depending on the initial situation, total harvest can be lower than before the support if catch-per-unit-effort declines sufficiently.

Figure A1. Support to variable input use in an open access fishery



Source: OECD (2010)

When it is assumed that fisheries management constrains effort at the level required to take a TAC set at maximum sustainable yield (MSY) (E_Q), fishers earn positive profits of R1-C1 in the initial situation (Figure A2). If support that lowers cost is then introduced, and effort is still assumed to be effectively controlled by the TAC so does not change, the support leads to higher profits as costs are lower with no changes to stock or effort level. This implies that support under a binding TAC is more transfer efficient - the value of the support tends to be reflected in increased profits instead of lost to deadweight losses. This is a consequence of the management regime; effective control means that support cannot impact effort or stocks and limited access means that positive profits are possible.

Figure A2. Support with a TAC and limited entry

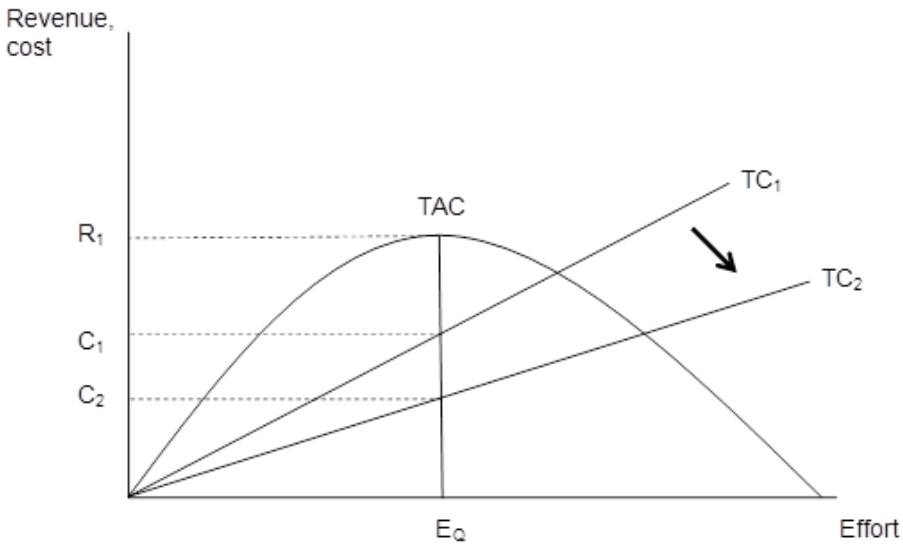


Figure A2 is something of a best-case scenario. It will hold under rights-based regimes (such as ITQs), where there is no incentive to compete-away rents, as would be the case with an enforced TAC that allowed free entry. In the situation of a binding TAC but unlimited entry, the TC curve always touches the yield curve at the TAC level (Munro & Sumaila, 2002). This is because fishers compete away profits not by increasing effort as in the open access case, but by capital stuffing and bidding up the cost of inputs such as fishing vessels or licenses such that profits are capitalised into the value of these inputs. Even when support is directed at variable costs this would ultimately become capitalised in the value of fixed inputs. The result is no change in stock, effort or profits as a result of support, but higher values of total investment for fixed inputs such as fishing vessels. This capitalisation effect may make it difficult to remove support once it is in place; fishers will have already invested the value of the support in capital and would suffer a real loss if it were removed.

The conclusion is that fishers' profits are a poor indication of the benefits that accrue from support. Either competitive forces or capitalisation of economic profits into fixed inputs means that long run accounting profits are zero. This does not mean that subsidies (or different management systems) do not confer benefits. As will be discussed below, producers' surplus is a better measure of the effective transfer resulting from a support policy, and the benefits of capitalised support accrue to some stakeholders—just not always those that are the target of support.

