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# Remuneration systems used in the fishing sector and their consequences on crew wages and labor rent creation

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## Abstract

In most fisheries worldwide, crew are paid through different shared remuneration systems rather than a fixed wage. In shared remuneration systems, wages can significantly increase when the economic performance of vessels improve, and consequently provide incentives to workers. However, in recent years, mainly due to high overexploitation levels that lead to reduced productivity and consequently lower salaries shared remuneration systems have lost their attractiveness. Different remuneration systems applied in fisheries world-wide are described and analyzed comparatively. Results explain how crew wages and rent distribution outcomes vary between the different remuneration systems depending on the state of exploitation of the resource.

## Introduction

The fishing sector is an important economic sector, source of wealth, food supply and nutrition security (McClanahan et al. 2013; Hall et al. 2013). In 2012, capture fisheries produced 91.3 million tons of fish, and 66.6 million tons of fish were obtained from aquaculture (FAO 2014a). Of these 158 million tons, 136.2 million tons were used for human consumption, which is equivalent to an average consumption of 19.2 kg of fish per capita. Around 58.3 million people were engaged in the primary sector of capture fisheries and aquaculture in 2012 (FAO 2014a). Of these, about 40 million were engaged in capture fisheries.

Many economic activities worldwide remunerate their workers using time based remunerations: fixed wages (monthly salaries) or hourly or daily rates (Schloss 1898; Kessler 2009). Additionally, in some remuneration systems workers' salary is complemented with incentives, by relating the wage to the worker's output (i.e., piece rate, task wage), using a combination of time and output remunerations or bonus and commission systems (Schloss 1898; Lazear 1986; Kessler 2009). Many of these remuneration systems were developed following the needs of the industrial sector (Schloss 1898).

In the agricultural and fishing sectors incentives play a more important role. In the agriculture sector sharecropping contracts are almost universal throughout the world, where the tenant pays a specific proportion of the produce or of the gross sales to the landlord (Johnson 1950; Stiglitz 1974; Reid 1976; Newbery 1977; Allen 1985).

In the fishing sector, remuneration systems based on productivity prevail, consequently providing incentives for the crew to increase production. Crew are usually remunerated through shared remuneration systems (also known as lay systems) rather than fixed wages (i.e., Zoetewij 1956; Acheson 1981; Anderson 1982; Platteau and Nugent 1992; Matthiasson 1997; McConnell and Price 2006). In these remuneration systems, crew members are paid with a share of the revenues (i.e., value of landings) or a share of the revenues minus costs.

This practice of paying the crew with shared remuneration systems is applied to both small scale and industrial fisheries, as well as in developed and developing countries. Indeed, it is extensive to fisheries worldwide as can be seen from Table 1:

**Table 1** Existing references on the use of shared remuneration systems

Continent	Country	Reference
Africa	Ghana	Christensen 1977
	Morocco	Malouli Idrissi et al. 2003
		Kamili 2006
	Senegal	Tietze et al. 2001
	Tunisia	Azabou et al. 1989
America	Brazil	Giasson 1981
	Canada	Breton 1973
	Chile	Salazar 2015
	Ecuador	Middleton 1977
	Barbados	Tietze et al. 2001
	French Guyana	Béné 1996
	Guadeloupe	Guyader et al. 2013
	Mexico	McGoodwin 1976
	United States	McConnell and Price 2006
		Abbott et al. 2010
Asia	India	Bavinck 2001
	Republic of Korea	Tietze et al. 2001
	Philippines	Smith et al. 1983
	Sri Lanka	Alexander 1977
	Thailand	ILO 2013
	Turkey	Ünal 2002
	Vietnam	Thuy et al. 2013
Europe	France	Guillen et al. 2015
	Iceland	Matthiasson 1997
	Italy	Colloca et al. 2003
	Spain	Lleonart, et al. 1999, 2003
		Maynou et al. 2006
		Prellezo and Iriondo 2016
	Sweden	Lofgren 1972
United Kingdom	Hatcher 2010	
Oceania	Australia	McCall Howard 2012
		George and New 2013
		Skirtun, Stephan and Mazur 2014

Shared remuneration systems have traditionally been used in fisheries because they improve productivity (Weitzman and Kruse 1990). This is because shared remuneration systems share risks (costs) and rents (profits) between the crew and the vessel owner (Stiglitz 1974; Sutinen 1979; Acheson 1981; Plourde and Smith 1989; McGoodwin 1991), and provide incentives based on outputs in situations where monitoring of worker's effort is unobservable or costly (Stiglitz 1974; Eisenhardt 1989; McConnell and Price 2006; Vestergaard 2010).

Moreover, in addition to the principal-agent problem where captains may have incentives to apply a different fishing effort depending if they are the owners of the vessels or not, in order to maximize their personal income (Eisenhardt 1989; Vestergaard 2010); the use of different remuneration systems leads to different fishing efforts in order to achieve the management objectives independently of the presence of the vessel owner (Guillen et al. 2015).

Shared remuneration systems allow the crew to obtain higher wages by capturing part of the fisheries rent when the economic performance of the vessel improves (Griffin et al. 1976), in part due to the crew work. Fisheries rent is a "surplus" from the exploitation of fisheries resources. It is estimated as the difference between total revenues obtained from the fishery and the total costs (estimated at their opportunity costs) of employing the various factors of production (including charges for replacement of assets) that together make up the firms participating in the fishery (Guillen et al. 2015).

Therefore, fisheries rent is divided between owners (capital) rent and labor rent. Being the owners rent the extra current profits (above the opportunity cost of capital); while labor rent is estimated as the difference between current wages and the opportunity cost of labor. This can act as an incentive to improve the attractiveness of the fishing sector on the labor market because it is an activity where the strenuousness of work onboard limits the labor supply, as well as an incentive to increase the labor time and effort.

However, there are important variations in the shared remuneration systems used worldwide. Main differences between shared remuneration systems depend on which costs are deducted from the crew part. Moreover, when crew are paid through shared remuneration systems, the sharing within crew members is often not homogeneous, highlighting differences in marginal productivity and payment of labor quasi rents.

The Sunken billions report (Willmann et al. 2008) estimates labor costs in global fisheries to be between 30 and 50% of total costs. Labor costs represent on average about 35% of the total EU fishing fleets costs (STECF 2012). While, Jin et al. (2002) estimate that labour costs represent 30 to 60% of total costs (including fixed costs) for the New England groundfish fleet. Labor costs constitute an important part of the fishing costs and consequently have a significant impact on the economic performance and strategies of the different fleets. It is, therefore, important to understand how labor costs rise and labor rent is created.

Fisheries management measures have a direct impact on the creation of fisheries (or resource) rent (see, for instance, Guillen et al. 2013); while the remuneration systems have a direct impact on the fisheries rent distribution between the vessel owner and the crew. In shared remuneration systems, therefore, fisheries management measures have also an impact on labor costs and crew wages.

Most countries manage their fisheries to achieve a combination of biologic, economic, social, and political objectives (Mardle et al. 2002; Hilborn 2007; Dichmont et al. 2010). However, management objectives are often conflicting and it is not possible to achieve all of them at the same time.

- As a biological objective, Maximum Sustainable Yield (MSY) is interpreted as the maximum long term average catch that can be achieved under prevailing conditions, including both the state of the ecosystem and size selectivity of the fishery (ICES 2010). Thus, the target of fisheries operating at MSY meets both biological sustainability and production maximization objectives (Beverton and Holt 1957; Hilborn and Stokes 2010). Hence, under this management objective, often revenues are maximized<sup>1</sup> but not profits. However, in this study, it is assumed that price is related to the fish biomass at sea, following Willmann et al. (2008). Consequently, the fishing effort level that maximizes production (catches) is not the same one that maximizes revenues.
- As an economic objective, Maximum Economic Yield (MEY) can be defined as the sustainable catch that maximizes the difference between total revenues and total costs of fishing (Huntsman 1951; Gordon 1954; Kompas 2005). So, the MEY should correspond to the catch of an optimally managed fishery aiming at maximizing the rents extracted from the fishery. Therefore, differentiating between maximizing rents (profits and labor rents) which strictly corresponds to MEY, and maximizing only profits.
- As a social objective, the maximum employment target can be defined, following Pilling et al. (2008), as the maximum effort, and consequently employment, in a non-loss making fishery. So this management objective corresponds to the bio-economic equilibrium or open access point. In an open access fishery, the bio-economic equilibrium is given at an effort level where profit is zero and total fishing cost is equal to total revenue (Hannesson 1993).

The objective of this study is to explore the effects and see the divergences of different remuneration systems by estimating the evolution of crew wages and the distribution of rents between labor and capital (the vessel owner) at several fisheries management targets. Here, the management objectives analyzed are maximum production (MSY), maximum revenues, maximum rents (MEY), maximum profits and maximum employment or bio-economic equilibrium compared to the status quo (when current fishing effort remains constant) for the global marine fisheries.

## **Methodology**

### **Compilation of fisheries remuneration systems used world-wide**

There are important variations in the shared remuneration systems used worldwide. One of the main variations in shared remuneration systems is on the extent to which crew participates in paying the costs (Zoetewij 1956). From a literature review, we identified 4 remuneration systems commonly used in fisheries: (i) fixed remuneration systems (case 1), (ii) shared remuneration system: proportional to catch or revenues (case 2), (iii) shared remuneration system: proportional to

revenues minus operational costs (case 3) and (iv) shared remuneration system: proportional to profits (case 4).

