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Assessment of socioeconomic impacts through physical multipliers: The case of fishing activity in Galicia (Spain)

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Abstract

In the context of fisheries 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 fisheries regulators and other decision-makers, facilitating the implementation of more holistic management frameworks.

Highlights

Physical multipliers capture backward and forward sectoral links simultaneously

Improving impact assessments derived from fisheries supply shocks

Physical multipliers are a useful tool for fisheries management

Support to decision-making for sectors linked to the exploitation of natural resources

Keywords

Input-Output multipliers; fisheries; socioeconomic impacts; ecosystem-based management

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 fisheries 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; Ramirez-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 to better face 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; Gonzalez-Laxe, 2010; Villasante et al., 2011). These fishing quotas by species and area are determined mainly according to scientific reports based on the fisheries 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; 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 impacts assessment tools different from the usual IO multipliers (Dietzenbacher, 2002; Miller y 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 impacts 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 $\left(x_i^{1(0)}\right)$ 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):

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

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},…,v_{cn}]) and the employment row vector per unit of output ($\mathbf{e_c}$ = [e_{c1},…,e_{cn}]), by the column vector of output modifications ($\Delta\mathbf{x}^{\mathbf{1(0)}\prime} = [\Delta x_1^1, \dots, \Delta x_n^1]$) we will obtain, respectively, the value of simple physical multipliers of value added ($pm(v)_1$) and employment ($\mathrm{pm(e)}_1$):

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

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 ($\bar{\mathbf{A}}$), and an extended Leontief inverse matrix ($\bar{\mathbf{L}}$), both with n +1 rows and n + 1 columns. The elements of $\bar{\mathbf{L}}$ ($\bar{l}_{ij}$) incorporate the total impacts (direct, indirect and induced). The sum of the n first elements from each one of the $\bar{\mathbf{L}}$ 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 ($\bar{m}[o(t)]_j = \sum_{i=1}^{n} \bar{l}_{ij}$).

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 ($\Delta_T x_j^{1(0)}$ =

$\overline{m}$ [o(t)]j $\Delta f_j^{1(0)}$). The sum of these total sectoral impacts would be our total physical multiplier of the output ($pm(o_t)_1$), 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:

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

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 ($\Delta_\mathbf{T}\mathbf{x}^{\mathbf{1(0)}\prime}$= $[\Delta_T x_1^{1(0)}, \ldots, \Delta_T x_n^{1(0)}]$) we will be able to obtain the total physical multipliers for value added and employment:

$$pm(v_t)_1 = \mathbf{v_c}\, \Delta_\mathbf{T}\mathbf{x}^{\mathbf{1(0)}} \quad ; \quad pm(e_t)_1 = \mathbf{e_c}\, \Delta_\mathbf{T}\mathbf{x}^{\mathbf{1(0)}} \qquad (4)$$

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.

2.2. Available data

For our case study we selected the economy of Galicia (Spain). It is an economy with a relatively strong dependence of fishing activity and it counts on an important fish-processing industry (Surís-Regueiro and Santiago, 2014). In Table 1, the main characteristics of the different fishing segments which operate in Galicia are described, including their related ecosystems and the fishing activity.

Table 1

For the realization of an applied exercise such as the one that we propose, it is mandatory to have, on the one hand, enough information of the Input-Output framework from the economy of reference and, on the other hand, information about the price elasticity of the different goods and services provided for in this economy.

In relation to the Input-Output framework, since 2005 and every 3 years, we have at our disposal the corresponding origin, destination and symmetrical matrices of Galicia (IGE, 2015). In July 2015 the data for the year 2011 were published, the latest available so far, and that we will take here as a reference. The symmetrical matrix distinguishes 71 branches of activity, and one of them is fishing. Operating with 71 branches is very cumbersome in an exercise like this, because it makes difficult the presentation of results and it does not provide relevant added information for the assessment. For this reason, it was decided to simplify the economy and contemplate only 15 homogeneous branches of activity (Table 2).

Table 2

The criteria applied for this new classification are very simple. Because of the objective of this work, the fishing and aquaculture activity branches (new homogeneous branches R01 and R02) were preserved and the rest were grouped depending on the affinity of the kinds of products generated according to the standard classifications used in the sector groups. In this new sector classification it was also taken into account the criteria of maintaining differentiated activities with strong connections to the fishing activity, both as fishing intermediate output demanders (cases of Manufacture of food products, branch R04, and Accommodation and food service activities, R12), and as intermediate inputs suppliers consumed by the fishing activity (cases of branches R06, R08, R11 y R13).

Once the construction process of the Symmetrical Tables (Total and Regional) of the Economy of Galicia in 2101 with 15 branches of activity is completed, we opted for differentiating 5 types or segments of activity within Fishing in Galicia: Shell-fishing on Foot (R01A), Artisanal Fishing (R01B), Coastal Fishing (R01C), Distant Water Fishing (R01D) and Long-distant Water Fishing (R01E). The final goal of this operative is to be able to build new Symmetrical Tables with 19 homogeneous branches of activity (5 fishing and 14 non-fishing), tables which will be the baseline for our case study.

The disaggregation of the fishing branch (R01) into 5 branches of activity proved to be a complex process in which we used information supplied by different sources. In particular, the output, GVA, employment and labor cost of these branches were collected from the official reports published by the Regional Government (IGE, 2015; Xunta de Galicia, 2016). The intermediate consumption and the industrial origin were gathered in the available microdata of the official survey on fishing activities that the Spanish Government carried out annually (Gobierno de España, 2012a y 2012b). The destiny of the intermediate and final outputs are assumed in the same proportion than the previous input-output tables, in where are described the same 5 branches (García Negro, 2003). All this collected data allows to rebuild the symmetric input-output table with 19 branches (i.e. 5 related to fishing and 14 no related) without having to assume other techniques for sectoral disaggregation used in cases of partial sectoral information (Woosky, 1984; Lindner et al., 2012). The results of this process can be checked in Appendix B, in where also are presented the conventional multipliers of demand and their related potential impact on Galicia.

In relation to the price elasticity of each sector output, there is no much information and it is not very accurate to the needs of our case study. In general, the values of price elasticity (in absolute terms) are growing if they are luxury products, if they have replacement supplies, if they have a good relative importance in the consumer basket or if the consumers and producers have enough time to adjust their behaviour (Mankiw, 2012; Perloff, 2016). In the case of Fishing in Galicia and Spain, the determination of prices is influenced by different factors (Castillo-Manzano et al, 2013). For all other products, the reduction made to just 14 non-fishing sectors prevents us from getting accurate information about the outputs elasticity, forcing us to use restrictive assumptions about their possible values. After consulting diverse documentation (Castillo-Manzano et al., 2013; BBVA Research, 2014; Arce et al., 2013; González and Urtasun, 2015), for this exercise we classified the different representative goods into 5 categories and assigned them a standard value for their price elasticity (in absolute terms): 0.25 for very low, 0.50 for low, 0.75 for medium, 1.00 for high and 1.25 for very high elasticity. The reference values of price elasticity taken for the goods of fishing sectors (Es) and of the non-fishing sectors (Ed) are reflected in Table 3. The simplification that this assignation implies compels us to make an assessment of sensitivity of the results obtained with different elasticity. On the one hand, assuming bigger and smaller price elasticity (in absolute terms) for all fishing products (scenarios 1 and 2, respectively) and maintaining for the rest of the outputs the values of price elasticity of the reference scenario, while on the other hand, with the reference price elasticity values for the fishing products and varying the price elasticity for the rest of the products (scenarios 3 and 4).

Table 3

3. Results: fishing physical multipliers for Galicia

The procedure described in the methodological section for a fishing branch is applicable to 5 fishing branches, all of them affected by possible supply shocks variations that affect their possibilities of production. Given that we have 5 fishing branches we will also have 5 cases, which we call: Shellfishing on Foot, Artisanal Fishing, Coastal Fishing, Distant Water Fishing and Long-distant Water Fishing. From the data of the economy of Galicia from Appendix B and applying the methodological procedure described in Appendix A and in the section 2.1, estimated values can be obtained for the physical multipliers linked to fishing supply shocks. Each one of the 5 cases contemplated must be estimated individually assuming, *ceteris paribus*, an initial change of 1% of the fishing quota tonnes available (see the details of the results obtained in each step of the procedure in Appendix C). A summary of the results obtained can be found in Table 4.

Table 4

As you can see, the direct and indirect multiplying effects on the economy of Galicia are stronger for the segment of the Coastal Fishing. A change of 1% in the tonnes produced by this sector could mean in the Galician economy a variation of up to €6 million of its internal production, which would imply a variation of €2.8 million of its GVA and it would affect 48 full-time equivalent employments (FTE). The fishing segments with less capacity of direct and indirect impact on production and income are Artisanal Fishing and Shell-fishing on Foot although, due to its productive characteristics (intensive in work), they also have a significant impact on employment. The interpretation of the total multipliers is similar to the previous one, but now including the induced effects. For instance, an increase of 1% in the fishing quotas (in tonnes) of the Distant Water Fishing fleet, could mean an increase on the Galician economy internal production of about €8 million, an increase of its GVA of €3.7 million and the creation of approximately 67 FTE. With a decrease of 1% in the quotas, the results would be obviously the same in quantity but in the opposite sign.

Furthermore, these results can be compared with the effects of the conventional I-O multipliers of the demand model. Particularly in a variation of 1% by sector, which implies the same variation on the final demand, the conventional multipliers include only the 39 – 77% of the total impact, in contrast to the procedure proposed (see Table 4 and Table B.3 in the Annex). The reason is that the conventional I-O multipliers of the demand model only take into account the backward sectoral linkages (i.e. the providers of input to the fishing sector) but, through the proposed procedure, the sectoral forward effects are also included (i.e. the sectors that use the output of fishing as inputs).

In Table 5 the estimates obtained in the sensitivity analysis of the results with modifications of the price elasticity values of the products from the different fishing sectors are shown (scenarios 1 and 2 of Table 3).

Table 5

For all the five cases addressed, the higher price elasticity is considered (in absolute terms) for the fishing products affected by the shock offer, the smaller are the direct, indirect and total impacts on the total value of the internal production, on the GVA and on the employment of the entire economy of Galicia. The results achieved in these 2 first scenarios respond to the economic rationale. More price elasticity for the fishing products implies more capacity of replacement supply and a better capacity from producers and consumers to adjust their behaviour to the new situation. With the foreseeable marginal increase of fishing products offered in the markets, the more elasticity we consider, the fewer the effects on the average price of these products. If fish price variation is small, the influence on the prices of the rest of products will be also of lower intensity, so their final demands will be slightly affected and the impacts on the total economy would be less.