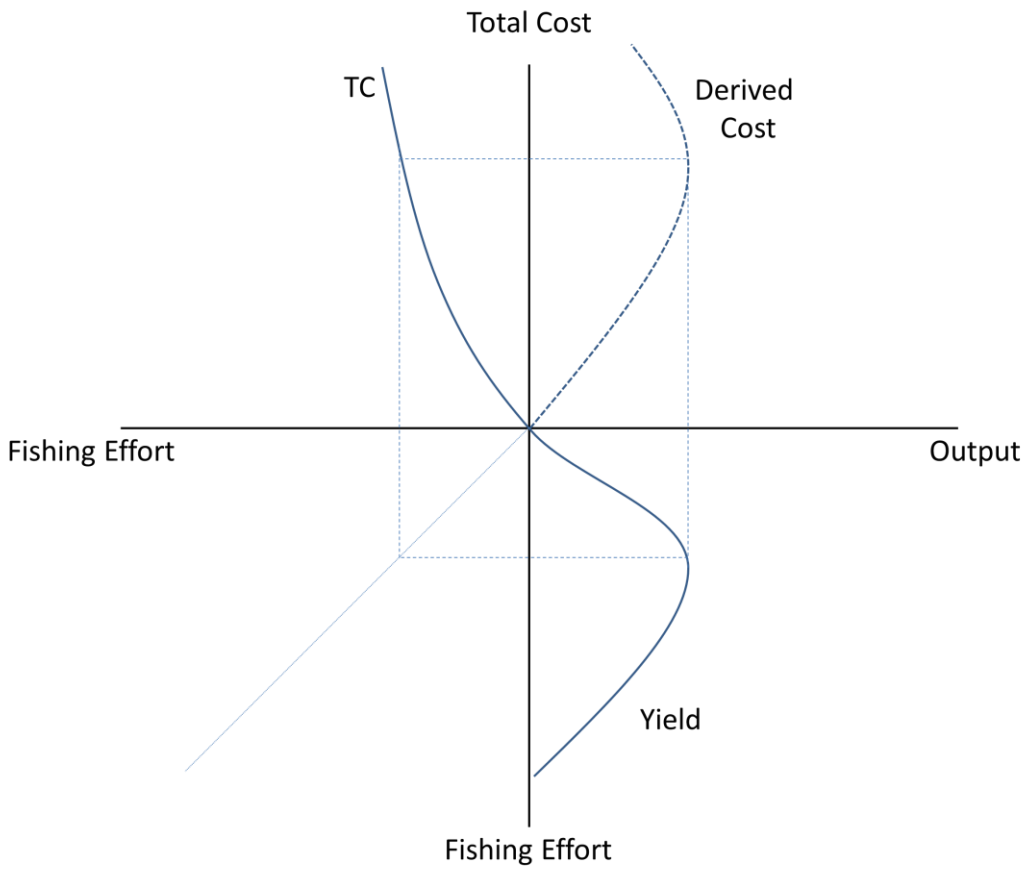
This analysis can also be misleading as all points on the yield curve represent separate long-term bionomic equilibria based on a stock-harvest pair; it is not a fixed relationship between revenue and effort in any given year. This means that the impact of subsidies in a medium-term time frame, which may be several years, cannot be illustrated at all. A subsidy may result in a level of effort and revenue north-east of the MSY

point (the peak of the yield function), and this situation may persist for many years before the impact of overfishing becomes felt. The stochastic nature of stock recruitment can further obscure the results.

Analysis of bio-economic equilibrium is also of limited use in identifying other relevant economic factors. For example, support can distort the choice of production inputs compared with a cost-minimising choice at market prices. The degree to which this occurs will depend on the extent to which production inputs, or factors of production, are substitutable and whether it is economically efficient to do so. For example, while fishers may not have an incentive to fish more under fixed individual quotas, they may elect to fish for longer periods of time and with different gear or crew size. Support affecting crew or fuel prices will affect this kind of decision-making.

The yield function shown in Figures A1 and A2 has been used to derive what has been called a "backward-bending supply function" (Copes, 1970) (Figure A3). However, this is not a true supply function, but rather a correspondence of all the equilibrium points of the yield function's intersection with the total cost function. This is explicitly a long-run correspondence, something that is clear from the definition of the yield function. What is less obvious is that this is not in fact a supply function – either short run or long run, as it relates total cost to output and not marginal cost.

