Ecological Economics 147 (2018) 276–297

Contents lists available at ScienceDirect

Ecological Economics

journal homepage: www.elsevier.com/locate/ecolecon

Analysis

Assessment of Socioeconomic Impacts Through Physical Multipliers: The Case of Fishing Activity in Galicia (Spain)

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ARTICLE INFO

Keywords:
Input-output multipliers
Fisheries
Socioeconomic impacts
Ecosystem-based management

ABSTRACT

In the context of fishery management based on the ecosystem-based approach, it is necessary to develop methods and tools in order to facilitate the decision making and balance the socioeconomic and environmental dimensions of sustainability. The goal of this document consists of providing an assessment tool of the possible socioeconomic impacts arising from the variation in the fishing opportunities. After defining what we call input-output physical multipliers, an application for the case of fishing in Galicia (Spain) was developed. The results show that this method is valid for obtaining a more accurate assessment of the possible socioeconomic impacts arising from a fishing supply shock, considering in equal measure the backward and forward linkages of fishing activity with other sectors. The defined multipliers permit the assessment and comparison *ex ante* of different management scenarios for fisheries. As a consequence, this is a method with the capacity to provide support for a better decision making to the fishery regulators and other decision-makers, facilitating the implementation of more holistic management frameworks.

1. Introduction

Over the last decades, there is a growing international consensus about the need of managing the exploitation of marine resources with a more holistic approach searching for sustainable development (Degnbol and McCay, 2007; De Young et al., 2008; Curtin and Prellezo, 2010; Berkes, 2012). For this, the ecosystem-based approach to the fishery management has supplied principles, concepts and frameworks that have contributed to the spread of the need to progress in achieving the sustainability of fishing activity (Garcia et al., 2003; Coll et al., 2013; Patrick and Link, 2015; Ramírez-Monsalve et al., 2016). In all the general frameworks of ecosystem-based management, management bodies of marine resources are required to incorporate assessments including both biological and environmental elements and other key components for the economic, social and institutional aspects. That is to say, the ecosystem-based approach for the fishing management must pursue the biological and environmental sustainability, but in balance with the economic and social interests (Jin et al., 2003; Cheung and Sumaila, 2008; BenDor et al., 2009). Within this context, it is necessary for these bodies to have the best information which helps them to connect the possible effects of the management decisions or the measures to be implemented with all the aspects of sustainability. Having measurement tools provides higher capacity of adaptation, more flexibility and allows better facing the challenge of the fishing policy (FAO, 2003; Levin et al., 2013).

Traditionally, fisheries had been managed through the recommendations of the sustainable catches of the main target species of the fishing fleets (Anderson and Seijo, 2010; Sanchirico et al., 2008). The catch limitations by means of annual quotas are still a widely used measure for fishing management (see the European Fisheries Policy, Carpenter et al., 2016; Daw and Gray, 2005; Garza-Gil et al., 2011; González Laxe, 2010; Villasante et al., 2011). These fishing quotas by species and area are determined mainly according to scientific reports based on the fishery stock assessment, with practically no reference to the field of economy. The little consideration to socioeconomic aspects of management decisions taken (e.g. involved jobs, highly fishing dependant areas, economic profitability of different fishing techniques) is commonly mentioned as the cause of failure of the fishing management measures adopted (Browman et al., 2004; Hilborn, 2007; Khalilian et al., 2010; Kulmala et al., 2008).