A second analysis consists of making the same exercise but modifying the assumed values for the price elasticity of the rest of branches of activity of the economy (scenarios 3 and 4 of Table 4). The results obtained in these 2 new scenarios are summarized in Table 6.

Table 6

For all the five cases addressed, the higher price elasticity is considered (in absolute terms) for the products of the non-fishing branches, the greater are the direct, indirect and total impacts on the value of the internal production, on the GVA and on the employment of the entire economy of Galicia. As in the previous case, these results seem to respond to the economic logic. Given product price variation caused by the initial supply shock in one fishing segment, the demand of goods and services will react with more intensity with high price elasticity. Under these conditions, a little change in the price will result in a noticeable change on the final product demand, what will end up causing greater direct, indirect and induced impacts on the overall economy.

4. Discussion

The complexity of assessing the impacts related to exogenous shocks primarily affects the primary sectors that directly exploit natural resources (e.g., agriculture, fisheries, and forestry). These sectors have a high degree of uncertainty in their medium- and long-term production forecasts (e.g., due to atmospheric or climatic events, fires, and spills at sea), or they are strongly regulated (e.g., via fishing quotas or prices fixed by the government). In addition, some industrial sectors in these economies may use these raw materials for their production (e.g., the agro-industry, forestry industries, canned food, and processed fish products) or to directly satisfy the final demand (e.g., restaurants). In these cases, the productive activity is also affected by changes in the supply of their main raw materials.

Within IO analysis schemes, impact assessments are typically based on the assumption that input coefficients and the prices of outputs are stable in the short and medium term. Nevertheless, this price stability seems difficult to assume for some outputs when a supply shock occurs. For instance, a significant decrease in landings of fish, due to an exogenous cause, affects not only the production of the regional processing industries but also the food service activities if these industries cannot find replacement supplies for those raw materials. In the short term, the scarcity of fish products causes an increase in prices that ultimately affects the prices of fish products and the prices of items served at seafood restaurants. If so, the typical assumption of invariability in final demand of the sectors with endogenous output is also affected.

If the information about the elasticity price is included in the proposed mixed price model (see Appendix A), the effects of fish price variation (exogenous output price $\tilde{\boldsymbol{p}}^{\mathrm{ex1}}$) on endogenous output prices ($\tilde{\boldsymbol{p}}^{\mathrm{en1}}$) can be estimated. Remarkably, we consider price variations in relation to the initial situation (period 0) and exclusively associate them with the supply shock under consideration (i.e., no additional factors are assumed to be capable of influencing the modification of these products' prices). To apply this mixed pricing model, two basic assumptions should be explained in detail.

On the one hand, we assumed stability in the relations of value added per unit of exogenous output ($\mathbf{v_c}^{ex\,1} = \mathbf{v_c}^{ex\,0}$) to calculate the price indexes. This assumption is reasonable for the sectors examined here. Fishing sector often has a slight relative weight on the overall economy (less than 1% of total GVA and employment of the Galician economy, IGE, 2015). Therefore, a slight change in the levels of these sectors' outputs hardly can result in significant variation in the average cost of wages or the average return of capital employed in the economy.

On the other hand, assuming that, in the short term, no real changes are required in the physical demand of the different intermediate inputs per unit of output seems equally reasonable, as can be illustrated in a brief example. After an initial shock in the supply of a fish product (e.g., tuna fish), in the short term, the canning industry will continue to demand a similar amount of tuna per can and will continue using the same facilities and working hours per unit produced as those used in previous periods. A similar situation will occur in restaurants. The dishes will require the same amount of tuna fish and the same kitchen, chefs and waiters per customer. In both cases, the changes are related to the costs of production (variation in the price of raw tuna fish), which will be reflected in the final price of the tuna can or in the price of dinner at the restaurant. Therefore, if the initial supply shock is not extreme, the input coefficients will remain stable and, for the application of the mixed price model, we can use the same matrix of total technical coefficients (**A**).

The new price indexes for endogenous outputs, as obtained through this mixed model ($\tilde{\boldsymbol{p}}^{en1}$), provide valuable information regarding each sector's sensitivity to exogenous supply shocks in fishing sectors. If $\tilde{p}_j^1 > \tilde{p}_i^1$ (with 1<i,j≤n), the outputs generated by the fishing sectors have greater relative relevance in the cost structure of industry j and in determining the price of the output of sector j. Consequently, sector j is more sensitive than sector i in terms of potential exogenous fishing supply shocks. The historical information on market behaviour allows us to determine the price elasticity of demand for each type of output. Through price variations ($\tilde{\boldsymbol{p}}^{en1}$), we can estimate quantitative changes in the final demand for these products in period 1 (Δd_i^1). A significant change in the price of fish due to an exogenous shock (government restrictions on

allowed catches) will affect the amount of output that is earmarked for final demand and the amount of final demand in other sectors that use these products as intermediate inputs (e.g., fish processing industry or restaurants).

Notably, both the initial supply shock (Δq_i^1) and the estimated final demand variation (Δd_i^1) are discussed in physical terms (in our example, tonnes of fish). These variations in supply and demand allow us to obtain the new values of exogenous outputs ($x_i^{ex\,1(0)}$) and exogenous demand ($f_i^{ex\,1(0)}$) in monetary terms for the initial period (moment 0). We do not assume constant prices in this scheme. Put simply, once the changes in physical terms are estimated (Δq_i^1 and Δd_i^1), we propose to calculate their value in monetary terms by using the base-period prices (period-0 prices). The selection of period-0 prices is an important element in estimating these impacts. This decision enables the use of the same regional input coefficients matrix ($\mathbf{A^{RR}}$) in the mixed IO model. Here, as in the price model, we assume that technical requirements in physical terms remain unchanged in the short term and that the input coefficients in monetary terms at period-0 prices remain unchanged. Therefore, the estimated results obtained through the mixed IO model ($f_i^{en\,1(0)}$ and $x_i^{en\,1(0)}$) and the physical output multipliers are also expressed in monetary units of the initial moment (at period-0 prices).

The proposed mixed IO model follows the same backward perspective as that found in standard IO models. Nevertheless, unlike typical assessments of impacts, this proposal considers exogenous final demand variations that are caused by the initial fishing supply shock ($\Delta f_i^{ex\,1(0)} \neq 0$). Remarkably, these variations in demand depend on price changes, and they are more pronounced under conditions of high sensitivity to exogenous supply shocks and the high price elasticity (in absolute terms) for these outputs. By considering the variations in the exogenous demand that are different from zero, the estimated physical multipliers simultaneously captures the effects linked to the backward linkages (the impact on sectors that supply intermediate inputs to fishing sector) and to the forward linkages (the impact on sectors that depend on the intermediate output from fisheries).

If the focus was exclusively on estimate the impacts on sectors related to fishing sectors, we have to use only the simple physical multipliers from Table 4 (direct and indirect impacts). However, we likely underestimate the total economic impacts. For this reason, impact assessments typically include induced effects throughout the economy. In order to estimate the total impacts, the traditional truncated total output multipliers are proposed. This recommendation is based on the type of partition applied in the mixed models tends to overestimate the induced impacts on sectors with endogenous output (the non-fishing sectors) as well as underestimate the impact on sectors with exogenous output (fishing sectors) that appear as immunes to induced effects (Papadas and Dahl, 1999). The differences in the estimations using either procedure will probably not be very high but, the formal proposal for estimating the total physical multipliers, appear to be more logical and consistent to the economic rationale. A variation in households' levels of available income would drive to a variation in the final demand and, according to consumption patterns, it would seem logic that all of an economy's sectors would —to a greater or lesser degree— be affected by the induced impact, without a sector independent to this phenomenon.

It is remarkable that the empirical results are influenced by the price elasticity values of both the fishing outputs as well as the outputs of the other sectors. The fact that accurate estimations of elasticity are not often available, on the one hand, limits the use of the procedure proposed and, on the other hand, it would be recommended to perform a sensitivity analyzes in order to study the robustness of the results against the price elasticities assumed.

In addition, we must keep in mind that physical multipliers refer to the socioeconomic impact derived from a marginal fishing supply shock ($\Delta q_i^1 = \Delta|1\%|$) with regard to an initial situation (period 0). However fishing branches can have different initial situations, and this might condition their interpretation. For example, in 2015, the Coastal Fishing segment in Galicia (branch 01C) disposed of fishing possibilities of around 60,000 t of fish, while this figure for the segment of Distant Water Fishing (branch 01D) was around 40,000 t. In other words, a supply shock equivalent to 600 t of quota would have a relative impact of 1% for Coastal Fishing, but of 1.5% for Distant Water Fishing. This circumstance is particularly relevant if there are two fishing segments competing for the same resources (e.g. Artisanal Fishing vs Coastal Fishing) or for resources that have their populations interconnected (e.g. Coastal Fishing vs Distant water fishing). In such cases, a change in the quota availability would have different consequences according to the assignation of this quota made between both fishing segments.

Another element to be considered is related to the composition of catches. Usually, the fishing segments have several target species, with annual quotas which not necessarily have to evolve in the same direction and with the same intensity. A lower quota availability of one species can be compensated by a higher availability of another one. So, catches of each segment will be composed of a combination of different species, each one of them with a relative economic weight that is different within the group. Therefore, for the application of physical multipliers, the change in availability of fishing quotas can be compared to the initial period of reference, by considering changes in availability of each one of the species according to the relative weight that they have within the initial group of reference.

If the IO table is rebuilt according to the impacts expressed in period-0 prices, the supply relationships per product unit in each sector should remain stable (input coefficients, income per unit of output, etc.). Variation should occur in the sectoral relationships of final demand per unit of output because the new prices should cause relative displacements to the final demand of the sectors less affected by the inflation.

Finally, the possibility of obtaining estimations on the socioeconomic impact under different management scenarios allows its use by policy makers. Furthermore, they could explain to the coastal communities and society how the improvements in the marine ecosystems and in the fisheries stocks are derived in social and economic benefits, especially in those areas with a clear dependence of fishing activity as Galicia.

5. Conclusions

Following the methodological procedure proposed by Surís-Regueiro and Santiago (2016, 2018) we can estimate physical multipliers that facilitate the assessment of socioeconomic impacts linked to possible fishing supply shocks. These physical multipliers offer us an estimation of the foreseeable monetary impact on the output and GVA of an economy derived from a marginal change in the total tonnes of fishing quota available in relation to the initial one of reference (from physical tonnes of fish to monetary values). This procedure will also permit the estimation of physical multipliers to assess the impact on employment (in this case it would be from physical tonnes of fish to physical units of FTE).