Figure A3. Correspondence of total cost and output



Source: Copes (1970).

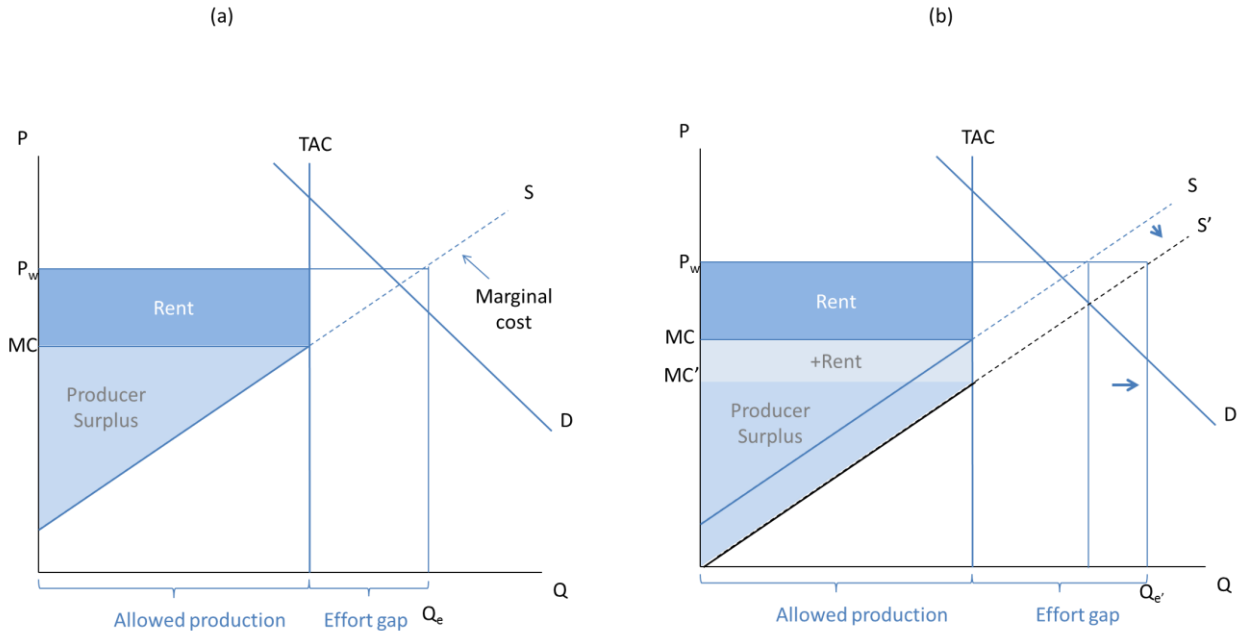
Preliminary analysis using marginal cost

Most authors considering the impact of subsidies on fishing start from the standard bio-economic model as in the prior section, using a concave yield function and linear total cost (see for example Tipping 2017, OECD 2010). In this analysis, support lowers the cost of effort, leading to more effort and a smaller fish stock in equilibrium. One limitation of this analysis is its implicitly long-run nature. Support may increase effort and harvest for some time before declining stock size reduces harvest, such that the intersection of the cost and yield curves is a poor indication of near-term impacts of support.

The following analysis was originally developed in OECD (2001) and OECD (2005) and has been adapted to the fisheries context. It forms the preliminary basis for an eventual model of support to the fisheries sector to be developed. It therefore represents an early view of the potential effects of support.

In the short run, a standard upward-sloping supply curve based on the industry marginal cost function is a more appropriate choice for analysis. This supply function may be interrupted by a TAC that effectively sets an upper limit on supply (Figure A4). From this representation, an alternative view of the generation of rents from the existence of a TAC can be observed.