However, sometimes fishermen's remuneration include items of several of these groups; for example: (i) in the small-scale purse seiners in Vietnam crew can be paid with a fixed wage (case 1) and a small bonus based on a share of the revenues (case 2) (Thuy et al. 2013); (ii) in the trawler fleet in Mediterranean Spain the main remuneration system is a share of the revenues minus operational costs (case 3), but crew also receive a small part of the landings (*morralla*, composed of species with low value<sup>2</sup>) (case 2) (Leonart et al. 1999, 2003; Alemany and Álvarez 2003; Maynou et al. 2006; Samy-Kamal et al. 2014).

It is also possible that in a fishery different remuneration systems coexist, as shown in (i) Ünal (2002) where 67% of the trawl vessels in Turkey used a fixed wage (case 1) and 33% a share system (case 3); (ii) Thuy et al. (2013) for the small-scale purse seiners in Vietnam that used a fixed wage with a small bonus based on a share of the revenues (cases 1 and 2) or a share remuneration of the revenues minus the variable costs (case 3); and (iii) fishers in Thailand receive a remuneration proportional to the sale of the catch<sup>3</sup> in 41.3% of the cases, a fix wage plus a proportion of the catch (38.9%), or a fix wage only (10.4%) (ILO 2013). Moreover, in recent years, together with the difficulties for vessel owners to find crew in certain fisheries, crew is asking to be paid with fixed wages rather than shared remuneration systems.

It should also be noted that due to the little attention paid to the remuneration systems used in fisheries, these systems are often not specified in detail and their functioning oversimplified. For example, this oversimplification can lead to the literature stating that fisheries operate through shared remuneration systems proportional to the catch (case 2); when in fact the same fisheries are actually remunerated through shared remuneration systems proportional to the revenues minus the operational costs (case 3).

#### **Case 1: fixed remuneration system**

In a fixed remuneration system, crew are paid with a constant (fixed) wage, either daily, monthly or at another time-scale. Examples of this system include:

- The US Chesapeake Bay blue crab fishery uses a pure (fix) wage system in approximately 40% of the trips (McConnell and Price 2006);
- The US factory trawlers in the Bering Sea harvesting and processing groundfish remunerate the processing crew and engineers primarily via a (fix) daily wage (McConnell and Price 2006);
- 67% of the trawl vessels in Turkey (Ünal 2002);
- Some small-scale purse seiners in Vietnam remunerate the crew with a daily fixed wage of about 30 to 40 thousand Vietnamese Dong (case 1), complemented with 10% of the total revenues shared between the crew (case 2) (Thuy et al. 2013);
- The industrial fleet of Saint-Malo (France) remunerates crew with a fixed wage to guarantee the crew a minimum wage and a shared wage to act as an incentive.

#### **Case 2: shared remuneration system (proportional to catch or revenues)**

Zoetewij (1956) points out that the income of fishermen is more often determined by the value of the catch rather than its size. Indeed, in those fisheries where no costs are

deducted from the revenues before compensating the crew, the remuneration is often proportional to the revenues and not the catch. A remuneration proportional to the catches only matches with remuneration proportional to the revenues when there is only one species or several species with the same price. The distinction between share of catches and revenues is relevant because it is possible to catch different species or sizes with different prices at the same time (i.e. a large amount of low valued species and just few of high valued ones), so both outcomes would be different. Some examples of fisheries using shared remuneration systems proportional to revenues are:

- The US factory trawlers in the Bering Sea harvesting and processing groundfish remunerate their harvesting crews with a share of the revenues (typically 30–35% in aggregate) (McConnell and Price 2006).
- In the French Guyana shrimp fishery remuneration is compounded by a share of the catch, and a bonus that provides incentives to the crew to target large shrimps during periods of high resource levels and smaller shrimps during months of lower catch levels (Béné 1996).
- Icelandic vessels remunerate their crew with a share of the revenues without considering the costs (Matthiasson 1997).
- In the artisanal fishery of Cilento (Italy), crew members receive about 50% of the revenues, and any fish that have not been sold because of damage or no commercial value (Colloca et al. 2003).
- In the Basque (North West of Spain) traditional purse seiner-live bait fleet, which fish small pelagics using purse seiners and big pelagics (tuna) using live bait with hooks, the crew receive 50% of the net value of landings (once the landing fee is deduced) (Astorkiza et al. 1998; Prellezo and Iriondo 2016).

### **Case 3: shared remuneration system (proportional to revenues minus operational costs)**

The share rate and the operating costs (or variable costs) that are deducted from the value of landings before sharing can vary between fishing fleets, fisheries, countries, and even vessels. For example, in the Netherlands, in general, fuel cost, which is the main operating cost, is deducted from the value of landings (Bartelings et al. 2015); while in France and Spain usually fuel, ice, food, and bait costs are deducted (Lleonart et al. 1999, 2003; Maynou et al. 2006; Macher et al. 2008). Some examples of fisheries using shared remuneration systems proportional to revenues minus operational costs are:

- The remuneration system in Moroccan fisheries is mainly based on shared remuneration for artisanal fishing and coastal fisheries (i.e., seiners, trawlers, longliners); while the high seas fleet remunerates their crew mainly with monthly wages, but includes a supplement based on a small percentage of the catch (Kamili, personal communication). The purse-seine fishery remunerates their crew with a 60% share of the revenues minus operational costs, but crew also receive a 1–2% of the landings (called *fakira*) (Kamili 2006); while in the artisanal fleet in the Nador Lagoon the share rate is 50% (Malouli Idrissi et al. 2003);
- In Tunisia crew are paid with a share of the revenues once operational costs are subtracted (Azabou et al. 1989);

- Almost all commercial fisheries in the US remunerate their crew with a share of the revenues minus certain costs (McConnell and Price 2006). Indeed, crew in the Bering Sea/Aleutian Island crab fisheries are remunerated with a share of the revenues minus certain costs. The costs items subtracted to the revenues, as well as the share rate (on average is around 40%, but varies between 30 and 50%) depends on the vessel (Abbott et al. 2010);
- 33% of the trawl vessels in Turkey remunerate their crew with this remuneration system (Ünal 2002);
- Some small-scale purse seiners in Vietnam use a share remuneration of the revenues minus the variable costs (Thuy et al. 2013);
- The trawl fisheries in the Spanish Mediterranean remunerate their crew with a share (often 50%) of the revenues minus operational costs (case 3), but crew also receive a small part of the landings (*morralla*, composed of low valued species) (case 2) (Lleonart et al. 1999, 2003; Maynou et al. 2006);
- In France, the most common remuneration system is based on a share of the revenue minus the operational costs (landings costs, fuel costs, bait costs, food costs and ice costs), as modeled in Macher et al. (2008) for the *nephrops* fishery in the Bay of Biscay.

#### **Case 4: shared remuneration system (proportional to profits)**

In this remuneration system, crew members are paid with a proportion of the profits. In this case, all costs are deduced to the revenues before sharing it with the crew. This is mostly a hypothetical model that allows us to cover all possible ranges, as it seldom occurs in reality.

- It could be the case in very artisanal fisheries where there is scarcity of labor and the possibility of obtaining production means cheaply (low capital investment), as in an artisanal fleet in the Canary Islands (Spain) using 5 m long vessels when there is no share to remunerate capital (Pascual Fernandez 1999).
- Theoretically, it could also be the case in cooperatives where all fishermen are owners of the production means.
- Theoretically, this could also be the case on small boats when there is only one crew, who is also the owner of the vessel. In this case, the distinction between remuneration of labor and remuneration of the invested capital is not systematic (Boncoeur et al. 2000).<sup>4</sup>

#### **The bioeconomic model**

In order to explore the sensitivity of existing remuneration systems to different management targets and so different economic performances, we analyzed the global marine fisheries as represented in the Sunken Billions (Willmann et al. 2008), using a Gordon-Schaefer bio-economic model (Gordon 1953, 1954; Schaefer 1954, 1957).

Basic population dynamics are used to illustrate how fisheries work and provide the basis for understanding issues such as optimal harvesting rates, predation and habitat destruction. Population dynamics describe the ways in which a given population grows and shrinks over time, due to by birth, death, and migration. Fish stock growth

(change) depends on recruitment, natural mortality, individual growth and harvesting. This may be summarized as follows:

$$\text{Stock growth} = \text{Recruitment} + \text{Individual growth} - \text{Natural mortality} - \text{Harvest.}$$

A typical model of population growth is based on the logistic equation, where the rate of growth is proportional to both the existing population and the amount of available resources, all else being equal (Verhulst 1838; Clark 1976). So, the growth of a fish stock can be expressed in the continuous version of the logistic model described by the differential equation used in the Verhulst/Pearl surplus production model (Schaefer 1970):

$$F(x_t) = rX_t \left( 1 - \frac{X_t}{K} \right) \quad (1)$$

Where  $X_t$  is the biomass level of the stock or stock size (weight of the stock) at time  $t$ ,  $F(X_t)$  represents the change in stock per unit of time  $dX(t)/dt$ , the constant  $r$  is the Malthusian parameter that refers to the rate of maximum population growth and  $K$  is the carrying capacity. In the equation, the unimpeded growth rate is modeled by the first term  $+rX$ . The value of the rate  $r$  represents the proportional increase of the population  $X$  in one unit of time. As the population grows, the second term, which is  $-rX^2/K$ , becomes larger than the first as some members of the population  $N$  interfere with each other by competing for some critical resource, such as food or living space. This antagonistic effect is called the *bottleneck*, and is modeled by the value of the parameter  $K$ . Competition diminishes the combined growth rate, until the value of  $X$  ceases to grow.