In the case study analyzed we estimate physical multipliers for the 5 different fishing segments of the economy of Galicia (Spain). The Coastal Fishing segment would have the biggest multiplier effects, followed by the Deep-see Fishing segment. The fishing segment with less capacity of impact on the economy would be the less industrialized segments, which are Artisanal Fishing and Sell-fishing on Foot, although they do have a significant capacity of impact on employment. These results are significantly sensitive to modifications of the assumed value for the price elasticity of the different sectoral products. On the one hand, the higher the fish price elasticity (in absolute terms), the less the possible impacts on the overall economy. On the other hand, the higher the price elasticity of the rest of non-fishing products (in absolute terms), the higher the possible impacts on the overall economy.

We understand that this methodology is valid to obtain a more accurate valuation, more adjusted to the socioeconomic impact linked to a fishing supply shock, because we would be considering simultaneously backward and forward sectoral linkages of these sectors. However, the usefulness of the method proposed is even greater when it comes to the assessment or comparison of different options for fishing management (e.g. to quantify *ex ante* the different impacts linked to changes in the fishing quotas authorized for one or another percentage, or assessing the possible impacts linked to changes in the distributions of quotas among different segments or methods of fishing). The assumptions and approaches used in this procedure lead to the loss of predictive capability (also making difficult their later verification), but we think that they do not modify the comparative possibilities of their results in different scenarios. Therefore, physical multipliers can be useful management tools in the framework of the ecosystem-based fisheries management, being able to provide support to the regulators for taking decisions (e.g. fishing public administrations) with the objective of balancing the environmental and socioeconomic components of sustainability.

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Tables

Table 1. The 5 fishing segments in Galicia (Spain)

Fishing segments	Place of fishery	Vessels	Main target species	Fishing segment description
R01A. Shell-fishing on foot	Coastline, beaches and intertidal sandbanks areas of Galicia	Its use is related to auxiliary activities	Bivalve molluscs	3954 licenses for gathering crustaceans in coast and intertidal sandbank areas (mainly for goose barnacle; 9%, and clams; 91%)
R01B. Artisanal fishing	Inland waters	Vessels between 6 and 15 m in length	Crustaceans, molluscs and rock fish	3930 vessels registering for fishing with small-scale gears
R01C. Coastal fishing	Iberian coastal waters, ICES VIIIc and IXa	Vessels between 15 and 29 m in length	Hake, sardine, horse mackerel, mackerel, nephrops, blue whiting, anglerfish	327 vessels: purse seiners (45%); longliners (24%); trawlers (20%) and gillnets (10%)
R01D. Distant water fishing	Celtic Sea, ICES Vb, VI, VII, VIIIabd	Vessels with average lengths of about 33 m	Hake, anglerfish, megrim, nephrops, ling, blue whiting	69 vessels: longline (64%) and trawlers (36%)
R01E. Long-distant water fishing	NAFO 3L, 3NO y 3M, NEAFC international waters	Vessels between 35 and 90 m in length	Cod, halibut, rays, swordfish, redfish, shrimp, white hake	104 frozen vessels: longliners (65%), trawlers (32%) and purse seiners (3%)

Source: Own compilation updated from Surís-Regueiro and Santiago (2014).

Table 2. The 15 sectors of activity considered and their correspondence

Code	Denomination	NACE Rev.2 codes *
R01	Fishing	A 03.1
R02	Aquaculture	A 03.2
R03	Agriculture, forestry and mining	A 01; A 02; B 05-09
R04	Manufacture of food products	C 10-12
R05	Manufacture of textiles, wearing, wood and paper	C 13-18
R06	Manufacture of petroleum, chemical, plastic and other non-metallic products	C 19-24
R07	Other manufactures	C 25-32
R08	Repair and supplies	C 33; D 35-39
R09	Construction	F 41-43
R10	Wholesale and retail trade	G 45-47
R11	Transportation and storage	H 49-53
R12	Accommodation and food service activities	I 55-56
R13	Services to companies and individuals	J 58-63; K 64-66; L 68; M 69-75; N 77-82
R14	Administration and public services	O 84; O 85-88; R 90-93 no market
R15	Other services	O 85-88; R 90-93 market; S 94-96; T 97

* Common statistical classification of economic activities in the European Community. Official Journal of the European Union, Regulation (EC) No 1893/2006 of the European Parliament and the Council of 20 December 2006, establishing the statistical classification on economic activities NACE Revision 2.
Source: Own compilation

Table 3. Scenarios according to the price elasticity assumed by sector

Fishing segments		Price elasticity Es		
		Scenario 1	Reference Scenario	Scenario 2
R01A	Shell-fishing on foot	-0.50	-0.75	-1.00
R01B	Artisanal fishing	-0.50	-0.75	-1.00
R01C	Coastal fishing	-0.25	-0.5	-0.75
R01D	Distant water fishing	-0.25	-0.5	-0.75
R01E	Long-distant water fishing	-0.75	-1.0	-1.25
Other segments		**Price elasticity Ed**		
		Scenario 3	**Reference Scenario**	**Scenario 4**
R02	Aquaculture	-0.50	-0.75	-1.00
R03	Agriculture, forestry and mining	-0.25	-0.50	-0.75
R04	Manufacture of food products	-0.25	-0.50	-0.75
R05	Manufacture of textiles, wearing, wood and paper	-0.50	-0.75	-1.00
R06	Manufacture of petroleum, chemical, plastic and other non-metallic products	-0.00	-0.25	-0.50
R07	Other manufactures	-0.50	-0.75	-1.00
R08	Repair and supplies	-0.25	-0.50	-0.75
R09	Construction	-0.50	-0.75	-1.00
R10	Wholesale and retail trade	-0.50	-0.75	-1.00
R11	Transportation and storage	-0.25	-0.50	-0.75
R12	Accommodation and food service activities	-1.00	-1.25	-1.50
R13	Services to companies and individuals	-0.50	-0.75	-1.00
R14	Administration and public services	-0.75	-1.00	-1.25
R15	Other services	-1.00	-1.25	-1.50

Table 4. Galicia's fishing physical multipliers in the reference scenario

Simple physical multipliers					
	Shellfish	**Artisanal**	**Coastal**	**Distant**	**Long-distant**
Output: $pm(o)_1$ (thousand € of period 0)	1022	2106	5966	5193	5927
GVA: $pm(v)_1$ (thousand € of period 0)	610	1097	2793	2189	2513
Employment: $pm(e)_1$ (employees FTE)	24.7	43.9	48.0	37.2	37.0
Total physical multipliers					
	Shellfish	**Artisanal**	**Coastal**	**Distant**	**Long-distant**
Output: $pm(o_t)_1$ (thousand € of period 0)	1825	3550	9642	8074	9234
GVA: $pm(v_t)_1$ (thousand € of period 0)	1038	1867	4751	3724	4275
Employment: $pm(e_t)_1$ (employees FTE)	33.0	58.9	86.1	67.0	71.3

Table 5. Fishery physical multipliers: Sensitivity analysis to changes in the price elasticity of Galician fishing outputs (sectors from R01A to R01E).

Scenario 1: Case of lower price elasticity for fishing sectors					
Direct and indirect impacts	**Shellfish**	**Artisanal**	**Coastal**	**Distant**	**Long-distant**
Output: $pm(o)_1$ (thousand € of period 0)	1341	2716	9884	8432	6812
GVA: $pm(v)_1$ (thousand € of period 0)	736	1338	4336	3465	2862
Employment: $pm(e)_1$ (employees FTE)	27.0	48.3	76.0	60.3	43.4
Total impacts	**Shellfish**	**Artisanal**	**Coastal**	**Distant**	**Long-distant**
Output: $pm(o_t)_1$ (thousand € of period 0)	2309	4476	15590	12991	10578
GVA: $pm(v_t)_1$ (thousand € of period 0)	1251	2275	7376	5894	4868
Employment: $pm(e_t)_1$ (employees FTE)	37.0	66.5	135.1	107.6	82.4
Scenario 2: Case of greater price elasticity for fishing sectors					
Direct and indirect impacts	**Shellfish**	**Artisanal**	**Coastal**	**Distant**	**Long-distant**
Output: $pm(o)_1$ (thousand € of period 0)	862	1801	4660	4113	5396
GVA: $pm(v)_1$ (thousand € of period 0)	547	977	2279	1764	2304
Employment: $pm(e)_1$ (employees FTE)	23.5	41.7	38.7	29.5	33.3
Total impacts	**Shellfish**	**Artisanal**	**Coastal**	**Distant**	**Long-distant**
Output: $pm(o_t)_1$ (thousand € of period 0)	1583	3087	7659	6435	8428
GVA: $pm(v_t)_1$ (thousand € of period 0)	931	1662	3877	3001	3919
Employment: $pm(e_t)_1$ (employees FTE)	31.0	55.1	69.8	53.5	64.7

Table 6. Fishery physical multipliers: Sensitivity analysis to changes in the price elasticity of Galician non-fishing outputs (sectors from R02 to R15)

Scenario 3: Case of lower price elasticity for no-fishing sectors					
Direct and indirect impacts	**Shellfish**	**Artisanal**	**Coastal**	**Distant**	**Long-distant**
Output: $pm(o)_1$ (thousand € of period 0)	792	1666	4553	4025	4969
GVA: $pm(v)_1$ (thousand € of period 0)	530	944	2301	1782	2179
Employment: $pm(e)_1$ (employees FTE)	23.2	41.2	39.2	29.9	31.1
Total impacts	**Shellfish**	**Artisanal**	**Coastal**	**Distant**	**Long-distant**
Output: $pm(o_t)_1$ (thousand € of period 0)	1489	2908	7581	6370	7837
GVA: $pm(v_t)_1$ (thousand € of period 0)	901	1606	3913	3031	3707
Employment: $pm(e_t)_1$ (employees FTE)	30.5	54.1	70.6	54.2	60.8
Scenario 4: Case of greater price elasticity for no-fishing sectors					
Direct and indirect impacts	**Shellfish**	**Artisanal**	**Coastal**	**Distant**	**Long-distant**
Output: $pm(o)_1$ (thousand € of period 0)	1247	2536	7349	6336	6864
GVA: $pm(v)_1$ (thousand € of period 0)	689	1247	3275	2588	2840
Employment: $pm(e)_1$ (employees FTE)	26.1	46.6	56.6	44.3	42.9
Total impacts	**Shellfish**	**Artisanal**	**Coastal**	**Distant**	**Long-distant**
Output: $pm(o_t)_1$ (thousand € of period 0)	2153	4178	11659	9741	10601
GVA: $pm(v_t)_1$ (thousand € of period 0)	1171	2122	5571	4402	4830
Employment: $pm(e_t)_1$ (employees FTE)	35.5	63.6	101.3	79.6	81.6

Appendix A. Methodological procedure

The methodological proposal by Surís-Regueiro and Santiago (2016, 2018) starts (initial period, denoted with a 0) with an exogenous supply shock (e.g. the establishment of fishing quotas by species) that affects the production possibilities of one or more fishing activity segments (branch 1 of the economy). This variation in the quantity of fish offered will end up leading to price changes, but it can also affect other outputs prices, especially if they use fish as an intermediate input.