Figure A4. Producer surplus and rent under TAC



For the TAC to be binding, the price of fish must be above the marginal cost at the TAC quantity. Otherwise, harvesting the full TAC would be unprofitable and the harvest level would be determined by the price. The price is drawn here as P_w, reflecting a world price that is not sensitive to domestic production. Demand in excess of domestic availability is imported. The marginal cost at the TAC quantity reflects the underlying supply function and the producer surplus is the area above the supply function and below marginal cost. Still assuming that effort is free to enter the fishery, desired effort is Q_e, and the TAC results in an effort gap between what the amount fishers wish to harvest versus what is allowed.

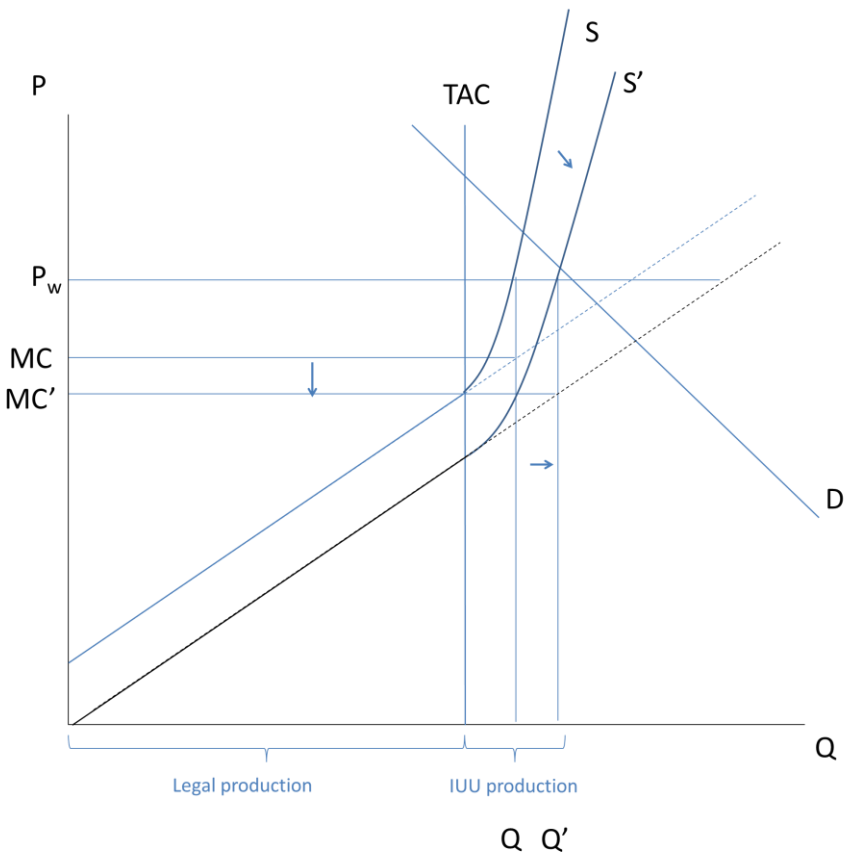
Marginal rents are the difference between price received and marginal cost, and the total rent is the marginal rent times quantity produced (TAC). They arise because the TAC constrains output at a point where marginal cost is below price. This is a consequence of the management system and this rent is the "untaxed resource rents" discussed in the context of the scope of support to fishers.

In the case of a new or increased support policy that reduces the marginal cost of production, the supply curve shifts down, increasing the rents generated in the fishery and increasing desired effort to Qe'

(Figure A4, Panel b). The TAC continues to restrain effort, but the gap between allowed and desired effort increases. This can be interpreted as increased pressure on the management system to increase TAC and increased potential return to IUU fishing. Increased support in a situation of a binding TAC can therefore increase total effort when IUU activity is taken into account, and generally puts more strain on the management and control system.

Management systems are rarely 100% effective in controlling effort, and fishers have a number of ways by which they can avoid controls. Consider the possibility that some fishing may exceed the TAC; this may be a subset of fishers that make up the industry supply curve who do IUU fishing, or a propensity of all firms to carry out IUU activity. If the probability of IUU fishing is proportional to the effort gap, then the amount will increase with added support. So long as the TAC is at least partially enforced, the sector will still generate rents, just a smaller amount than the case under perfect enforcement (Figure A5).