This implies that stock growth follows a parabolic growth curve. By defining  $B_1$  as  $k$  and  $B_2$  as  $(k/r)$ , then eq. 1 could be rewritten as:  $F(x_t) = B_1X_t - B_2X_t^2$ . The natural equilibrium (maximum stock size) is reached when the stock of fish is equal to the environmental carrying capacity,  $X = K$ . That is why  $K$  is termed as the maximum value that  $X$  can reach. To obtain the maximum natural growth in equilibrium and the corresponding stock size, the first order derivative of eq. 1 should equal to zero:

$$\frac{dX}{dt} = r \left( \frac{1-2X_t}{K} \right) = 0 \quad (2)$$

From this, it is obtained that the stock size where maximum growth of the fish stock occurs is at  $\frac{K}{2}$ .

It is assumed that the short-run harvest function follows the common Schaefer harvest function (Schaefer 1957), where the catch or harvest is proportional to the fishing effort and the stock level:

$$H = qEX \quad (3)$$

Where  $H$  is the harvest,  $q$  is the catchability coefficient and  $E$  is the fishing effort. The catchability coefficient ( $q$ ) expresses how effective the fishing effort is in relation to the stock level by a given fishing fleet.

The fishing effort, or sometimes just called effort, is a measure of the amount of fishing. Frequently some surrogate is used relating to a given combination of inputs into the fishing activity, such as the number of vessels, number of hours or days spent fishing, numbers of hooks used, kilometers of nets used, etc. (OECD 1998). Fishing effort



adjustments simulated in this study correspond to capacity adjustments (changes in the number of vessels). Vessels in the fishery are assumed to be similar (homogeneous), and consequently have the same harvesting power and cost structure. In addition, fishing days by vessel and crew size per vessel are assumed to be constant.

If it is assumed that harvest (fishing) is done on a sustainable way, then the stock biomass that is removed by fishing has to be equal to the stock growth. Then the long-term harvest function is:

$$H = F(X) = rX \left(1 - \frac{X}{K}\right) \quad (4)$$

Considering eq. 3, harvest can be rewritten as:

$$F(X) = rX \left(1 - \frac{X}{K}\right) - qEX \quad (5)$$

Then, the stock at equilibrium under a sustainable exploitation is equal to:

$$X = \frac{K}{r} (r - qE) \quad (6)$$

While the sustainable harvest level is determined by:

$$H = qE \frac{K}{r} (r - qE) \quad (7)$$

The gross revenue of a fishery is equivalent to the value of landings, and so equals quantity harvested multiplied by the price of fish (value of landings, VL). In the global fisheries model employed in the Sunken billions (Willmann et al. 2008), the average price of landings is a function of the global marine commercial biomass. The model uses a value of 0.2 for the elasticity of demand with respect to biomass, which means that if the biomass doubles, then the landings price increases by 20%.

$$VL = p H \quad (8)$$

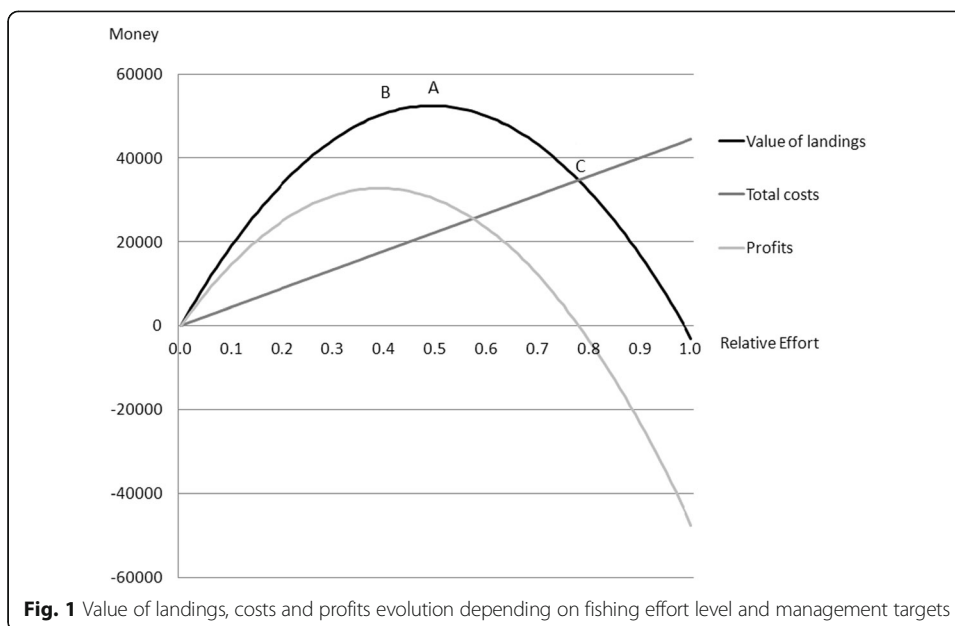
$$P = 0.92 + 0.2 \frac{X_e - X_{sq}}{X_{sq}} \quad (9)$$

Then the value of landings curve will have the same shape as the sustainable harvest or yield curve, scaled up or down depending on the price. Following the Gordon-Schaefer bio-economic surplus production model (Gordon 1953, 1954), the value of landings' function is expressed in terms of effort (developing eq. 8 in terms of eq. 7).

In our application, it is assumed a constant marginal cost of effort for simplicity. This is based on the homogenous vessels assumption, where the vessels are added to (or taken out of) the fishery at the same cost as the previous one. The cost function is proportional (linear) to effort at a constant cost,  $a$ , per unit of effort. In Fig. 1 the total cost line (TC), is shown as an upward-sloping straight line. This corresponds to the traditional model where wages are assumed fixed, and consequently they are proportional to effort.

$$TC = a E \quad (10)$$

Net profits, or vessel owner rents, can therefore be estimated from the difference between the revenues generated (value of landings) and the total costs.



$$NP = VL - TC \tag{11}$$

Fisheries rent is often considered as a “surplus” profit over and above that considered normal. In traditional models, the total fishery rent is equal to the profits and so the vessel’s owner rent. The labor market is assumed to be in equilibrium, and consequently crew is remunerated with a fixed wage equal to the opportunity cost of labor.

From previous Fig. 1, different reference points (management targets) can be delimited. The Maximum Sustainable Yield (MSY) corresponds to the maximum harvest sustainable over time that can be obtained from a fish stock (point A in Fig. 1), which equals to the maximum growth of the fish stock. Maximum Economic Yield (MEY) is the sustainable harvest level that maximizes rents (equal to profits in this case), and so it corresponds to the effort level where there is the maximum distance between the revenue curve and the total costs line (point B in Fig. 1). The bio-economic equilibrium occurs when profits are 0 at equilibrium, and so at the harvest and effort levels when revenues are equal to the costs (point C in Fig. 1). Theoretically, bioeconomic equilibrium takes place at open access, which is the condition where access to the fishery (for the purpose of harvesting fish) is unrestricted; i.e., the right to catch fish is free and open to all (OECD 2012).

However, when shared remuneration systems are taken into account, costs continue to be considered proportional to the number of vessels in the fleet (i.e., to the effort), except for labor costs that will depend on the revenues and the extent of costs deduced in each shared remuneration system. Therefore, total costs are disaggregated into labor costs (assumed to be 40%, following Willmann et al. (2008)) and other costs that are proportional to fishing effort (60%).

Wages from all remuneration systems are assumed to be equal at the current fishing effort level. The share rates of the different remuneration systems are identified so that labor costs at the current effort level are the same.

Analyzing these 4 remuneration systems allow us to model the most common remuneration systems used in fisheries:

- Case 1: Fixed remuneration system: in a fixed remuneration system, wages are constant. Labor costs or crew costs (LC) are equal to the total crew gross remuneration, and are obtained multiplying the average fixed wage ( $wage_1$ ) by the total crew number ( $crew$ ).

$$LC_1 = wage_1 \times crew \quad (12)$$

- Case 2: Shared remuneration system (proportional to revenues/catch): in such remuneration systems, wages are proportional to the value of landings (i.e., catch).

$$LC_2 = share\_rate_2 \cdot VL \quad (13)$$

- Case 3: Shared remuneration system (proportional to revenues minus operational costs): In this system, crew members obtain a share of the difference between the total value of landings and the variable (operating) costs (VC). Then crew costs are obtained as:

$$LC_3 = share\_rate_3 \cdot (VL - VC) \quad (14)$$

- Case 4: Shared remuneration system (proportional to profits): In this shared remuneration system, crew members obtain a share of the profits and hence, crew costs are calculated as:

$$LC_4 = share\_rate_4 \cdot NP \quad (15)$$

When we refer to wages in this study, we refer to gross wages (i.e., including social security). This is because net wages would depend on each country's regulations (i.e. taxes), while gross wages are only influenced by the fishing activity. Average gross wage is proportional to the labor costs per unit of effort. The average crew wage at any effort level ( $e$ ) and for each remuneration system ( $w$ ) is equal to the total crew remuneration (labor costs, LC) divided by the crew number ( $crew$ ) (see eq. 16). Crew number is unknown, but it is known to be proportional to effort (eq. 17). Therefore, by combining eqs. 16 and 17, crew wage can be expressed as a function of the labor costs per unit of effort (eq. 18). Hence, crew wages for any remuneration system at any effort level as a function of the current (status quo) wage, which is equal to the fixed wage, can be estimated as a function of labor costs and effort at status quo and at the effort level (eq. 19).

$$wage_{ew} = \frac{LC_{ew}}{crew} \quad (16)$$

$$crew = cE \quad (17)$$

$$wage_{ew} = \frac{LC_{ew}}{cE_e} \quad (18)$$

$$\frac{wage_{ew}}{wage_{sq}} = \frac{LC_{ew}E_{sq}}{E_eLC_{sq}} \quad (19)$$

Since crew wages can increase over the fixed wage in shared remunerations systems (assumed to be equal to the opportunity cost of labor), then labor rent can be created. Labor rent (or crew surplus): is estimated from the difference between crew wages and the opportunity cost of labor:

$$LR = wage_{ew} - ocl \quad (20)$$

$$LR = wage_{ew} - wage_{OA} \quad (21)$$

where *ocl* is the opportunity cost of labor.