Let us imagine that, *céteris páribus*, there is a positive marginal change in the fishing opportunities (it would work equally with negative marginal changes). That is to say, for the next period (period 1) the fishing fleet will dispose of 1% more of quota (in tonnes) than in the previous period (q_1^0):

$$\Delta q_1^1 / q_1^0 = 1\% \qquad \text{(A.1)}$$

This exogenous supply shock might alter the fish price. It seems reasonable to think that if there is an increase in the fishing products supply, the prices of these goods will tend to fall. The sensitivity of these prices changes due to variations in the offered quantity is given to us by the inverse price elasticity of the products linked to the supply shock $[\mathrm{Es}_i^{-1} = (\Delta p_i / p_i)/(\Delta q_i / q_i)]$. That is:

$$\Delta p_1^1 \;=\; \mathrm{Es}_1^{-1}\, p_1^0\, (\Delta q_1^1 \,/\, q_1^0) \qquad \text{(A.2)}$$

Assuming stability of input coefficients through a mixed input-output price model, we will be able to estimate how the price variation in the output that suffers the supply shock is transferred to the prices of other outputs of the economy. In our economy with n branches of activity we assume that fish prices are determined exogenously as a consequence of the supply shock. For this sector with exogenous prices we can build the corresponding vector of price indexes ($\tilde{\boldsymbol{p}}'^{ex} = [\tilde{p}_1]$). For the rest of the sectors of the economy, the relations of value added per unit of output ($\mathbf{v_c}'^{ex} = [v_{c2}, \ldots, v_{cn}]$) will be based on exogenous variables. Partitioning the input coefficients matrix (**A**), we could write:

$$\begin{bmatrix} \tilde{\boldsymbol{p}}^{\mathbf{ex}} \\ \tilde{\boldsymbol{p}}^{\mathbf{en}} \end{bmatrix} = \begin{bmatrix} \mathbf{A'}_{11} & \mathbf{A'}_{21} \\ \mathbf{A'}_{12} & \mathbf{A'}_{22} \end{bmatrix} \begin{bmatrix} \tilde{\boldsymbol{p}}^{\mathbf{ex}} \\ \tilde{\boldsymbol{p}}^{\mathbf{en}} \end{bmatrix} + \begin{bmatrix} \mathbf{v_c}^{\mathbf{en}} \\ \mathbf{v_c}^{\mathbf{ex}} \end{bmatrix} \qquad \text{(A.3)}$$

The matrix $\mathbf{A_{11}}$ collects the elements from the first row and column from **A**, the matrix $\mathbf{A_{12}}$ the elements from the first row and the last n-1 columns, the matrix $\mathbf{A_{21}}$ the elements from the last n-1 rows and from the first column and the matrix $\mathbf{A_{22}}$ the elements from the last n-1 rows and columns from **A**. The same notation criterion can be used for matrices partitioned from the identity matrix (**I)** and Leontief Inverse Matrix (**L**).

Operating from (3), the result is:

$$\begin{bmatrix} \mathbf{v_c}^{\mathbf{en}} \\ \tilde{\boldsymbol{p}}^{\mathbf{en}} \end{bmatrix} = \begin{bmatrix} (\mathbf{I_{11}} - \mathbf{A'}_{11}) - \mathbf{A'}_{21}\,\mathbf{L'}_{22}\,\mathbf{A'}_{12} & -\mathbf{A'}_{21}\,\mathbf{L'}_{22} \\ \mathbf{L'}_{22}\,\mathbf{A'}_{12} & \mathbf{L'}_{22} \end{bmatrix} \begin{bmatrix} \tilde{\boldsymbol{p}}^{\mathbf{ex}} \\ \mathbf{v_c}^{\mathbf{ex}} \end{bmatrix} \qquad \text{(A.4)}$$

Where $\mathbf{L'_{22}} = (\mathbf{I_{22}}\text{-}\mathbf{A'_{22}})^{-1}$.

Given a variation of exogenous prices in 1 ($\tilde{\boldsymbol{p}}^{ex\ 1}$ known) and assuming that $\mathbf{v_c}^{ex\ 1} = \mathbf{v_c}^{ex\ 0}$, the system (A4) would allow us to estimate $\mathbf{v_c}^{en\ 1}$ and $\tilde{\boldsymbol{p}}^{en\ 1}$. In other words, this mixed input-output price model would lead us to estimate the relative price variations derived from the exogenous modification in the level of prices of the fishing sector output.

In this methodological proposal, the outputs price variation will imply changes in the final production and demand, but the estimation of these effects will be different according to the type of sector that is generating the output. In the case of non-fishing sectors, variations in the final demand will depend on the demand price elasticity for these products. This information is exogenous to the IO model, reason why it is assumed that these final demands are determined exogenously. So, these price variations of the endogenous outputs n-1 will imply changes in their final demand in 1 (Δd_i^1). In addition, these variations in the demanded quantity of endogenous outputs can be estimated through the information observed of price elasticity of the demand for these products $[\mathrm{Ed_i} = (\Delta d_i/d_i)/(\Delta p_i/p_i)]$.

$$\Delta d_i^1 \,/\, d_i^0 \;=\; \mathrm{Ed_i}\;(\Delta p_i^1 \,/\, p_i^0) \quad ; \quad 2 \le i \le n \qquad \text{(A.5)}$$

In the case of the fishing sector, it is assumed that, at least in the short and medium term, they will try to maintain the supply commitments with the industries dependant on these raw materials. The intermediate inputs supply demanded by the other sectors will be prioritized and, as a consequence, the impact on the quantity aimed to supply the final demand of fishing products will depend on the dimension of the supply shock suffered and on the evolution of the demand of the other sectors.

If we operate with the initial period prices (period 0), the expected variations, both in the quantity offered of exogenous output (Δq_1^1) and in the demanded quantities of endogenous outputs (Δd_i^1), would be directly transferred to their monetary values. If we call $x_1^{ex\,1(0)}$ the value of exogenous output (the fishing one) and $fx_i^{ex\,1(0)}$ the value of exogenous demands (the ones from the rest of sectors), both expressed in monetary units of the period 0, we would have:

$$x_1^{ex\,1(0)} = x_1^{ex\,0}\,[1 + (\Delta q_1^1 / q_1^0)] \quad ; \quad f_i^{ex\,1(0)} = f_i^{ex\,0}\,[1 + (\Delta d_i^1 / d_i^0)] \qquad \text{(A.6)}$$

Given the expected values for the exogenous variables ($x_1^{ex\,1(0)}$ and $f_i^{ex\,1(0)}$) and assuming the stability of the elements from the regional input coefficients matrix ($\mathbf{A^{RR}}$) (after the initial supply shock there is no possibilities of technical replacement, not even through importations) the mixed output-input model can be used to estimate the endogenous variables ($f_1^{en\,1(0)}$ y $x_i^{en\,1(0)}$):

$$\begin{bmatrix} (\mathbf{I}_{11} - \mathbf{A}_{11}^{RR}) & (\mathbf{I}_{12} - \mathbf{A}_{12}^{RR}) \\ (\mathbf{I}_{21} - \mathbf{A}_{21}^{RR}) & (\mathbf{I}_{22} - \mathbf{A}_{22}^{RR}) \end{bmatrix} \begin{bmatrix} \mathbf{x}^{ex} \\ \mathbf{x}^{en} \end{bmatrix} = \begin{bmatrix} \mathbf{f}^{en} \\ \mathbf{f}^{ex} \end{bmatrix} \qquad \text{(A.7)}$$

Operating, from (A7) we will have:

$$\begin{bmatrix} \mathbf{f}^{en\,1(0)} \\ \mathbf{x}^{en\,1\,(0)} \end{bmatrix} = \begin{bmatrix} (\mathbf{I}_{11} - \mathbf{A}_{11}^{RR}) - \mathbf{A}_{12}^{RR}\,\mathbf{L}_{22}^{RR}\,\mathbf{A}_{21}^{RR} & -\mathbf{A}_{12}^{RR}\,\mathbf{L}_{22}^{RR} \\ \mathbf{L}_{22}^{RR}\,\mathbf{A}_{21}^{RR} & \mathbf{L}_{22}^{RR} \end{bmatrix} \begin{bmatrix} \mathbf{x}^{ex\,1(0)} \\ \mathbf{f}^{ex\,1(0)} \end{bmatrix} \qquad \text{(A.8)}$$

Where $\mathbf{L}_{22}^{RR} = (\mathbf{I}_{22} - \mathbf{A}_{22}^{RR})^{-1}$.

The difference between the value of the period-1 sectoral output and the one in period-0 ($\Delta x_i^{1(0)} = x_i^{1(0)} - x_i^{0(0)}$) allows us to quantify the direct and indirect effect on the regional economy associated to the marginal exogenous initial supply shock in the fishing sector (valued at period-0 prices).