The input-output (IO) analysis gives us not only theoretical extensions but also practical developments for the assessment and measurement of socioeconomic effects, for instance, derived from environmental impacts (Lenzen et al., 2003; Ferng, 2003; Suh, 2004;

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https://doi.org/10.1016/j.ecolecon.2018.01.020
Received 20 February 2017; Received in revised form 7 September 2017; Accepted 15 January 2018

Hertwich, 2011; Cordier et al., 2011; Liu and Piper, 2016), linked to disasters or attacks (Santos and Haimes, 2004; Okuyama, 2007; Hallegate, 2008; Okuyama and Santos, 2014; Santos et al., 2014) or to the development of certain industrial activities (Kinnaman, 2011; Jacobsen et al., 2014; Malik et al., 2014). Within the context of IO analysis, the assessing studies of socioeconomic impacts arising from fishing activities are relatively few (we could mention the work of Papadas and Dahl, 1999; Leung and Pooley, 2002; Jin et al., 2003; Cai et al., 2005; Fernández-Macho et al., 2008; Dyck and Sumaila, 2010; Seung and Waters, 2013; Vega et al., 2014; García-de-la-Fuente et al., 2016). The fishing activity is subject to different factors (climatic, environmental, institutional, etc.) that can make fishing possibilities rather variable. That is, the levels of production of fishermen are determined by a set of exogenous factors that are mostly beyond their control. This characteristic differentiates fishing activity from most of the productive industries (where exogenous final demand is the driving force that guides the behaviour of the producers), that is why it is recommendable to use impact assessment tools different from the usual IO multipliers (Dietzenbacher, 2002; Miller and Blair, 2009; Seung, 2016).

The basic objective of this work is to provide a tool for the assessment and measurement of socioeconomic impacts (in terms of value of production, value added and employment) derived from the limitation or determination of the fishing opportunities of fleets. This tool, based on the input-output analysis, facilitates the measurement of possible socioeconomic impacts even before the amount and distribution among the different fleets of these annual quotas are decided. This is what we call here “physical multipliers” which offer us the impact assessment that would have the modifications of the fishing opportunities in physical terms (quotas in tonnes) on the total output value of an economy (in monetary terms). Besides, in this paper they are applied to a concrete case study, the fishing in Galicia (Spain), in order to illustrate how this tool could be obtained in practice.

To achieve these objectives, the paper presents the following organization: in Section 2, the methodology for the theoretical collection of these multipliers is developed and it recounts the available information to be able to apply it in our case study. Afterwards, in Section 3 the results achieved are presented. In Section 4 there is a discussion about the methodology used. Finally, Section 5 summarizes the main conclusions. Furthermore, as support material, it includes 3 appendices where details are given about, respectively, the methodology, the initial information for our case study and the results obtained in each step of the methodological procedure applied.

2. Material and Methods

2.1. Methodology

In order to facilitate the exposure, we are going to suppose that we have an economy composed by “n” branches of activity, and one of them is fishing (sector 1). The fishing administration manages the resources applying annual ceilings on catches of species of commercial interest that, afterwards share in quotas among the fishermen. The different fishing management scenarios imply limits on the fishing opportunities of the fishing sector. In other words, the output of the fishing branch will be determined exogenously (by the fishing administration), that is why we cannot initially use the traditional demand multipliers. To deal with the impact measurement arising from these supply shocks, Surís-Regueiro and Santiago (2016, 2018) recently developed a stepwise procedure based on price models and mixed models (endogenous and exogenous) in the input-output analysis framework (Miller and Blair, 2009), which we can adapt to the fishing case (see details in Appendix A).

The rationality of this proposal comes from the idea that a variation or exogenous shock in the volume of fishing quotas in the initial period (period 0) will imply fish price variations, but also in the prices of the outputs of other sectors. Price variations will end up affecting the production volumes and the final demands until a new balance is achieved in the next period (period 1). The difference between the final monetary value of the output of the sector i ($x_i^{1(0)}$) and the initial one ($x_i^{0(0)}$), both measured at period-0 prices, provides us a measurement of the fishing supply shock impact in the sector i ($\Delta x_i^{1(0)}$). If we start from a marginal change of 1% in the quota of fish available, the sum of all these sectoral impacts will offer us the value of the multiplier we are looking for, that in order to differentiate it from the traditional ones, we can call it simple physical multiplier, the pm(o):