## Data

Biologic and economic parameters are estimated from the global marine fisheries model used in the Sunken billions report (Willmann et al. 2008).

Table 2 reports the biological parameters necessary to estimate the logistic function represented in eqs. 1, 2, 3, 4, 5, 6 and 7.

Table 3 reports the economic parameters price and cost per unit of fishing effort (*E* costs) necessary to estimate eqs. 8, 9, 10 and 11. The average landings price depends on the global marine commercial biomass. The model uses a value of 0.2 for the elasticity of demand with respect to biomass (Willmann et al. 2008), which means that if the global biomass doubles, then the landings price increases by 20%.

## Results

Figure 2 summarizes the results obtained in the analysis using the parameters in Tables 2 and 3. A table with all the values is provided in the Appendix.

From Fig. 2 (and Table in the Appendix) it can be observed that the costs trajectories from the different remuneration systems 1, 2 and 3 meet at the current fishing effort level (relative fishing effort level of 1, as can be seen in Table 4), as assumed in the model. While the cost trajectory from remuneration system 4 follows the revenues curve, because it is assumed that there are no profits but all remaining revenues are split between the crew members.

The maximum difference between the costs trajectories from the different remuneration systems and the revenue curve (which equals to the maximum profits point) happens at different effort levels, depending on the remuneration system. While the maximum rents (equal to the gross value added) takes place at the same fishing effort level (relative fishing effort level of 0.45), the same for the maximum revenue (relative

**Table 2** Biological parameters

Variable	Value
K	72.32
r	5.26
q	3.45

Source: own estimations from Sunken Billions report (Willmann et al. 2008)

**Table 3** Economic parameters

Variable	Value
Price	$0.92 + 0.2 \frac{X_e - X_{sq}}{X_{sq}}$
E costs	83.8

Source: Sunken Billions report (Willmann et al. 2008)

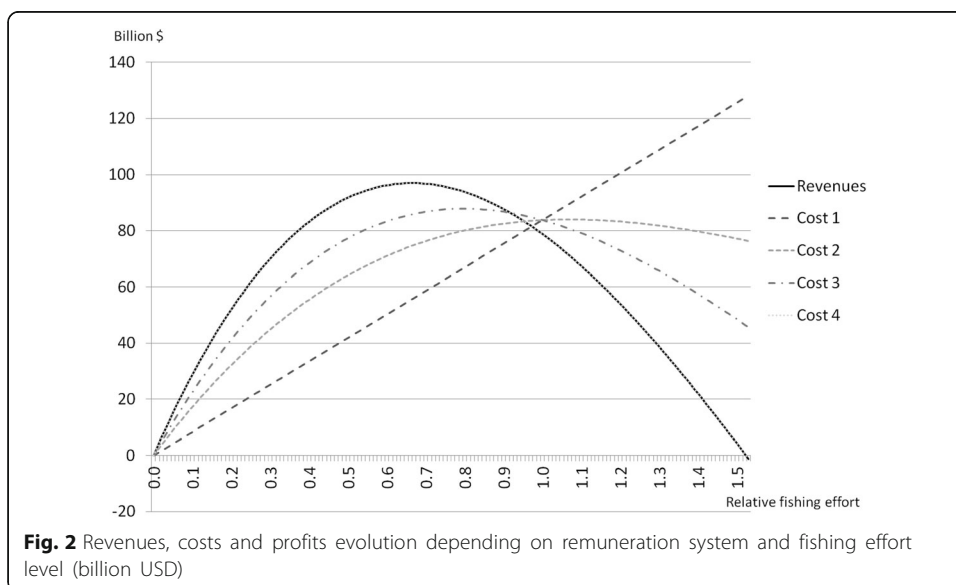
effort level of 0.66), and the maximum harvest (MSY) (relative effort level of 0.76), that take place at the same fishing effort level independently of the remuneration system. The maximum revenue and the maximum production (MSY) do not take place at the same effort level because price increases when the available biomass increases, and consequently when landings decrease. It should be noted that the cost curve in case 4 follows the revenues curve, as it assumes that all profits are split between the crew members.

Thus, Table 4 reports the different relative fishing effort levels at which the different management objectives take place for each remuneration system.

At each management objective, and consequently at its corresponding fishing effort level, different fisheries rents can be obtained. Fisheries rents start from zero when there is no fishing and increase as fishing activity increases up to the MEY level, subsequently decreasing until bioeconomic equilibrium is reached, and rents are again zero (See Table 5).

Fisheries rent are composed of profits (owner rents) and labor rents. Because crew wages increase under shared remuneration systems, crew can capture part of the fisheries rent. The amount of fisheries rent captured by the crew will depend on the remuneration system. Table 6 shows the distribution of fisheries rent between owner and crew at each management objective under the different remuneration systems.

By definition, at the bioeconomic equilibrium level no profits are generated, but labor can still obtain some rents (depending on the opportunity cost of labor assumption). Under a shared remuneration proportional to revenues labor rent would be 4.02 billion dollars, while under a shared remuneration proportional to revenues minus operational



**Fig. 2** Revenues, costs and profits evolution depending on remuneration system and fishing effort level (billion USD)

**Table 4** Effort level for each management objective and remuneration system

		Costs case 1	Costs case 2	Costs case 3	Costs case 4
Max rents (MEY)	A	0.45	0.45	0.45	0.45
Max profits	B	0.45	0.45	0.43	-
Max revenues	C	0.66	0.66	0.66	0.66
MSY	D	0.76	0.76	0.76	0.76
Open access	E	0.97	0.95	0.91	-
Current	F	1.00	1.00	1.00	1.00

costs labor rent would be \$10.72 billion. At MEY, profits under fixed remuneration systems are \$50.34 billion, while labor rent is null; under a shared remuneration proportional to revenues, profits are \$28 billion and labor rent \$22.34 billion; under a shared remuneration proportional to revenues minus operational costs, profits are \$14.75 billion and labor rent \$35.59 billion; and under a shared remuneration proportional (equal) to profits, profits are null and labor rent \$50.34 billion.

Table 7 reports the average crew wages as a function of current wage (equal to fixed wage) per remuneration system and management objective.

Table 7 shows that average crew wages can increase under shared remuneration systems when more restrictive management objectives are achieved (i.e., MSY, MEY), and consequently when fish stocks improve. Thus, when fishing at MSY, wages are a 59, 94 and 93% higher than current level under shared remuneration proportional to revenues, revenues minus operational costs and profits, respectively. Similarly, at MEY average wages are a 148, 236 and 232% higher than current level under shared remuneration proportional to revenues, revenues minus operational costs and profits, respectively.

Average wages increase when fishing effort decreases, and so when stock size (biomass at sea) increases. Consequently, maximum average wages occur at the lowest fishing effort level above zero. Thus, attempting to maximize average crew wages is an unrealistic management objective if not defined for a certain crew number and time period.

## Discussion

Shared remuneration systems have traditionally proven, and continue to prove, useful in fisheries because they provide an incentive to crew when their work is sometimes difficult to monitor. This way, rents and risks are shared between the vessel owner and the crew; the vessel owner does not have to dole out remuneration at fixed levels if catches are low (Acheson 1981; McGoodwin 1991). However, when the economic performance of a fleet increases, crew wages increase significantly and when this happens, the crew are able to capture some of the fishery rents (extraordinary profits).