Appendix B. Input-Output Tables of Galicia (Spain) for 2011 with 19 sectors

Table B.1. Total Input-Output Transactions Table of Galicia 2011 at basis prices with 19 sectors (in thousands of €)

	R01A	R01B	R01C	R01D	R01E	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	Oi	FC	GCF	Exp	FD	R
R01A	122	526	559	0	0	714	0	20663	0	158	0	160	0	2	0	5278	1	65	97	28345	11331	0	10890	22222	50567
R01B	0	789	1001	519	0	1365	0	39520	0	302	0	307	0	3	0	10094	1	125	185	54213	21672	0	20829	42502	96715
R01C	0	0	2341	1515	1087	2923	0	84597	1	647	0	657	0	6	1	21607	3	267	397	116050	46393	0	44588	90981	207030
R01D	0	0	0	3052	1035	2416	0	69934	0	535	0	543	0	5	1	17862	2	221	328	95935	38352	0	36860	75211	171147
R01E	0	0	0	0	6701	3962	0	114672	1	877	0	890	0	9	1	29289	4	362	538	157306	62886	0	60439	123325	280630
R02	9	95	282	368	639	2365	0	65680	3	5640	0	834	1	29	97	76981	10	5979	3037	162049	73115	0	86856	159971	322020
R03	7	72	213	278	482	1300	515999	1810133	217568	2008668	8488	715349	111828	186335	4	49155	11698	4656	2427	5644660	550589	147331	1128044	1825964	7470624
R04	42	446	1325	1727	2997	23746	817546	1948660	409	16534	60	10231	142	30610	1732	1352715	4387	29692	53940	4296941	2866356	95312	4184950	7146618	11443559
R05	33	356	1056	1377	2388	6999	771	222690	1155728	67826	199799	33616	108683	78465	14871	45133	184879	61573	72513	2258756	958910	38559	2256677	3254146	5512902
R06	487	5233	15529	20246	35119	17967	199968	293783	255925	2200630	2687183	498359	994017	356674	687403	103588	102061	80021	129165	8683358	1540532	73108	4612652	6226292	14909650
R07	30	327	970	1264	2193	1363	97090	291269	75530	397391	4506472	387145	588037	263903	43308	43377	266100	90282	203152	7259203	1108463	1805373	8748226	11662062	18921265
R08	160	1721	5108	6660	11553	34208	60926	190714	135342	891493	510899	1530418	131111	369401	147968	166697	227707	216154	130921	4769162	1198479	0	1504383	2702862	7472024
R09	1	8	24	32	55	272	19022	26464	6174	24702	75835	288179	4528810	126632	88781	34199	471989	76751	46013	5813943	488477	5870037	0	6358514	12172457
R10	120	1290	3827	4989	8655	14147	139325	316198	160243	172681	255263	58320	319915	408545	200369	301004	118789	351550	98455	2933685	5867670	300401	1341515	7509586	10443271
R11	234	2516	7465	9733	16883	14781	80635	321675	107427	295306	178732	119050	128249	861063	1580781	21257	295737	95398	35092	4172014	911854	4139	1079417	1995410	6167424
R12	0	0	0	0	0	0	324	7885	1755	12398	32627	42851	16146	57714	41365	26279	128703	50021	35571	453639	5915328	0	0	5915328	6368967
R13	192	2060	6114	7972	13828	25919	114224	544943	178803	281525	614066	584852	858291	1802481	364701	486480	3306326	873209	587691	10653678	7617210	1584413	1718253	10919876	21573554
R14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10221267	0	0	10221267	10221267
R15	27	292	868	1131	1962	6254	4363	14668	26430	15195	31071	41523	20408	74810	18459	57300	148347	125141	374620	962870	4878798	5474	75110	4959382	5922252
Ci	1466	15731	46683	60864	105578	160701	2050193	6384148	2321339	6392509	9100495	4313284	7805639	4616687	3189843	2848294	5266744	2061467	1774142	58515807	44377682	9924147	26909689	81211518	139727325
GVA	35205	54404	103451	63249	97929	128313	1927490	1493906	952355	1384844	2722476	2811654	4366818	5632257	2267210	3366769	12720372	8159800	4013035	52301537					
X	36670	70135	150134	124112	203508	289014	3977683	7878054	3273694	7777353	11822971	7124938	12172457	10248944	5457053	6215063	17987116	10221267	5787177	110817344					
Imp	13897	26579	56896	47034	77123	33006	3492941	3565505	2239208	7132297	7098294	347086	0	194327	710371	153904	3586438	0	135075	28909981					
R	50567	96715	207030	171147	280630	322020	7470624	11443559	5512902	14909650	18921265	7472024	12172457	10443271	6167424	6368967	21573554	10221267	5922252	139727325					
e	2001	3394	1628	912	955	4606	62821	38695	26585	20057	50219	23343	94454	169792	50383	57310	145929	160092	124665	1037840					

Oi: Intermediate Outputs; FC: Final Consumption; GCF: Gross Capital Formation, Exp: Exports; FD: Final Demand; R: Total Resources

Ci: Intermediate Consumption; GVA: Gross Value Added; X: Regional production; Imp: Imports CIF; E: Employment in number of Full Time Equivalents (FTE)

Source: Own elaboration based on IGE (2015).

Table B.2. Regional Input-Output Transactions Table of Galicia 2011 at basis prices with 19 sectors (in thousands of €)

	R01A	R01B	R01C	R01D	R01E	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	Oi	FC	GCF	Exp	FD	X
R01A	122	526	559	0	0	714	0	14805	0	16	0	116	0	2	0	3306	1	0	97	**20264**	5516	0	10890	**16406**	**36670**
R01B	0	789	1001	519	0	1365	0	28317	0	30	0	222	0	3	0	6323	1	0	185	**38757**	10550	0	20829	**31379**	**70135**
R01C	0	0	2341	1515	1087	2923	0	60615	1	64	0	475	0	6	1	13536	2	1	397	**82964**	22583	0	44588	**67171**	**150134**
R01D	0	0	0	3052	1035	2416	0	50109	0	53	0	392	0	5	1	11190	2	0	328	**68584**	18669	0	36860	**55528**	**124112**
R01E	0	0	0	0	6701	3962	0	82164	1	87	0	643	0	9	1	18348	3	1	538	**112458**	30611	0	60439	**91050**	**203508**
R02	9	95	282	368	639	2365	0	49530	3	559	0	684	1	29	97	69442	9	5559	3037	**132708**	69450	0	86856	**156306**	**289014**
R03	7	71	210	274	475	1292	510272	1251877	172690	116624	5087	17897	103018	81495	0	29703	8601	4541	2240	**2306374**	429691	147331	1128044	**1671309**	**3977683**
R04	41	437	1296	1690	2931	7696	721426	666023	116	688	59	2955	97	23483	71	699749	3145	14056	25888	**2171846**	1426682	95312	4184950	**5706208**	**7878054**
R05	30	322	956	1246	2162	2628	370	48223	233828	30826	75802	14267	91393	32009	2275	9341	120994	15506	48628	**730806**	249522	38559	2256677	**2542888**	**3273694**
R06	356	3821	11339	14783	25643	10011	84223	57205	99777	442129	559525	352916	513460	56358	416196	16368	21894	18343	10233	**2714579**	393463	73108	4612652	**5062774**	**7777353**
R07	4	39	115	150	259	476	48081	84706	20184	153219	1553438	176090	332883	36789	4819	15992	34863	11631	53001	**2526738**	116896	1805373	8748226	**9296233**	**11822971**
R08	160	1721	5108	6660	11553	34208	60365	189704	133186	737396	453138	1456161	128094	366097	147324	165171	222397	184090	119542	**4422076**	1198479	0	1504383	**2702862**	**7124938**
R09	1	8	24	32	55	272	19022	26464	6174	24702	75835	288179	4528810	126632	88781	34199	471989	76751	46013	**5813943**	488477	5870037	0	**6358514**	**12172457**
R10	115	1234	3662	4774	8281	13607	130575	299773	154648	165963	245868	56110	304141	389368	131792	285697	112547	336568	94635	**2739358**	5867670	300401	1341515	**7509586**	**10248944**
R11	221	2369	7031	9166	15900	13637	72375	290912	97788	272028	165412	110395	117392	807697	1183807	19412	252215	77770	29721	**3545248**	828290	4139	1079417	**1911805**	**5457053**
R12	0	0	0	0	0	0	315	4018	1006	8667	18206	26683	9244	33654	39105	24240	60263	45635	28699	**299735**	5915328	0	0	**5915328**	**6215063**
R13	164	1756	5211	6794	11785	21624	105582	330196	146160	194723	454582	441644	671309	1512631	306555	443695	2127666	816506	483674	**8082257**	7332606	1584413	1718253	**9904859**	**17987116**
R14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	10221267	0	0	**10221267**	**10221267**
R15	27	292	868	1131	1962	6254	4363	14067	20824	14600	30030	39046	19327	74162	18343	54523	144261	107100	337155	**888336**	4821072	5474	75110	**4898841**	**5787177**
Ci	**1256**	**13480**	**40003**	**52154**	**90470**	**125450**	**1756969**	**3548709**	**1086386**	**2162373**	**3636982**	**2984875**	**6819170**	**3540429**	**2339168**	**1920235**	**3580852**	**1714058**	**1284011**	**36697030**	**39446821**	**9924147**	**26909689**	**74120314**	**110817344**

Oi: Intermediate Outputs; FC: Final Consumption; GCF: Gross Capital Formation, Exp: Exports; FD: Final Demand; X: Regional production; Ci: Intermediate Consumption

Source: Own elaboration based on IGE (2015).

Table B.3. Galicia's fishing multipliers from conventional I-O demand model and impacts estimated linked with a variation of 1% in the value of output for regional final demand

Simple multipliers					
	Shellfish	**Artisanal**	**Coastal**	**Distant**	**Long-distant**
Output: m(o)	1.05039	1.28542	1.39902	1.63794	1.67963
GVA: m(v)	0.98184	0.89713	0.85619	0.77007	0.75505
Employment: m(e)	0.05508	0.05127	0.01424	0.01218	0.00953
Total multipliers					
	Shellfish	**Artisanal**	**Coastal**	**Distant**	**Long-distant**
Output: m(o_t)	2.34247	2.46602	2.52574	2.65134	2.67326
GVA: m(v_t)	1.67013	1.52603	1.45639	1.30991	1.28435
Employment: m(e_t)	0.06904	0.06404	0.02642	0.02314	0.02027
Direct and indirect impacts					
	Shellfish	**Artisanal**	**Coastal**	**Distant**	**Long-distant**
Output: m(o) (thousand € of period 0)	385	902	2100	2033	3418
GVA: m(v) (thousand € of period 0)	360	629	1285	956	1537
Employment: m(e) (employees FTE)	20	36	21	15	19
Total impacts					
	Shellfish	**Artisanal**	**Coastal**	**Distant**	**Long-distant**
Output: m(o_t) (thousand € of period 0)	859	1730	3792	3291	5440
GVA: m(v_t) (thousand € of period 0)	612	1070	2187	1626	2614
Employment: m(e_t) (employees FTE)	25.3	44.9	39.7	28.7	41.2

Source: Own elaboration.