Figure A5. Incomplete TAC enforcement allows supply response to support



In the case of a simple cost structure as shown in Figure A4 (linearly increasing marginal cost), the amount of producer surplus from the increase in support does not change and the entire value of the support accrues to holders of assets that accumulate rents — typically quotas or licenses with durable property rights or relatively fixed capital such as vessels. The value of quota or vessels in the fleet consequently increases by an amount equal to the quantity of support provided.

Even though the producer surplus is unchanged by the introduction of support in panel b of Figure A4, the distribution of the surplus between fishers and other factor suppliers (such as crew, fuel or gear) will change depending on the incidence of the support. This cannot be easily shown in a graphical representation and some derivations are provided in a later section. The initial distribution of producer surplus between factors (including fishers) is according to the factor share in value of production, but changes resulting from changes in support will depend on the nature of the supply function.

It may seem of little interest whether the benefits of support accrue to fishers through the producer surplus they earn through their owned factors of production or via generation of rents, but there can be some important implications for the distribution of benefits. Rents become capitalised in the value of the related policy instrument (quota or licenses) or the most fixed factor of production (usually vessels). The benefits accrue to those incumbents who own these assets at the time the support is introduced. New entrants or others acquiring vessels or quota must pay the capitalised value of support through a higher asset price. The support benefit for them is balanced by an increased capital cost, and the incumbents are the only ones who benefit—and the benefit is only realised upon sale of the asset. Fishers who pay the higher price for assets do not benefit from support, but stand to lose if the support is later withdrawn and the value of their assets fall. Fishers who lease quota must also pay a higher price to account for the support value. Support becomes entrenched even though current fishers do not benefit.[7]

Beneficiaries of support

The investigation of the beneficiaries of support depends on certain assumptions about the relevant incentives and scope of possible reactions by those implicated by a policy. A useful assumption is constant factor shares in production. These are a defining characteristic of the Cobb-Douglas production function, a common choice for analysis (Helmberger 1991, and Helmberger and Chavas, 1999). It is assumed that constant factor shares give a good approximation of changes in factor payments caused by changes in support measures, even if the underlying aggregate production function is not exactly of the Cobb-Douglas form.

In the case of two factors (capital and labour), the two equations for measuring the gross increase in factor earnings caused by an increase in support payments are:

$$\Delta GFE_k = s_k * n_k * \Delta TR,$$

$$\Delta GFE_l = s_l * l_f * \Delta TR.$$

ΔGFE_k and ΔGFE_l are, respectively, the change in gross factor earnings of capital and labour caused by a change in support. The symbol s_k stands for the share of total costs of production attributable to capital — vessels and the value of licenses and quota. The symbol s_l corresponds to the share of total costs of production attributable to labour, either by the vessel owner or crew. Finally, n_r is the proportion of the capital that is owned by fishers and l_f is the proportion of total labour supplied by fishers. It is shown below that the four parameters s_k, n_k s_l and l_f are key determinants of the transfer efficiency of support.

The ease with which fishers can adjust the quantities of capital and labour they use will be reflected in the elasticity of factor supply for those two factors. The higher the elasticity of factor supply, the greater is the adjustment in factor use in response to a policy-induced change in factor returns, and the less the net gain in income for a given change in support. Helmberger proposes a simple formula for using the elasticity of factor supply in calculating the net gain in factor returns due to a policy-induced increase in factor payments. The general version of the formula is

$$\Delta NFE = 1/(1+e) * \Delta GFE$$

ΔNFE is the net gain in factor earnings due to a policy-induced increase in gross factor earnings and e is the elasticity of supply of a factor.

A zero elasticity of supply for a factor corresponds to that situation where the factor is completely fixed in production. This is the only situation in which all the gains in factor payments induced by an increase in support can be counted as net gain in factor earnings. In all other circumstances, the elasticity of factor supply (which is always positive) serves to regulate what fraction of the gross gain in factor earnings gets counted as net gain.