**Table 5** Total rent evolution (billion USD)

	Costs case 1	Costs case 2	Costs case 3	Costs case 4
MEY	50.34	50.34	50.34	50.34
Max profits	50.34	50.34	50.21	-
Max revenues	41.68	41.68	41.68	41.68
MSY	31.72	31.72	31.72	31.72
Current	-4.95	-4.95	-4.95	-4.95
Open access	0.00	4.02	10.72	-

**Table 6** Profit and labour rent evolution (billion USD)

	Costs case 1	Costs case 2	Costs case 3	Costs case 4
MEY	50.34; 0.00	28.00; 22.34	14.75; 35.59	0.00; 50.34
Max profits	50.34; 0.00	28.00; 22.34	14.78; 35.43	0.00; –
Max revenues	41.68; 0.00	22.57; 19.11	11.25; 30.43	0.00; 41.68
MSY	31.72; 0.00	16.64; 15.08	7.70; 24.02	0.00; 31.72
Current	–4.95; 0.00	–4.95; 0.00	–4.95; 0.00	0.00; –4.95
Open access	0.00; 0.00	0.00; 4.02	0.00; 10.72	0.00; –

In this paper, we compared the fixed remuneration system with three different shared remuneration systems commonly used in fisheries: (1) proportional to revenues, (2) proportional to revenues minus operational costs and (3) proportional to profits. By investigating these three shared remuneration systems with a simple bioeconomic model, we were able to analyze the entire spectrum of shared remuneration systems. The shared remuneration proportional to revenues minus operational costs (case 3) may be the most standard remuneration system in fisheries; while the shared remuneration proportional to revenues (case 2) represents the extreme case where no costs are deducted from revenues and the shared remuneration proportional to profits (case 4) represents the extreme case where all costs are deducted. So, any particular shared remuneration system can be represented, depending on the number of costs items that are deducted from revenues; e.g., if less costs items are deducted than in case 3, then the remuneration system will behave somewhere in the middle between cases 2 and 3.

Results confirm, as shown in the Sunken Billions report (Willmann et al. 2008), that global marine fisheries are underperforming of about \$50 billion per year,<sup>5</sup> and society could capture a substantial part of them by improving fisheries management (e.g., by fishing at maximum rents or MSY points). However, these \$50 billion per year could not be directly translated into profits, because crew members can capture part of the fisheries rent in shared remuneration systems once the economic performance improves. For example, if global fisheries would be managed at MSY, it could be obtained about \$32 billion per year (\$50 billion per year when maximizing rents). If labor would be remunerated with fixed salaries, then these \$32 billion per year would become part of the profits (capital rent); instead if crew are remunerated with shared remuneration systems 2, 3 and 4, then profits would not be \$32 billion per year but \$17 billion, \$8 billion and \$0 billion per year, respectively. The rest of the fisheries rents become part of the labor rents.

Similar results were obtained for the Bay of Biscay *nephrops* fishery where crew members receive a shared salary as in case 3. Guillen et al. (2015) estimated that if

**Table 7** Crew wages as a function of current wage (equal to fixed wage)

	Costs case 1	Costs case 2	Costs case 3	Costs case 4
MEY	1.00	2.48	3.36	3.32
Max profits	1.00	2.48	3.46	-
Max revenues	1.00	1.86	2.38	2.38
MSY	1.00	1.59	1.94	1.93
Current	1.00	1.00	1.00	0.85
Open access	1.00	1.12	1.34	-

the *nephrops* fishery recovers to MSY, salaries would increase by 95% and by 320% if it reaches MEY; while for global marine fisheries, wages would increase by 94 and 236%, respectively.

In shared remuneration systems, labor costs are independent of the crew number, and consequently the average wage depends on the crew number. While in fixed remuneration systems, the average wage is fixed (constant), and so labor costs are proportional to the crew number.

Our results also confirm that the fishing effort required to achieve certain management objectives may be affected by the crew costs, and consequently by the remuneration system in place. Because under shared remuneration systems costs are not proportional to fishing effort, the effort level required to achieve some economic based management objectives (e.g., maximum profits and maximum employment) vary depending on the remuneration systems. While, the effort level required to achieve other management objectives (e.g., MSY and maximum rents) is independent of the remuneration system.

When looking at the bioeconomic equilibrium (open-access point) in Fig. 1, the fixed remuneration is less conservative than the shared remunerations. In other words, the bioeconomic equilibrium is reached at a higher fishing effort level for the fixed remuneration. However, in Guillen et al., (2015), fixed remuneration was found to be more conservative, mainly as a result of the initial value given to the opportunity cost of labor:

- When the fishery is in bioeconomic equilibrium (no profit or losses) and so the opportunity cost of labor is assumed to be equal to the bioeconomic equilibrium salary, then the open access level is the same for all remuneration systems.
- When the fishery is having profits and the opportunity cost of labor is assumed to be higher than the bioeconomic equilibrium salary, then the fixed remuneration is less conservative.
- When the fishery is having losses and the opportunity cost of labor is assumed to be lower than the bioeconomic equilibrium salary, then the fixed remuneration is more conservative.

Similarly, maximum profits are achieved at different fishing effort levels. When it is assumed that the fisheries follow a logistic model, the fixed salaries are the less conservative. Instead, then a different behavior of the fishery is assumed, as in Guillen et al., (2015), where a hockey stick model is used, then the fixed salaries were more conservative.

In addition, since in most common shared remuneration systems (case 2 and 3) the fishing effort that maximizes profits is different than the one that maximizes labor rents; consequently, there is a principal-agent problem if vessel owners are not present in the fishing vessels (Eisenhardt 1989; Vestergaard 2010). When a vessel owner is not present, crew would prefer to increase their fishing effort, if they do not have to bear the operational costs, in order to increase their revenues. However, in the global perspective, taking into account the shared remuneration systems analyzed, when vessel owners are not present, crew would prefer to reduce overall fishing effort in order to maximize their rents. Moreover, in shared remuneration systems where only the vessel owner bears the capital and investment costs (cases 2 and 3), Hannesson (2007) showed that it could lead to non-optimal (i.e., lower) levels of investment. Indeed, in many



fisheries, vessel owners pay all investment costs, but the crew receives part of the increases in catch that result (Alexander 1973).

The share rate and the costs items that are deducted to the value of landings may change between countries, fleets, fisheries and vessels, as well as over time. For example, in the Netherlands, mainly fuel cost is deducted to the value of landings (Bartelings et al. 2015); while in France and Spain fuel, ice, food, and bait costs are commonly deducted (Lleonart et al. 1999, 2003; Maynou et al. 2006; Macher et al. 2008). Same happens for quota costs; in Iceland and Australia quota costs are often borne entirely by the vessel owner while in the UK quota costs are shared between the owner and the crew, along with other variable operating costs (Hatcher 2010). Moreover, sometimes costs items deducted from revenues and share rates may vary between vessels in the same fleet. Indeed, in the Bering Sea/Aleutian Island crab fisheries, about 80% of the vessels share quota costs with the crew, while about 20% do not (see Abbott et al. 2010 for more examples for that particular US fishery).

The analysis assumes a fixed share rate of the crew part. But the share rate can change if there are significant changes in the fishing conditions: (i) important new investments (e.g., electronic equipment, introduction of steam-driven fishing vessels in the Basque Country in Spain led to decrease the crew share to 30% - Pascual Fernandez 1999), (ii) significant variations in fuel prices (Matthiasson 1997), (iii) changes in management (i.e., introduction of ITQs (Squires et al. 1995; Guyader and Thebaud 2001)). Thus, the share remuneration systems have proven to be a self-adaptive and time-consistent remuneration system that can adapt to changing circumstances (Hämäläinen et al. 1990; McConnell and Price 2006).

So, the share rate could be adjusted either by vessel owners to capture a larger part of the rents or to keep the crew during the bad years. It could be thus possible that once a stock starts recovering, vessel owners change the share rate to increase the vessel owner share (and consequently decrease the crew share), in order to capture more rent once crew wages start to increase. If the share rate could be continually revised to reflect equilibrium in the labor market, the crew would always get the opportunity cost of their labor (Hannesson 2007), and consequently results would be similar to the ones obtained assuming constant wages. This way, the share system would still serve the purpose of an incentive contract to ensure that crew members exert the necessary effort to obtain a wage equal to their opportunity wage (Hannesson 2007). While the vessels owners would capture all the rents (i.e. accumulate all the capital).

However, there are also cases where the share rate has not been revised despite significant changes in a fishery. For example, with the implementation of catch shares in the Bering Sea/Aleutian Island crab fisheries, the share rate has remained practically unchanged leading to substantial increases in the remuneration for many crew members (Abbott et al. 2010). Therefore, whether a remuneration system in a fishery behaves as fixed or shared, and consequently the possibility for the crew to capture part of the vessel owners rent, depends in part on the fixity of the share rate, and so on the negotiation capacity of each of the parts.

However, in recent years, an increase in the use of the fixed remuneration systems worldwide has been observed (Thuy et al. 2013; Ünal personal communication). This is mainly a result of lower and more uncertain catches and revenues, as stocks are becoming more overexploited. Increased stock overexploitation and overcapacity (fishing

effort level increases, i.e., moving rightwards in Fig. 1) lead to lower wages and so more difficulties to find crew when wages are below the opportunity cost of labor. In that case, crew would switch jobs to their best alternative job possible. In this sense, Willmann et al. (2008) reported that more than 75% of the fish stocks were underperforming in economic terms in 2004, leading to \$5 billion losses (without accounting for the potential of global fisheries). Accordingly, FAO (2014a) reports that the number of stocks fished at unsustainable biologic levels peaked at 32.5% in 2008, since then declined slightly to 28.8% in 2011.