Appendix C. Procedure for estimating the fishing physical multipliers of Galicia

Table C.1. Total Technical Coefficients Matrices to apply the Price Mixed Model. Galicia 2011

	R01A	R01B	R01C	R01D	R01E	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15
	Matrix A'$_{11}$					**Matrix A'$_{21}$**													
R01A	0.00334	-	-	-	-	0.00024	0.00018	0.00113	0.00090	0.01329	0.00083	0.00437	0.00002	0.00328	0.00639	-	0.00523	-	0.00074
R01B	0.00750	0.01125	-	-	-	0.00136	0.00102	0.00637	0.00507	0.07461	0.00466	0.02454	0.00012	0.01839	0.03587	-	0.02938	-	0.00417
R01C	0.00372	0.00667	0.01559	-	-	0.00188	0.00142	0.00883	0.00703	0.10343	0.00646	0.03403	0.00016	0.02549	0.04972	-	0.04073	-	0.00578
R01D	-	0.00418	0.01221	0.02459	-	0.00297	0.00224	0.01392	0.01109	0.16312	0.01019	0.05366	0.00026	0.04020	0.07842	-	0.06423	-	0.00911
R01E	-	-	0.00534	0.00509	0.03293	0.00314	0.00237	0.01472	0.01174	0.17257	0.01078	0.05677	0.00027	0.04253	0.08296	-	0.06795	-	0.00964
	Matrix A'$_{12}$					**Matrix A'$_{22}$**													
R02	0.00247	0.00472	0.01011	0.00836	0.01371	0.00818	0.00450	0.08216	0.02422	0.06217	0.00472	0.11836	0.00094	0.04895	0.05114	-	0.08968	-	0.02164
R03	-	-	-	-	-	-	0.12972	0.20553	0.00019	0.05027	0.02441	0.01532	0.00478	0.03503	0.02027	0.00008	0.02872	-	0.00110
R04	0.00262	0.00502	0.01074	0.00888	0.01456	0.00834	0.22977	0.24735	0.02827	0.03729	0.03697	0.02421	0.00336	0.04014	0.04083	0.00100	0.06917	-	0.00186
R05	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.06646	0.00012	0.35303	0.07818	0.02307	0.04134	0.00189	0.04895	0.03282	0.00054	0.05462	-	0.00807
R06	0.00002	0.00004	0.00008	0.00007	0.00011	0.00073	0.25827	0.00213	0.00872	0.28295	0.05110	0.11463	0.00318	0.02220	0.03797	0.00159	0.03620	-	0.00195
R07	-	-	-	-	-	-	0.00072	0.00001	0.01690	0.22728	0.38116	0.04321	0.00641	0.02159	0.01512	0.00276	0.05194	-	0.00263
R08	0.00002	0.00004	0.00009	0.00008	0.00012	0.00012	0.10040	0.00144	0.00472	0.06995	0.05434	0.21480	0.04045	0.00819	0.01671	0.00601	0.08209	-	0.00583
R09	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00919	0.00001	0.00893	0.08166	0.04831	0.01077	0.37205	0.02628	0.01054	0.00133	0.07051	-	0.00168
R10	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.01818	0.00299	0.00766	0.03480	0.02575	0.03604	0.01236	0.03986	0.08401	0.00563	0.17587	-	0.00730
R11	0.00000	0.00000	0.00000	0.00000	0.00000	0.00002	0.00000	0.00032	0.00273	0.12597	0.00794	0.02712	0.01627	0.03672	0.28968	0.00758	0.06683	-	0.00338
R12	0.00085	0.00162	0.00348	0.00287	0.00471	0.01239	0.00791	0.21765	0.00726	0.01667	0.00698	0.02682	0.00550	0.04843	0.00342	0.00423	0.07827	-	0.00922
R13	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00065	0.00024	0.01028	0.00567	0.01479	0.01266	0.02624	0.00660	0.01644	0.00716	0.18382	-	0.00825
R14	0.00001	0.00001	0.00003	0.00002	0.00004	0.00058	0.00046	0.00290	0.00602	0.00783	0.00883	0.02115	0.00751	0.03439	0.00933	0.00489	0.08543	-	0.01224
R15	0.00002	0.00003	0.00007	0.00006	0.00009	0.00052	0.00042	0.00932	0.01253	0.02232	0.03510	0.02262	0.00795	0.01701	0.00606	0.00615	0.10155	-	0.06473

Source: Own elaboration based on IGE (2015).

Table C.2. Regional Technical Coefficients Matrices to apply the Mixed Model. Galicia 2011

	R01A	R01B	R01C	R01D	R01E	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15
	Matrix $\mathbf{A}_{11}^{RR}$					**Matrix $\mathbf{A}_{12}^{RR}$**													
R01A	0.00334	0.00750	0.00372	-	-	0.00247	-	0.00188	0.00000	0.00000	-	0.00002	0.00000	0.00000	0.00000	0.00053	0.00000	0.00000	0.00002
R01B	-	0.01125	0.00667	0.00418	-	0.00472	-	0.00359	0.00000	0.00000	-	0.00003	0.00000	0.00000	0.00000	0.00102	0.00000	0.00000	0.00003
R01C	-	-	0.01559	0.01221	0.00534	0.01011	-	0.00769	0.00000	0.00001	-	0.00007	0.00000	0.00000	0.00000	0.00218	0.00000	0.00000	0.00007
R01D	-	-	-	0.02459	0.00509	0.00836	-	0.00636	0.00000	0.00001	-	0.00006	0.00000	0.00000	0.00000	0.00180	0.00000	0.00000	0.00006
R01E	-	-	-	-	0.03293	0.01371	-	0.01043	0.00000	0.00001	-	0.00009	0.00000	0.00000	0.00000	0.00295	0.00000	0.00000	0.00009
	Matrix $\mathbf{A}_{21}^{RR}$					**Matrix $\mathbf{A}_{22}^{RR}$**													
R02	0.00024	0.00136	0.00188	0.00297	0.00314	0.00818	-	0.00629	0.00000	0.00007	-	0.00010	0.00000	0.00000	0.00002	0.01117	0.00000	0.00054	0.00052
R03	0.00018	0.00101	0.00140	0.00221	0.00234	0.00447	0.12828	0.15891	0.05275	0.01500	0.00043	0.00251	0.00846	0.00795	-	0.00478	0.00048	0.00044	0.00039
R04	0.00111	0.00623	0.00863	0.01361	0.01440	0.02663	0.18137	0.08454	0.00004	0.00009	0.00000	0.00041	0.00001	0.00229	0.00001	0.11259	0.00017	0.00138	0.00447
R05	0.00082	0.00459	0.00637	0.01004	0.01062	0.00909	0.00009	0.00612	0.07143	0.00396	0.00641	0.00200	0.00751	0.00312	0.00042	0.00150	0.00673	0.00152	0.00840
R06	0.00971	0.05448	0.07552	0.11911	0.12601	0.03464	0.02117	0.00726	0.03048	0.05685	0.04733	0.04953	0.04218	0.00550	0.07627	0.00263	0.00122	0.00179	0.00177
R07	0.00010	0.00055	0.00076	0.00121	0.00127	0.00165	0.01209	0.01075	0.00617	0.01970	0.13139	0.02471	0.02735	0.00359	0.00088	0.00257	0.00194	0.00114	0.00916
R08	0.00437	0.02454	0.03403	0.05366	0.05677	0.11836	0.01518	0.02408	0.04068	0.09481	0.03833	0.20438	0.01052	0.03572	0.02700	0.02658	0.01236	0.01801	0.02066
R09	0.00002	0.00012	0.00016	0.00026	0.00027	0.00094	0.00478	0.00336	0.00189	0.00318	0.00641	0.04045	0.37205	0.01236	0.01627	0.00550	0.02624	0.00751	0.00795
R10	0.00313	0.01759	0.02439	0.03847	0.04069	0.04708	0.03283	0.03805	0.04724	0.02134	0.02080	0.00788	0.02499	0.03799	0.02415	0.04597	0.00626	0.03293	0.01635
R11	0.00602	0.03378	0.04683	0.07385	0.07813	0.04718	0.01820	0.03693	0.02987	0.03498	0.01399	0.01549	0.00964	0.07881	0.21693	0.00312	0.01402	0.00761	0.00514
R12	-	-	-	-	-	-	0.00008	0.00051	0.00031	0.00111	0.00154	0.00375	0.00076	0.00328	0.00717	0.00390	0.00335	0.00446	0.00496
R13	0.00446	0.02504	0.03471	0.05474	0.05791	0.07482	0.02654	0.04191	0.04465	0.02504	0.03845	0.06199	0.05515	0.14759	0.05618	0.07139	0.11829	0.07988	0.08358
R14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
R15	0.00074	0.00417	0.00578	0.00911	0.00964	0.02164	0.00110	0.00179	0.00636	0.00188	0.00254	0.00548	0.00159	0.00724	0.00336	0.00877	0.00802	0.01048	0.05826

Source: Own elaboration based on IGE (2015).

Table C.3. Price vectors for marginal changes in quantity per segment

	Shellfish		Artisanal		Coastal		Distant		Long-distant	
Ramas	$\Delta q^1/q^0$	$\tilde{p}^{ex1}$	$\Delta q^1/q^0$	$\tilde{p}^{ex1}$	$\Delta q^1/q^0$	$\tilde{p}^{ex1}$	$\Delta q^1/q^0$	$\tilde{p}^{ex1}$	$\Delta q^1/q^0$	$\tilde{p}^{ex1}$
R01A	1%	0.98667	0%	1	0%	1	0%	1	0%	1
R01B	0%	1	1%	0.98667	0%	1	0%	1	0%	1
R01C	0%	1	0%	1	1%	0.98000	0%	1	0%	1
R01D	0%	1	0%	1	0%	1	1%	0.98000	0%	1
R01E	0%	1	0%	1	0%	1	0%	1	1%	0.99000