$$\mathrm{pm(o)}_1 = \sum_{i=1}^{n} \Delta x_i^{1(0)} \tag{1}$$

This multiplier offers us quantitative information of the direct and indirect effects on the output value of an economy derived from an increase on the marginal percentage in quantity of tonnes available for fishing catch in period 1. With this indicator, you can obtain a quantification of the monetary effects derived from a modification in physical units (tonnes of fish). This is the reason to be named “physical multiplier” (from physical output to output value). If we multiply the row vector of the relation of value added per unit of output ($\mathbf{v_c} = [v_{c1}, \ldots, v_{cn}]$) and the employment row vector per unit of output ($\mathbf{e_c} = [e_{c1}, \ldots, e_{cn}]$), by the column vector of output modifications ($\Delta \mathbf{x}^{1(0)\prime} = [\Delta x_1^{1}, \ldots, \Delta x_n^{1}]$) we will obtain, respectively, the value of simple physical multipliers of value added ($\mathrm{pm(v)}_1$) and employment ($\mathrm{pm(e)}_1$):

$$\mathrm{pm(v)}_1 = \mathbf{v_c}\, \Delta \mathbf{x}^{1(0)};\ \mathrm{pm(e)}_1 = \mathbf{e_c}\, \Delta \mathbf{x}^{1(0)} \tag{2}$$

The interpretation of these multipliers is similar to the previous one. They would be revealing us the direct and indirect impacts on value added (in period-0 monetary units) and on employment (in number of full-time equivalent jobs), respectively, derived from a shock equivalent to 1% of catches in the fishing branch in physical terms.

In order to estimate the induced effects, the traditional demand model is usually extended by “endogenizing” the household final consumption (Miller and Blair, 2009). In this input-output model closed with respect to households, we will have an extended input coefficients matrix ($\overline{\mathbf{A}}$), and an extended Leontief inverse matrix ($\overline{\mathbf{L}}$), both with n + 1 rows and n + 1 columns. The elements of $\overline{\mathbf{L}}$ ($\bar{l}_{ij}$) incorporate the total impacts (direct, indirect and induced). The sum of the n first elements from each one of the $\overline{\mathbf{L}}$ columns will represent the multiplying effects of the total outputs on each one of the original n sectors. This sum will give us the so-called truncated total output multipliers ($\overline{\mathrm{m}}[\mathrm{o(t)}]_j = \sum_{i=1}^{n} \bar{l}_{ij}$).

Knowing the variation of the final demand in year 1 of the n sectors of the economy ($\Delta f_j^{1(0)}$) after the initial fishing shock, we could estimate the total impact on each sector output ($\Delta_T x_j^{1(0)} = \overline{\mathrm{m}}[\mathrm{o(t)}]j\ \Delta f_j^{1(0)}$). The sum of these total sectoral impacts would be our total physical multiplier of the output ($\mathrm{pm(o_t)}_1$), because it would be giving us a quantification of the total effects on the output of the economy arising from a marginal percentage variation on the fishing sector production in physical terms:

$$\mathrm{pm(o_t)}_1 = \sum_{j=1}^{n} \Delta_T x_j^{1(0)} \tag{3}$$

Operating as in the previous case, from the row vectors of the relations of value added per unit of output ($\mathbf{v_c}$) and employment per unit of output ($\mathbf{e_c}$), and the column vector of the output total variations ($\Delta_T \mathbf{x}^{1(0)\prime} = [\Delta_T x_1^{1(0)}, \ldots, \Delta_T x_n^{1(0)}]$) we will be able to obtain the total physical multipliers for value added and employment:

$$\mathrm{pm(v_t)}_1 = \mathbf{v_c}\, \mathbf{\Delta_T x^{1(0)}};\ \mathrm{pm(e_t)}_1 = \mathbf{e_c}\, \mathbf{\Delta_T x^{1(0)}} \tag{4}$$

On this occasion, these multipliers would be providing information about the total impacts (direct, indirect and induced) on the value added and employment, respectively, derived from the initial percentage marginal variation of the tonnes available for fishing in that economy.