The current low salaries<sup>6</sup> in the fishing sector also explain the increasing use of foreign and unskilled crew in many fisheries worldwide. Foreign crew is often more risk averse as fishing is often the sole source of income, and so would prefer fix wages (Nguyen and Leung 2009). In addition, due to the low wages it is difficult to find skilled labor, and so is replaced with unskilled labor. In these circumstances, vessel owners are also not willing to pay more for unskilled labor; while the availability of unemployed unskilled labor also works as an incentive for crew to work hard. Thus, the increase of fish stocks being overfished worldwide (Worm et al. 2009; FAO 2014a), the increasing use of foreign manpower and the industrialization of fishing fleets may reduce the use of shared remuneration systems.

Shared remuneration systems have a general functioning more similar to conventional remuneration systems where workers are paid a piece rate (an amount of money that relates to their output), rather than the time they input (i.e., fixed remuneration systems). In addition, in shared remuneration systems the crew share is often divided between the crew in a non-homogenous way where crew receive different wages based on their ranks or grades. Hence, wages reflect differences in marginal productivity inside the crew. In some fisheries, crew members may receive higher wages on the basis of age and experience (Breton 1973); while, in other cases all crew equally receive the same amount, regardless of experience (Lofgren 1972; Colloca et al. 2003). In some fisheries, mostly artisanal ones, if a crew member owns the fishing gear, he/she may obtain a larger part of the share (McCall Howard 2012). When fishing success depends on highly skilled specialists, these specialists may receive a higher percentage of the catch (Prins 1965; Wadel 1972). For example, in the Moroccan purse-seine fishery, the captain receives on average 4.5 times the wage of normal fishermen (deckhand), the mechanic 2.37 times, the person in charge to mend the nets 2 times, and the cook 1.25 times the wage of a deckhand (see Kamili (2006) for a more detailed explanation). Purse-seiners in Greece remunerate the captain and the mechanic with 2.5 times the wage of deckhand each, and crew knowing how to mend nets and on the stern receive 1.5 times more. While in Brazil, on an 18-tonne vessel, the captain receives on average 4.5 times, the mechanic 2.5 times, and the cook 1.5 times the wage of deckhand (Giasson 1981). So, the division of the crew share among the crew members behaves as a tournament contract where crew members are rewarded by their rank in the organization (Lazear and Rosen 1981; Green and Stockey 1983).

## Conclusions

If a more rational fisheries management is in place and stocks recover, this may not be fully translated in an increase in the profitability of the fishing sector. In

fact, in most fisheries worldwide, crew members are remunerated through different shared remuneration systems rather than a fixed wage. In shared remuneration systems, crew wages can be significantly higher than fixed wages (i.e., more than double) when the stocks and consequently the economic performance of vessels improve. This leads the crew to capture part of the fisheries rents as crew rents. These particular remuneration systems suit the needs of the fishing sector by providing incentives to the workers, which probably has been the historical reason for its wide adoption and maintenance.

However, the use of the shared remuneration systems worldwide appears to have decreased in recent years because of lower and more uncertain catches and revenues due to overfished fish stocks (Worm et al. 2009; FAO 2014a), the industrialization of fishing fleets (Thuy et al. 2013; Ünal personal communication), increases in fuel prices that lower the economic performance, and the difficulties to find and attract crew.

Hence, it is important to understand the particularities and variety of the shared remuneration systems in the fishing sector and the implications the remuneration systems have on crew wages, the firm's economic performance and the optimal fishing effort level.

## Endnotes

<sup>1</sup>When assuming prices to be constant in relation to quantity landed and size of the individuals landed

<sup>2</sup>It is also an extended practice worldwide that the crew receives a small fraction of the catch. Depending on the country and fishery, this fraction of the catch could be a part of the main species or based on low value species or small size and damaged individuals. It is called "morralla" in Spain (Alemany and Álvarez 2003; Reglero and Morales-Nin 2008; Samy-Kamal et al. 2014) and Cuba (Baisre 2000), "godaille" in France (Jorion 1979; Del Sol et al. 1998), French Guyana (Guéguen 2001) and Martinique (Failler 1996), and "fakira" in Morocco (Baddy and Guénette 2002; Kamili 2006).

<sup>3</sup>From ILO (2004) it seems that to the proportion of the catch sale could be also deducted operational costs.

<sup>4</sup>The distinction between remuneration of labour and remuneration of the invested capital is not systematic for many units, especially for those in which the owner is also the fisher onboard (Boncoeur et al. 2000) which is the case for most small scale fleets in Europe (Guyader et al. 2013) and worldwide (Thuy et al. 2013).

<sup>5</sup>As pointed out by Willmann et al. (2008), losses to the global economy from unsustainable exploitation of living marine resources substantially exceed these estimates. These estimates exclude losses related to recreational fisheries, marine tourism and illegal fishing, as well as the economic contribution of dependent activities such as fish processing, distribution, and consumption. It also excludes the value of biodiversity losses, pollution and greenhouse gas emissions.

<sup>6</sup>In some countries, wages in the fisheries sector have been below the minimum legal salary during some months. It should be also taken into account the wages by hour at sea, considering the long time spent onboard together with the harsh and risky working conditions, instead of absolute wages per year.

**Appendix**

**Table 8** Summary of the outputs obtained

Fishing effort	Harvest (Million tons)	Revenues (Billion \$)	Operational costs (35%) (Billion \$)	Fixed costs (25%) (Billion \$)	Labour costs: case 1 (40%) (Billion \$)	Labour costs: case 2 (Billion \$)	Labour costs: case 3 (Billion \$)	Labour costs: case 4 (Billion \$)	Labour costs: case 1 (Billion \$)	Labour costs: case 2 (Billion \$)	Labour costs: case 3 (Billion \$)	Labour costs: case 4 (Billion \$)	Total Costs: Case 1 (Billion \$)	Total Costs: Case 2 (Billion \$)	Total Costs: Case 3 (Billion \$)	Total Costs: Case 4 (Billion \$)	Profits: case 1 (Billion \$)	Profits: case 2 (Billion \$)
0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.01	2.5	3.1	0.3	0.2	0.3	1.3	1.9	1.8	0.8	1.8	2.4	3.1	0.8	1.8	2.4	3.1	2.3	1.3
0.02	4.9	6.2	0.6	0.4	0.7	2.6	3.8	3.5	1.7	3.7	4.8	6.2	1.7	3.7	4.8	6.2	4.5	2.6
0.03	7.3	9.2	0.9	0.6	1.0	3.9	5.7	5.2	2.5	5.4	7.2	9.2	2.5	5.4	7.2	9.2	6.7	3.8
0.04	9.7	12.2	1.2	0.8	1.3	5.2	7.5	6.9	3.4	7.2	9.5	12.2	3.4	7.2	9.5	12.2	8.9	5.0
0.05	12.1	15.1	1.5	1.0	1.7	6.4	9.2	8.6	4.2	8.9	11.8	15.1	4.2	8.9	11.8	15.1	10.9	6.2
0.06	14.4	18.0	1.8	1.3	2.0	7.6	11.0	10.2	5.0	10.7	14.0	18.0	5.0	10.7	14.0	18.0	12.9	7.3
0.07	16.7	20.8	2.1	1.5	2.3	8.8	12.7	11.8	5.9	12.3	16.2	20.8	5.9	12.3	16.2	20.8	14.9	8.4
0.08	18.9	23.5	2.3	1.7	2.7	10.0	14.3	13.4	6.7	14.0	18.3	23.5	6.7	14.0	18.3	23.5	16.8	9.5
0.09	21.1	26.2	2.6	1.9	3.0	11.1	15.9	14.9	7.5	15.7	20.5	26.2	7.5	15.7	20.5	26.2	18.6	10.5
0.10	23.3	28.8	2.9	2.1	3.4	12.2	17.5	16.4	8.4	17.3	22.5	28.8	8.4	17.3	22.5	28.8	20.4	11.5
0.11	25.5	31.4	3.2	2.3	3.7	13.3	19.1	17.9	9.2	18.9	24.6	31.4	9.2	18.9	24.6	31.4	22.2	12.5
0.12	27.6	33.9	3.5	2.5	4.0	14.4	20.6	19.3	10.1	20.4	26.6	33.9	10.1	20.4	26.6	33.9	23.8	13.5
0.13	29.7	36.4	3.8	2.7	4.4	15.5	22.0	20.7	10.9	22.0	28.6	36.4	10.9	22.0	28.6	36.4	25.5	14.4
0.14	31.7	38.8	4.1	2.9	4.7	16.5	23.5	22.1	11.7	23.5	30.5	38.8	11.7	23.5	30.5	38.8	27.0	15.2
0.15	33.7	41.1	4.4	3.1	5.0	17.5	24.8	23.5	12.6	25.0	32.4	41.1	12.6	25.0	32.4	41.1	28.5	16.1
0.16	35.7	43.4	4.7	3.4	5.4	18.5	26.2	24.8	13.4	26.5	34.2	43.4	13.4	26.5	34.2	43.4	30.0	16.9
0.17	37.7	45.6	5.0	3.6	5.7	19.4	27.5	26.1	14.2	27.9	36.1	45.6	14.2	27.9	36.1	45.6	31.4	17.7
0.18	39.6	47.8	5.3	3.8	6.0	20.3	28.8	27.4	15.1	29.4	37.9	47.8	15.1	29.4	37.9	47.8	32.8	18.4
0.19	41.5	50.0	5.6	4.0	6.4	21.2	30.1	28.6	15.9	30.8	39.6	50.0	15.9	30.8	39.6	50.0	34.1	19.2
0.20	43.3	52.0	5.9	4.2	6.7	22.1	31.3	29.8	16.8	32.2	41.3	52.0	16.8	32.2	41.3	52.0	35.3	19.9