The net gain in income due to a change in support is equal to the sum of the induced net gains in factor earnings on the capital and labour supplied by fishers. Accordingly, the relationship shown in the above equation can be used to calculate the net gain in income due to an increase in support:

$$\Delta FI = \Delta GFE_k / (1+ e_k) + \Delta GFE_l / (1+e_l).$$

ΔFI is the change in fishers' income due to the change in support payments. The symbol e_k refers to the elasticity of supply of capital (whether owned by fishers or by others) and e_l is the elasticity of the supply of fishers' labour.

This leads to the following formula for estimating the gain in income associated with a given increase in total revenues.

$$\Delta FI = [s_k * n_k / (1+e_k) + s_l * l_f / (1+e_l)] * \Delta TR$$

This shows that, all other things being equal, the increase in income due to an increase in total revenues will be smaller: *a)* the smaller the cost shares of fishers' capital and labour and *b)* the larger is the elasticity of supply of those factors.

More generally, the supply function can be expressed as a function of the elasticities of supply of the factors of production used, the elasticity of substitution between them, and the factor value shares in output (Dewbre, Antón, & Thompson, 2001). The elasticity of supply for a two-factor case can be expressed as:

$$\frac{e_k s_k \sigma + e_l s_l \sigma + e_k e_l}{\sigma + e_k s_k + e_l s_l},$$

where s is the factor share with respect to capital and labour (k and l subscripts) and σ is the elasticity of substitution between them.

Relative effect of different types of support on effort

The question of the incidence of support has been long studied in the context of agriculture (Gardner, 1979; Houck, 1989; Griliches, Holdreth, & Grilicihs, 1959). In an early study, Floyd (1965) derives the supply function of output as a function of input supply, and Gardner (1987) expanded on and generalised this analysis. It has been used investigate the relative impacts of different support types (see for example Dewbre, Antón and Thompson, 2001; Hertel 1989). The mathematical development that follows below is based largely on the exposition by Gardner.

Consider the production of an output, *x*, that depends on two inputs, *a* and *b*. Notionally for fisheries, x is fishing effort, and landings will depend on both effort and stock size, as reflected in the catch per unit effort. This analysis excludes stock effects and focusses on desired fishing effort. It is therefore most representative of the case of highly schooling fish stocks. The six following equations define the economic system:

Production function:	$x = f(a, b)$
Equality of value of marginal product (VMP) to factor price:	$f_a P_x = P_a$
	$f_b P_x = P_b$
Factor supplies:	$a = g(P_a)$
	$b = h(P_b)$
Product demand:	$x = D(P_x)$

The goal is to solve this as a system of equations via substitution. The first step however is to take total differentials of all equations, convert these differentials to percentage changes by dividing by the relevant variable. For the production function, this results in:

$$dx = f_a da + f_b db$$

$$\frac{dx}{xab} = \frac{P_a}{P_x xb}\frac{da}{a} + \frac{P_b}{P_x xa}\frac{db}{b} \quad \text{(dividing by xab and using } f_i = \frac{P_i}{P_x}\text{)}$$

$$\frac{dx}{x} = \frac{P_a a}{P_x x}\frac{da}{a} + \frac{P_b b}{P_x x}\frac{db}{b} \quad \text{(multiply by ab)}$$

$$EX = K_a Ea + K_b Eb \tag{1}$$

Where E is the percentage change operator and K_i is the value share of factor i. Equation 1 indicates that the percentage change in effort is equal to the percentage change in inputs multiplied by their factor shares.

Similar operations can be used to find:

$$EP_a = -\frac{K_b}{\sigma}Ea + \frac{K_b}{\sigma}Eb + EP_x \tag{2}$$

$$EP_b = -\frac{K_a}{\sigma}Eb + \frac{K_a}{\sigma}Ea + EP_x \tag{3}$$

Where σ is the Allen partial elasticity of substitution $\sigma = \frac{f_a f_b}{x f_{ab}}$.

The supply function is found by applying a change in output price. Divide (1) by EP_x and substitute in (2) and (3). This yields:

$$\frac{Ex}{EP_x} = \frac{e_a e_b + \sigma(K_a e_a + K_b e_b)}{\sigma + K_a e_b + K_b e_a} \tag{4}$$

Where e_i is the supply elasticity of factor i $\left(e_i = \frac{Ei}{EP_i}\right)$.