Table C.4. Impact on non-fishing sector prices by segment

	Shellfish		Artisanal		Coastal		Distant		Long-distant	
	$\tilde{p}^{ex\,1}$	$V_c^{en\,1}$	$\tilde{p}^{ex\,1}$	$V_c^{en\,1}$	$\tilde{p}^{ex\,1}$	$V_c^{en\,1}$	$\tilde{p}^{ex\,1}$	$V_c^{en\,1}$	$\tilde{p}^{ex\,1}$	$V_c^{en\,1}$
R01A	0.98667	0.94675	1	0.96003	1	0.96004	1	0.96004	1	0.96004
R01B	1	0.77581	0.98667	0.76252	1	0.77571	1	0.77571	1	0.77571
R01C	1	0.68911	1	0.68915	0.98000	0.66938	1	0.68906	1	0.68906
R01D	1	0.50961	1	0.50967	1	0.50987	0.98000	0.49011	1	0.50962
R01E	1	0.48121	1	0.48121	1	0.48133	1	0.48132	0.99000	0.47155
	Shellfish		**Artisanal**		**Coastal**		**Distant**		**Long-distant**	
	V_c^{ex1}	$\tilde{p}^{en\,1}$	V_c^{ex1}	$\tilde{p}^{en\,1}$	V_c^{ex1}	$\tilde{p}^{en\,1}$	V_c^{ex1}	$\tilde{p}^{en\,1}$	V_c^{ex1}	$\tilde{p}^{en\,1}$
R02	0.44397	0.99996	0.44397	0.99993	0.44397	0.99976	0.44397	0.99980	0.44397	0.99984
R03	0.48458	0.99999	0.48458	0.99998	0.48458	0.99992	0.48458	0.99993	0.48458	0.99995
R04	0.18963	0.99995	0.18963	0.99990	0.18963	0.99968	0.18963	0.99974	0.18963	0.99978
R05	0.29091	1.00000	0.29091	0.99999	0.29091	0.99998	0.29091	0.99999	0.29091	0.99999
R06	0.17806	0.99999	0.17806	0.99999	0.17806	0.99996	0.17806	0.99997	0.17806	0.99997
R07	0.23027	1.00000	0.23027	0.99999	0.23027	0.99998	0.23027	0.99999	0.23027	0.99999
R08	0.39462	1.00000	0.39462	0.99999	0.39462	0.99998	0.39462	0.99998	0.39462	0.99999
R09	0.35875	1.00000	0.35875	1.00000	0.35875	0.99999	0.35875	0.99999	0.35875	0.99999
R10	0.54955	1.00000	0.54955	1.00000	0.54955	0.99999	0.54955	0.99999	0.54955	0.99999
R11	0.41546	1.00000	0.41546	1.00000	0.41546	0.99999	0.41546	0.99999	0.41546	0.99999
R12	0.54171	0.99998	0.54171	0.99995	0.54171	0.99985	0.54171	0.99988	0.54171	0.99990
R13	0.70719	1.00000	0.70719	1.00000	0.70719	1.00000	0.70719	1.00000	0.70719	1.00000
R14	0.79832	1.00000	0.79832	1.00000	0.79832	1.00000	0.79832	1.00000	0.79832	1.00000
R15	0.69344	1.00000	0.69344	1.00000	0.69344	0.99999	0.69344	0.99999	0.69344	0.99999

Table C.5. Estimated changes in quantities demanded

	Shellfish	Artisanal	Coastal	Distant	Long-distant
	$(\Delta d^1 / d^0)$	$(\Delta d^1 / d^0)$	$(\Delta d^1 / d^0)$	$(\Delta d^1 / d^0)$	$(\Delta d^1 / d^0)$
R02	0.00290%	0.00554%	0.01779%	0.01471%	0.01206%
R03	0.00064%	0.00123%	0.00394%	0.00326%	0.00267%
R04	0.00259%	0.00494%	0.01588%	0.01312%	0.01076%
R05	0.00020%	0.00038%	0.00122%	0.00101%	0.00083%
R06	0.00015%	0.00029%	0.00095%	0.00078%	0.00064%
R07	0.00021%	0.00041%	0.00130%	0.00108%	0.00088%
R08	0.00016%	0.00031%	0.00100%	0.00083%	0.00068%
R09	0.00011%	0.00021%	0.00069%	0.00057%	0.00047%
R10	0.00009%	0.00018%	0.00058%	0.00048%	0.00039%
R11	0.00008%	0.00016%	0.00052%	0.00043%	0.00035%
R12	0.00295%	0.00565%	0.01813%	0.01498%	0.01229%
R13	0.00004%	0.00007%	0.00024%	0.00020%	0.00016%
R14	0.00007%	0.00013%	0.00041%	0.00034%	0.00028%
R15	0.00018%	0.00034%	0.00108%	0.00089%	0.00073%

Table C.6. Estimating the value of outputs and exogenous final demands
(In thousand € of period 0)

		Shellfish	Artisanal	Coastal	Distant	Long-distant
	$x^{ex\ 0(0)}$	$x^{ex\ 1(0)}$	$x^{ex\ 1(0)}$	$x^{ex\ 1(0)}$	$x^{ex\ 1(0)}$	$x^{ex\ 1(0)}$
R01A	36,670	37,037	36,670	36,670	36,670	36,670
R01B	70,135	70,135	70,837	70,135	70,135	70,135
R01C	150,134	150,134	150,134	151,636	150,134	150,134
R01D	124,112	124,112	124,112	124,112	125,353	124,112
R01E	203,508	203,508	203,508	203,508	203,508	205,543
		Shellfish	**Artisanal**	**Coastal**	**Distant**	**Long-distant**
	$f^{ex\ 0(0)}$	$f^{ex\ 1(0)}$	$f^{ex\ 1(0)}$	$f^{ex\ 1(0)}$	$f^{ex\ 1(0)}$	$f^{ex\ 1(0)}$
R02	156,306	156,311	156,315	156,334	156,329	156,325
R03	1,671,309	1,671,320	1,671,329	1,671,375	1,671,363	1,671,354
R04	5,706,208	5,706,356	5,706,490	5,707,114	5,706,957	5,706,822
R05	2,542,888	2,542,893	2,542,898	2,542,919	2,542,914	2,542,909
R06	5,062,774	5,062,782	5,062,789	5,062,822	5,062,814	5,062,806
R07	9,296,233	9,296,253	9,296,271	9,296,354	9,296,333	9,296,315
R08	2,702,862	2,702,866	2,702,870	2,702,889	2,702,884	2,702,880
R09	6,358,514	6,358,521	6,358,528	6,358,558	6,358,550	6,358,544
R10	7,509,586	7,509,593	7,509,600	7,509,630	7,509,622	7,509,616
R11	1,911,805	1,911,807	1,911,808	1,911,815	1,911,813	1,911,812
R12	5,915,328	5,915,503	5,915,662	5,916,400	5,916,214	5,916,055
R13	9,904,859	9,904,863	9,904,866	9,904,883	9,904,879	9,904,875
R14	10,221,267	10,221,274	10,221,280	10,221,309	10,221,302	10,221,295
R15	4,898,841	4,898,850	4,898,857	4,898,894	4,898,885	4,898,877

Table C.7. Estimating the value of final demands and endogenous outputs
(In thousand € of period 0)

		Shellfish	Artisanal	Coastal	Distant	Long-distant
	$f^{en\ 0(0)}$	$f^{en\ 1(0)}$	$f^{en\ 1(0)}$	$f^{en\ 1(0)}$	$f^{en\ 1(0)}$	$f^{en\ 1(0)}$
R01A	16,406	16,771	16,400	16,398	16,404	16,404
R01B	31,379	31,378	32,071	31,363	31,369	31,375
R01C	67,171	67,169	67,167	68,636	67,145	67,151
R01D	55,528	55,527	55,525	55,518	56,730	55,511
R01E	91,050	91,047	91,045	91,034	91,036	93,007
		Shellfish	**Artisanal**	**Coastal**	**Distant**	**Long-distant**
	$x^{en\ 0(0)}$	$x^{en\ 1(0)}$	$x^{en\ 1(0)}$	$x^{en\ 1(0)}$	$x^{en\ 1(0)}$	$x^{en\ 1(0)}$
R02	289,014	289,022	289,030	289,065	289,057	289,053
R03	3,977,683	3,977,733	3,977,782	3,977,999	3,977,948	3,977,912
R04	7,878,054	7,878,248	7,878,429	7,879,256	7,879,056	7,878,895
R05	3,273,694	3,273,702	3,273,714	3,273,756	3,273,751	3,273,756
R06	7,777,353	7,777,375	7,777,432	7,777,596	7,777,619	7,777,733
R07	11,822,971	11,823,000	11,823,028	11,823,155	11,823,127	11,823,109
R08	7,124,938	7,124,967	7,125,019	7,125,192	7,125,191	7,125,253
R09	12,172,457	12,172,477	12,172,499	12,172,592	12,172,575	12,172,572
R10	10,248,944	10,248,974	10,249,015	10,249,169	10,249,153	10,249,172
R11	5,457,053	5,457,076	5,457,126	5,457,280	5,457,291	5,457,375
R12	6,215,063	6,215,239	6,215,400	6,216,146	6,215,959	6,215,800
R13	17,987,116	17,987,162	17,987,228	17,987,469	17,987,450	17,987,496
R14	10,221,267	10,221,274	10,221,280	10,221,309	10,221,302	10,221,295
R15	5,787,177	5,787,190	5,787,205	5,787,265	5,787,256	5,787,256

Table C.8. Estimations of direct and indirect impacts on output, Galicia
(In thousand € of period 0)

		Shellfish	Artisanal	Coastal	Distant	Long-distant
		$\Delta x^{1(0)}$	$\Delta x^{1(0)}$	$\Delta x^{1(0)}$	$\Delta x^{1(0)}$	$\Delta x^{1(0)}$
R01A	Shell-fishing on foot	367	0	0	0	0
R01B	Artisanal fishing	0	701	0	0	0
R01C	Coastal fishing	0	0	1,501	0	0
R01D	Distant water fishing	0	0	0	1,241	0
R01E	Long-distant water fishing	0	0	0	0	2,035
R02	Aquaculture	8	16	51	43	39
R03	Agriculture, forestry and mining	50	99	316	265	229
R04	Manufacture of food products	194	375	1,202	1,002	841
R05	Manufacture of textiles, wearing, wood and paper	8	20	62	57	62
R06	Manufacture of petroleum, chemical, plastic and other non-metallic products	22	79	243	266	380
R07	Other manufactures	29	57	184	156	138
R08	Repair and supplies	29	81	254	253	315
R09	Construction	20	42	135	118	115
R10	Wholesale and retail trade	30	71	225	209	228
R11	Transportation and storage	23	73	227	238	322
R12	Accommodation and food service activities	176	337	1,083	896	737
R13	Services to companies and individuals	46	112	353	334	380
R14	Administration and public services	7	13	42	35	28
R15	Other services	13	28	88	79	79
	TOTAL GALICIA: $m(o)_i$	**1,022**	**2,106**	**5,966**	**5,193**	**5,927**

Table C.9. Estimations of direct and indirect impacts on final demand, Galicia
(In thousand € of period 0)

		Shellfish	Artisanal	Coastal	Distant	Long-distant
		$\Delta f^{1(0)}$	$\Delta f^{1(0)}$	$\Delta f^{1(0)}$	$\Delta f^{1(0)}$	$\Delta f^{1(0)}$
R01A	Shell-fishing on foot	365	-6	-9	-2	-2
R01B	Artisanal fishing	-1	692	-16	-10	-4
R01C	Coastal fishing	-2	-4	1,466	-25	-19
R01D	Distant water fishing	-2	-3	-10	1,202	-17
R01E	Long-distant water fishing	-3	-5	-16	-14	1,957
R02	Aquaculture	5	9	28	23	19
R03	Agriculture, forestry and mining	11	20	66	54	45
R04	Manufacture of food products	148	282	906	749	614
R05	Manufacture of textiles, wearing, wood and paper	5	10	31	26	21
R06	Manufacture of petroleum, chemical, plastic and other non-metallic products	8	15	48	40	32
R07	Other manufactures	20	38	121	100	82
R08	Repair and supplies	4	8	27	22	18
R09	Construction	7	14	44	36	30
R10	Wholesale and retail trade	7	14	44	36	30
R11	Transportation and storage	2	3	10	8	7
R12	Accommodation and food service activities	175	334	1,072	886	727
R13	Services to companies and individuals	4	7	24	20	16
R14	Administration and public services	7	13	42	35	28
R15	Other services	9	16	53	44	36
	TOTAL GALICIA: $m(o)_i$	**767**	**1,457**	**3,930**	**3,230**	**3,618**