**Table 8** Summary of the outputs obtained (Continued)

0.21	45.2	54.1	6.2	4.4	7.0	23.0	32.4	31.0	17.6	33.5	43.0	54.1	36.5	20.5
0.22	47.0	56.1	6.4	4.6	7.4	23.8	33.6	32.1	18.4	34.9	44.6	56.1	37.6	21.2
0.23	48.7	58.0	6.7	4.8	7.7	24.7	34.7	33.2	19.3	36.2	46.2	58.0	38.7	21.8
0.24	50.4	59.9	7.0	5.0	8.0	25.4	35.8	34.3	20.1	37.5	47.8	59.9	39.8	22.3
0.25	52.1	61.7	7.3	5.2	8.4	26.2	36.8	35.4	20.9	38.8	49.4	61.7	40.7	22.9
0.26	53.8	63.5	7.6	5.4	8.7	27.0	37.8	36.4	21.8	40.0	50.9	63.5	41.7	23.4
0.27	55.4	65.2	7.9	5.7	9.0	27.7	38.8	37.4	22.6	41.3	52.3	65.2	42.6	23.9
0.28	57.0	66.9	8.2	5.9	9.4	28.4	39.7	38.4	23.5	42.5	53.8	66.9	43.4	24.4
0.29	58.6	68.5	8.5	6.1	9.7	29.1	40.6	39.3	24.3	43.7	55.2	68.5	44.2	24.8
0.30	60.1	70.1	8.8	6.3	10.1	29.8	41.5	40.2	25.1	44.9	56.5	70.1	44.9	25.2
0.31	61.6	71.6	9.1	6.5	10.4	30.4	42.3	41.1	26.0	46.0	57.9	71.6	45.6	25.6
0.32	63.1	73.1	9.4	6.7	10.7	31.1	43.1	41.9	26.8	47.1	59.2	73.1	46.3	25.9
0.33	64.5	74.5	9.7	6.9	11.1	31.7	43.9	42.7	27.6	48.3	60.5	74.5	46.9	26.2
0.34	65.9	75.9	10.0	7.1	11.4	32.3	44.6	43.5	28.5	49.3	61.7	75.9	47.4	26.5
0.35	67.3	77.2	10.3	7.3	11.7	32.8	45.3	44.3	29.3	50.4	62.9	77.2	47.9	26.8
0.36	68.6	78.5	10.6	7.5	12.1	33.4	46.0	45.0	30.2	51.5	64.1	78.5	48.3	27.0
0.37	69.9	79.7	10.8	7.7	12.4	33.9	46.6	45.7	31.0	52.5	65.2	79.7	48.8	27.2
0.38	71.16	80.9	11.1	8.0	12.7	34.4	47.3	46.3	31.8	53.5	66.3	80.9	49.1	27.4
0.39	72.39	82.1	11.4	8.2	13.1	34.9	47.8	47.0	32.7	54.5	67.4	82.1	49.4	27.6
0.40	73.6	83.2	11.7	8.4	13.4	35.4	48.4	47.6	33.5	55.5	68.5	83.2	49.7	27.7
0.41	74.8	84.2	12.0	8.6	13.7	35.8	48.9	48.1	34.3	56.4	69.5	84.2	49.9	27.8
0.42	75.9	85.3	12.3	8.8	14.1	36.2	49.4	48.7	35.2	57.4	70.5	85.3	50.1	27.9
0.43	77.0	86.2	12.6	9.0	14.4	36.7	49.8	49.2	36.0	58.3	71.4	86.2	50.2	28.0
0.44	78.1	87.1	12.9	9.2	14.7	37.1	50.3	49.7	36.9	59.2	72.4	87.1	50.3	28.0
0.45	79.1	88.0	13.2	9.4	15.1	37.4	50.7	50.1	37.7	60.0	73.3	88.0	50.3	28.0

**Table 8** Summary of the outputs obtained (Continued)

0.46	80.1	88.9	13.5	9.6	15.4	37.8	51.0	50.5	38.5	60.9	74.1	88.9	50.3	28.0
0.47	81.1	89.7	13.8	9.8	15.7	38.1	51.4	50.9	39.4	61.7	75.0	89.7	50.3	27.9
0.48	82.0	90.4	14.1	10.1	16.1	38.4	51.7	51.3	40.2	62.6	75.8	90.4	50.2	27.9
0.49	82.9	91.1	14.4	10.3	16.4	38.7	52.0	51.6	41.0	63.4	76.6	91.1	50.1	27.8
0.50	83.8	91.8	14.7	10.5	16.8	39.0	52.2	51.9	41.9	64.1	77.3	91.8	49.9	27.6
0.51	84.6	92.4	14.9	10.7	17.1	39.3	52.4	52.2	42.7	64.9	78.1	92.4	49.7	27.5
0.52	85.4	93.0	15.2	10.9	17.4	39.5	52.6	52.4	43.6	65.7	78.8	93.0	49.4	27.3
0.53	86.2	93.5	15.5	11.1	17.8	39.8	52.8	52.6	44.4	66.4	79.4	93.5	49.1	27.1
0.54	87.0	94.0	15.8	11.3	18.1	40.0	52.9	52.8	45.2	67.1	80.1	94.0	48.8	26.9
0.55	87.7	94.5	16.1	11.5	18.4	40.2	53.0	53.0	46.1	67.8	80.7	94.5	48.4	26.7
0.56	88.4	94.9	16.4	11.7	18.8	40.3	53.1	53.1	46.9	68.5	81.3	94.9	48.0	26.4
0.57	89.0	95.3	16.7	11.9	19.1	40.5	53.2	53.2	47.7	69.2	81.8	95.3	47.5	26.1
0.58	89.6	95.6	17.0	12.1	19.4	40.7	53.2	53.2	48.6	69.8	82.4	95.6	47.0	25.8
0.59	90.2	95.9	17.3	12.4	19.8	40.8	53.2	53.3	49.4	70.4	82.9	95.9	46.5	25.5
0.60	90.7	96.2	17.6	12.6	20.1	40.9	53.2	53.3	50.3	71.0	83.4	96.2	45.9	25.1
0.61	91.2	96.4	17.9	12.8	20.4	41.0	53.2	53.2	51.1	71.6	83.8	96.4	45.3	24.8
0.62	91.7	96.6	18.2	13.0	20.8	41.1	53.1	53.2	51.9	72.2	84.2	96.6	44.7	24.4
0.63	92.2	96.7	18.5	13.2	21.1	41.1	53.0	53.1	52.8	72.8	84.6	96.7	44.0	24.0
0.64	92.6	96.8	18.8	13.4	21.4	41.2	52.9	53.0	53.6	73.3	85.0	96.8	43.2	23.5
0.65	93.0	96.9	19.1	13.6	21.8	41.2	52.7	52.8	54.4	73.9	85.4	96.9	42.5	23.1
0.66	93.3	97.0	19.3	13.8	22.1	41.2	52.5	52.6	55.3	74.4	85.7	97.0	41.68	22.57
0.67	93.6	97.0	19.6	14.0	22.4	41.2	52.3	52.4	56.1	74.9	86.0	97.0	40.8	22.1
0.68	93.9	96.9	19.9	14.2	22.8	41.2	52.1	52.2	57.0	75.4	86.3	96.9	40.0	21.5
0.69	94.2	96.8	20.2	14.4	23.1	41.2	51.9	51.9	57.8	75.8	86.5	96.8	39.1	21.0
0.70	94.4	96.7	20.5	14.7	23.5	41.1	51.6	51.6	58.6	76.3	86.8	96.7	38.1	20.4