A support to factor a that increases P_a expressed as an *ad valorem* rate of support (multiplying price) has the following impact:

$$EP_a = \frac{Ea}{e_a} + ES_a$$

That is, the percentage change in factor price equals the percentage change in subsidy plus an adjustment for movement along the factor supply function. Substituting the above into equations (2) and (3) and resolving the system results, after some manipulation, in

$$\frac{Ex}{ES_x} = \frac{-\eta[e_a e_b + \sigma(K_a e_a + K_b e_b)]}{e_a e_b - \eta(\sigma + K_a e_b + K_b e_a) + \sigma(K_a e_a + K_b e_b)} \tag{5}$$

$$\frac{Ex}{ES_a} = \frac{-K_a \eta e_a (e_b + \sigma)}{e_a e_b - \eta(\sigma + K_a e_b + K_b e_a) + \sigma(K_a e_a + K_b e_b)} \tag{6}$$

$$\frac{Ex}{ES_b} = \frac{-K_b \eta e_b (e_a + \sigma)}{e_a e_b - \eta(\sigma + K_a e_b + K_b e_a) + \sigma(K_a e_a + K_b e_b)} \tag{7}$$

Where the denominator of these equations is the determinant of the matrix of parameters for the simultaneous system.[8] η is the elasticity of demand.

Taking the difference of (5), (6) and (7) shows that a subsidy inducing a percentage change in effort is equivalent to subsidies that induce the same percentage change in all inputs:

$$\frac{Ex}{ES_x} = -\frac{Ex}{ES_a} - \frac{Ex}{ES_b}$$

The above is expressed in percentage change and is relatively intuitive given that the production function is homogenous of degree 1. This provides a basis for understanding how unequal changes in input support can effect output. Dewbre, Antón and Thompson (2001) apply this framework to equivalent levels of support and find that for a subsidy of equal monetary value applied to an input or to output, the ratio of effect is equal to:

$$\frac{e_a(\sigma + e_a)}{e_a e_b + \sigma(K_a e_a + K_b e_b)}$$

This equation holds only in the special case of no initial support and no effect of domestic production on price (P_w fixed; small country assumption). They find in general that the range of difference in impact under less restrictive conditions is always positive—input support is always more distortive for a given quantity—but cannot be further defined. This is because the initial level of support matters in calculating the proportional impact of additional support on price.

The division of rents and producer surplus

In the case of a TAC allocated as quota, the rents do not go either factor of production but to quota owners. As shown in Figure 14, the rental rate is the difference between P_x and the (marginal) cost on the supply curve, $R = P_x - C_x$. If the quota assigned to a fisher changes, the percentage change in C_x is a move along the supply function found as the reciprocal of (4). So change in rents for a change in quota (change in allowed *x*) is

$$\frac{dR}{dx} = \frac{dP_x}{dx} - \frac{dC_x}{dx}$$

Expressing R as a percentage of price:

$$\frac{dR}{dx}\frac{x}{P_x} = \frac{dP_x}{dx}\frac{x}{P_x} - \frac{dC_x}{dx}\frac{x}{C_x}\frac{C_x}{P_x}$$

or

$$\frac{ER}{Ex} = \frac{1}{\eta} - \frac{C_x/P_x}{\varepsilon}$$

Where η is the demand elasticity and □ is the supply elasticity.

Support to input or output use raises factor supply prices (and therefore producer surplus), but quota reduces factor prices (reducing benefits to fishers and input suppliers) while increasing rents (increasing benefits to incumbent quota holders). The factor price change for a change in quota is:

$$\frac{EP_a}{Ex} = \frac{\sigma + e_b}{e_a e_b + \sigma(K_a e_a + K_b e_b)}$$

And the change in quantity of the factor is just the above multiplied by the elasticity of supply of the factor.

8. The equations for S_b and S_x are not shown here, but are derived in a similar way.

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