Table C.10. Regional Technical Coefficients Matrix with households inclued ($\bar{\mathbf{A}}$) for estimation of total impacts. Galicia 2011

	R01A	R01B	R01C	R01D	R01E	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	H*
R01A	0.00334	0.00750	0.00372	-	-	0.00247	-	0.00188	0.00000	0.00000	-	0.00002	0.00000	0.00000	0.00000	0.00053	0.00000	0.00000	0.00002	0.00020
R01B	-	0.01125	0.00667	0.00418	-	0.00472	-	0.00359	0.00000	0.00000	-	0.00003	0.00000	0.00000	0.00000	0.00102	0.00000	0.00000	0.00003	0.00039
R01C	-	-	0.01559	0.01221	0.00534	0.01011	-	0.00769	0.00000	0.00001	-	0.00007	0.00000	0.00000	0.00000	0.00218	0.00000	0.00000	0.00007	0.00083
R01D	-	-	-	0.02459	0.00509	0.00836	-	0.00636	0.00000	0.00001	-	0.00006	0.00000	0.00000	0.00000	0.00180	0.00000	0.00000	0.00006	0.00069
R01E	-	-	-	-	0.03293	0.01371	-	0.01043	0.00000	0.00001	-	0.00009	0.00000	0.00000	0.00000	0.00295	0.00000	0.00000	0.00009	0.00112
R02	0.00024	0.00136	0.00188	0.00297	0.00314	0.00818	-	0.00629	0.00000	0.00007	-	0.00010	0.00000	0.00000	0.00002	0.01117	0.00000	0.00054	0.00052	0.00255
R03	0.00018	0.00101	0.00140	0.00221	0.00234	0.00447	0.12828	0.15891	0.05275	0.01500	0.00043	0.00251	0.00846	0.00795	-	0.00478	0.00048	0.00044	0.00039	0.01495
R04	0.00111	0.00623	0.00863	0.01361	0.01440	0.02663	0.18137	0.08454	0.00004	0.00009	0.00000	0.00041	0.00001	0.00229	0.00001	0.11259	0.00017	0.00138	0.00447	0.05236
R05	0.00082	0.00459	0.00637	0.01004	0.01062	0.00909	0.00009	0.00612	0.07143	0.00396	0.00641	0.00200	0.00751	0.00312	0.00042	0.00150	0.00673	0.00152	0.00840	0.00916
R06	0.00971	0.05448	0.07552	0.11911	0.12601	0.03464	0.02117	0.00726	0.03048	0.05685	0.04733	0.04953	0.04218	0.00550	0.07627	0.00263	0.00122	0.00179	0.00177	0.01435
R07	0.00010	0.00055	0.00076	0.00121	0.00127	0.00165	0.01209	0.01075	0.00617	0.01970	0.13139	0.02471	0.02735	0.00359	0.00088	0.00257	0.00194	0.00114	0.00916	0.00429
R08	0.00437	0.02454	0.03403	0.05366	0.05677	0.11836	0.01518	0.02408	0.04068	0.09481	0.03833	0.20438	0.01052	0.03572	0.02700	0.02658	0.01236	0.01801	0.02066	0.03671
R09	0.00002	0.00012	0.00016	0.00026	0.00027	0.00094	0.00478	0.00336	0.00189	0.00318	0.00641	0.04045	0.37205	0.01236	0.01627	0.00550	0.02624	0.00751	0.00795	0.01793
R10	0.00313	0.01759	0.02439	0.03847	0.04069	0.04708	0.03283	0.03805	0.04724	0.02134	0.02080	0.00788	0.02499	0.03799	0.02415	0.04597	0.00626	0.03293	0.01635	0.19972
R11	0.00602	0.03378	0.04683	0.07385	0.07813	0.04718	0.01820	0.03693	0.02987	0.03498	0.01399	0.01549	0.00964	0.07881	0.21693	0.00312	0.01402	0.00761	0.00514	0.02457
R12	-	-	-	-	-	-	0.00008	0.00051	0.00031	0.00111	0.00154	0.00375	0.00076	0.00328	0.00717	0.00390	0.00335	0.00446	0.00496	0.21637
R13	0.00446	0.02504	0.03471	0.05474	0.05791	0.07482	0.02654	0.04191	0.04465	0.02504	0.03845	0.06199	0.05515	0.14759	0.05618	0.07139	0.11829	0.07988	0.08358	0.25786
R14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
R15	0.00074	0.00417	0.00578	0.00911	0.00964	0.02164	0.00110	0.00179	0.00636	0.00188	0.00254	0.00548	0.00159	0.00724	0.00336	0.00877	0.00802	0.01048	0.05826	0.14595
H*	0.51073	0.41267	0.36657	0.27111	0.25600	0.23513	0.25803	0.09217	0.15487	0.08485	0.12021	0.20815	0.18851	0.29028	0.21315	0.28324	0.37205	0.41004	0.36104	-

* Additional Household Sector.

Source: Own elaboration based on IGE (2015).

Table C.11. Estimations of total impacts on output, Galicia
(In thousand € of period 0)

		Shellfish	Artisanal	Coastal	Distant	Long-distant
		$\Delta x^{1(0)}$	$\Delta x^{1(0)}$	$\Delta x^{1(0)}$	$\Delta x^{1(0)}$	$\Delta x^{1(0)}$
R01A	Shell-fishing on foot	367	1	1	1	1
R01B	Artisanal fishing	1	702	3	2	2
R01C	Coastal fishing	1	2	1,507	4	5
R01D	Distant water fishing	1	2	5	1,245	4
R01E	Long-distant water fishing	2	3	7	6	2,042
R02	Aquaculture	11	22	65	55	52
R03	Agriculture, forestry and mining	73	139	418	346	321
R04	Manufacture of food products	246	468	1,440	1,188	1,055
R05	Manufacture of textiles, wearing, wood and paper	18	37	105	91	100
R06	Manufacture of petroleum, chemical, plastic and other non-metallic products	41	115	333	336	461
R07	Other manufactures	38	74	225	189	175
R08	Repair and supplies	78	169	478	428	516
R09	Construction	54	104	292	242	256
R10	Wholesale and retail trade	160	305	820	675	763
R11	Transportation and storage	65	148	418	388	493
R12	Accommodation and food service activities	298	557	1,642	1,334	1,240
R13	Services to companies and individuals	261	499	1,338	1,106	1,265
R14	Administration and public services	7	13	42	35	28
R15	Other services	103	190	502	403	451
Total	**TOTAL GALICIA**	**1,825**	**3,550**	**9,642**	**8,074**	**9,234**

Table C.12. Estimations of total impacts on GVA, Galicia
(In thousand € of period 0)

		Shellfish	Artisanal	Coastal	Distant	Long-distant
		$\Delta GVA^{1(0)}$	$\Delta GVA^{1(0)}$	$\Delta GVA^{1(0)}$	$\Delta GVA^{1(0)}$	$\Delta GVA^{1(0)}$
R01A	Shell-fishing on foot	352	1	1	1	1
R01B	Artisanal fishing	0	545	2	2	2
R01C	Coastal fishing	1	1	1,038	3	3
R01D	Distant water fishing	1	1	2	634	2
R01E	Long-distant water fishing	1	1	4	3	983
R02	Aquaculture	5	10	29	24	23
R03	Agriculture, forestry and mining	35	67	203	168	156
R04	Manufacture of food products	43	81	250	206	183
R05	Manufacture of textiles, wearing, wood and paper	5	11	31	27	29
R06	Manufacture of petroleum, chemical, plastic and other non-metallic products	7	18	53	54	74
R07	Other manufactures	9	17	51	43	40
R08	Repair and supplies	31	66	187	168	202
R09	Construction	19	37	104	86	91
R10	Wholesale and retail trade	87	166	447	368	416
R11	Transportation and storage	26	59	167	155	198
R12	Accommodation and food service activities	159	297	874	710	660
R13	Services to companies and individuals	182	349	935	773	885
R14	Administration and public services	5	10	32	27	22
R15	Other services	70	129	341	274	306
	TOTAL GALICIA	**1,038**	**1,867**	**4,751**	**3,724**	**4,275**

Table C.13. Estimations of total impacts on employment, Galicia
(Number of employees Full Time Equivalents, FTE)

		Shellfish	Artisanal	Coastal	Distant	Long-distant
		Δ FTE[1]	Δ FTE[1]	Δ FTE[1]	Δ FTE[1]	Δ FTE[1]
R01A	Shell-fishing on foot	20.0	0.0	0.1	0.1	0.1
R01B	Artisanal fishing	0.0	34.0	0.1	0.1	0.1
R01C	Coastal fishing	0.0	0.0	16.3	0.0	0.1
R01D	Distant water fishing	0.0	0.0	0.0	9.1	0.0
R01E	Long-distant water fishing	0.0	0.0	0.0	0.0	9.6
R02	Aquaculture	0.2	0.3	1.0	0.9	0.8
R03	Agriculture, forestry and mining	0.0	0.0	0.0	0.0	0.0
R04	Manufacture of food products	1.2	2.3	7.1	5.8	5.2
R05	Manufacture of textiles, wearing, wood and paper	0.1	0.3	0.9	0.7	0.8
R06	Manufacture of petroleum, chemical, plastic and other non-metallic products	0.1	0.3	0.9	0.9	1.2
R07	Other manufactures	0.2	0.3	1.0	0.8	0.7
R08	Repair and supplies	0.3	0.6	1.6	1.4	1.7
R09	Construction	0.4	0.8	2.3	1.9	2.0
R10	Wholesale and retail trade	2.7	5.1	13.6	11.2	12.6
R11	Transportation and storage	0.6	1.4	3.9	3.6	4.6
R12	Accommodation and food service activities	2.7	5.1	15.1	12.3	11.4
R13	Services to companies and individuals	2.1	4.0	10.9	9.0	10.3
R14	Administration and public services	0.1	0.2	0.7	0.5	0.4
R15	Other services	2.2	4.1	10.8	8.7	9.7
	TOTAL GALICIA	**33.0**	**58.9**	**86.1**	**67.0**	**71.3**