**Table 8** Summary of the outputs obtained (Continued)

0.71	946	966	208	14.9	23.8	41.1	51.3	51.3	51.3	595	76.7	87.0	96.6	37.1	19.9
0.72	947	964	21.1	15.1	24.1	41.0	51.0	51.0	50.9	60.3	77.2	87.2	96.4	36.1	19.2
0.73	948	962	21.4	15.3	24.5	40.9	50.6	50.6	50.5	61.1	77.6	87.3	96.2	35.1	18.6
0.74	949	960	21.7	15.5	24.8	40.8	50.3	50.3	50.1	62.0	78.0	87.5	96.0	34.0	18.0
0.75	9499	957	22.0	15.7	25.1	40.7	49.9	49.9	49.7	62.8	78.4	87.6	95.7	32.9	17.3
0.76	9501	954	22.3	15.9	25.5	40.5	49.5	49.5	49.2	63.7	78.7	87.7	95.4	31.7	16.6
0.77	9500	950	22.6	16.1	25.8	40.4	49.1	49.1	48.7	64.5	79.1	87.7	95.0	30.5	15.9
0.78	9495	947	22.9	16.3	26.1	40.2	48.6	48.6	48.1	65.3	79.4	87.8	94.7	29.3	15.2
0.79	949	942	23.2	16.5	26.5	40.1	48.1	48.1	47.5	66.2	79.8	87.8	94.2	28.1	14.5
0.80	948	938	23.5	16.8	26.8	39.9	47.6	47.6	46.9	67.0	80.1	87.8	93.8	26.8	13.7
0.81	946	933	23.7	17.0	27.1	39.7	47.1	47.1	46.3	67.8	80.4	87.8	93.3	25.5	12.9
0.82	945	928	24.0	17.2	27.5	39.5	46.6	46.6	45.6	68.7	80.7	87.8	92.8	24.1	12.2
0.83	942	923	24.3	17.4	27.8	39.2	46.0	46.0	44.9	69.5	80.9	87.7	92.3	22.8	11.3
0.84	940	917	24.6	17.6	28.1	39.0	45.4	45.4	44.2	70.4	81.2	87.6	91.7	21.4	10.5
0.85	937	911	24.9	17.8	28.5	38.7	44.8	44.8	43.5	71.2	81.5	87.5	91.1	19.9	9.7
0.86	934	905	25.2	18.0	28.8	38.5	44.2	44.2	42.7	72.0	81.7	87.4	90.5	18.5	8.8
0.87	931	898	25.5	18.2	29.1	38.2	43.6	43.6	41.9	72.9	81.9	87.3	89.8	17.0	7.9
0.88	927	892	25.8	18.4	29.5	37.9	42.9	42.9	41.0	73.7	82.1	87.1	89.2	15.5	7.0
0.89	923	884	26.1	18.6	29.8	37.6	42.2	42.2	40.2	74.5	82.3	86.9	88.4	13.9	6.1
0.90	919	877	26.4	18.8	30.2	37.3	41.5	41.5	39.2	75.4	82.5	86.7	87.7	12.3	5.2
0.91	914	869	26.7	19.1	30.5	37.0	40.8	40.8	38.3	76.2	82.7	86.5	86.9	10.7	4.2
0.92	909	861	27.0	19.3	30.8	36.6	40.1	40.1	37.3	77.1	82.9	86.3	86.1	9.1	3.3
0.93	904	853	27.3	19.5	31.2	36.3	39.3	39.3	36.4	77.9	83.0	86.0	85.3	7.4	2.3
0.94	898	845	27.6	19.7	31.5	35.9	38.5	38.5	35.3	78.7	83.1	85.8	84.5	5.7	1.3
0.95	892	836	27.8	19.9	31.8	35.5	37.7	37.7	34.3	79.6	83.3	85.5	83.6	4.0	0.3

**Table 8** Summary of the outputs obtained (Continued)

0.96	886	82.7	28.1	20.1	32.2	35.1	36.9	33.2	80.4	83.4	85.2	82.7	2.3	-0.7
0.97	879	81.7	28.4	20.3	32.5	34.8	36.1	32.1	81.2	83.5	84.8	81.7	0.5	-1.8
0.98	872	80.8	28.7	20.5	32.8	34.3	35.2	30.9	82.1	83.6	84.5	80.8	-1.3	-2.8
0.99	865	79.8	29.0	20.7	33.2	33.9	34.4	29.8	82.9	83.7	84.1	79.8	-3.1	-3.9
1.00	857	78.8	29.3	20.9	33.5	33.5	33.5	28.5	83.753	83.8	83.8	78.8	-5.0	-5.0
1.01	849	77.8	29.6	21.1	33.8	33.1	32.6	27.3	84.6	83.8	83.4	77.8	-6.8	-6.0
1.02	841	76.7	29.9	21.4	34.2	32.6	31.7	26.0	85.4	83.9	82.9	76.7	-8.7	-7.2
1.03	832	75.6	30.2	21.6	34.5	32.2	30.8	24.8	86.3	83.9	82.5	75.6	-10.6	-8.3
1.04	823	74.5	30.5	21.8	34.8	31.7	29.8	23.4	87.1	83.9	82.1	74.5	-12.6	-9.4
1.05	814	73.4	30.8	22.0	35.2	31.2	28.9	22.1	87.9	84.0	81.6	73.4	-14.5	-10.6
1.06	804	72.3	31.1	22.2	35.5	30.7	27.9	20.7	88.8	84.0	81.1	72.3	-16.5	-11.7
1.07	794	71.1	31.4	22.4	35.8	30.2	26.9	19.3	89.6	84.0	80.7	71.1	-18.5	-12.9
1.08	784	69.9	31.7	22.6	36.2	29.7	25.9	17.8	90.5	84.0	80.2	69.9	-20.6	-14.1
1.09	773	68.7	32.0	22.8	36.5	29.2	24.9	16.3	91.3	84.0	79.6	68.7	-22.6	-15.3
1.10	763	67.4	32.2	23.0	36.9	28.7	23.8	14.8	92.1	83.9	79.1	67.4	-24.7	-16.5
1.11	751	66.2	32.5	23.2	37.2	28.1	22.8	13.3	93.0	83.9	78.5	66.2	-26.8	-17.7
1.12	740	64.9	32.8	23.5	37.5	27.6	21.7	11.7	93.8	83.9	78.0	64.9	-28.9	-19.0
1.13	728	63.6	33.1	23.7	37.9	27.0	20.6	10.1	94.6	83.8	77.4	63.6	-31.0	-20.2
1.14	716	62.3	33.4	23.9	38.2	26.5	19.5	8.5	95.5	83.8	76.8	62.3	-33.2	-21.5
1.15	703	60.9	33.7	24.1	38.5	25.9	18.4	6.8	96.3	83.7	76.2	60.9	-35.4	-22.8
1.16	690	59.6	34.0	24.3	38.9	25.3	17.3	5.2	97.2	83.6	75.6	59.6	-37.6	-24.0
1.17	677	58.2	34.3	24.5	39.2	24.7	16.2	3.4	98.0	83.5	75.0	58.2	-39.8	-25.3
1.18	663	56.8	34.6	24.7	39.5	24.1	15.0	1.7	98.8	83.4	74.3	56.8	-42.0	-26.6
1.19	649	55.4	34.9	24.9	39.9	23.5	13.9	-0.1	99.7	83.3	73.7	55.4	-44.3	-28.0
1.20	635	53.9	35.2	25.1	40.2	22.9	12.7	-1.9	100.5	83.2	73.0	53.9	-46.6	-29.3



**Table 8** Summary of the outputs obtained (Continued)

1.21	62.1	52.5	35.5	25.3	40.5	22.3	11.5	-3.7	101.3	83.1	72.3	52.5	-488	-306
1.22	60.6	51.0	35.8	25.5	40.9	21.7	10.3	-5.6	102.2	83.0	71.6	51.0	-51.2	-320
1.23	59.1	49.5	36.1	25.8	41.2	21.1	9.1	-7.5	103.0	82.9	70.9	49.5	-53.5	-333
1.24	57.5	48.0	36.3	26.0	41.5	20.4	7.9	-9.4	103.9	82.7	70.2	48.0	-55.8	-347
1.25	55.9	46.5	36.6	26.2	41.9	19.8	6.7	-11.4	104.7	82.6	69.5	46.5	-58.2	-361
1.26	54.3	45.0	36.9	26.4	42.2	19.1	5.4	-13.4	105.5	82.4	68.8	45.0	-60.5	-375
1.27	52.7	43.4	37.2	26.6	42.5	18.5	4.2	-15.4	106.4	82.3	68.0	43.4	-62.9	-389
1.28	51.0	41.9	37.5	26.8	42.9	17.8	2.9	-17.4	107.2	82.1	67.3	41.9	-65.3	-403
1.29	49.3	40.3	37.8	27.0	43.2	17.1	1.7	-19.5	108.0	82.0	66.5	40.3	-67.8	-417
1.30	47.5	38.7	38.1	27.2	43.6	16.4	0.4	-21.6	108.9	81.8	65.7	38.7	-70.2	-43.1
1.31	45.7	37.1	38.4	27.4	43.9	15.8	-0.9	-23.8	109.7	81.6	64.9	37.1	-72.6	-44.5
1.32	43.9	35.5	38.7	27.6	44.2	15.1	-2.2	-25.9	110.6	81.4	64.1	35.5	-75.1	-46.0
1.33	42.1	33.8	39.0	27.8	44.6	14.4	-3.5	-28.1	111.4	81.2	63.3	33.8	-77.6	-47.4
1.34	40.2	32.2	39.3	28.1	44.9	13.7	-4.8	-30.4	112.2	81.0	62.5	32.2	-80.1	-48.8
1.35	38.3	30.5	39.6	28.3	45.2	13.0	-6.1	-32.6	113.1	80.8	61.7	30.5	-82.6	-50.3
1.36	36.4	28.8	39.9	28.5	45.6	12.3	-7.5	-34.9	113.9	80.6	60.9	28.8	-85.1	-51.8
1.37	34.4	27.1	40.2	28.7	45.9	11.5	-8.8	-37.2	114.7	80.4	60.0	27.1	-87.6	-53.2
1.38	32.4	25.4	40.5	28.9	46.2	10.8	-10.2	-39.6	115.6	80.2	59.2	25.4	-90.1	-54.7
1.39	30.3	23.7	40.7	29.1	46.6	10.1	-11.5	-42.0	116.4	79.9	58.3	23.7	-92.7	-56.2
1.40	28.3	22.0	41.0	29.3	46.9	9.4	-12.9	-44.4	117.3	79.7	57.5	22.0	-95.2	-57.7
1.41	26.1	20.3	41.3	29.5	47.2	8.6	-14.3	-46.8	118.1	79.5	56.6	20.3	-97.8	-59.2
1.42	24.0	18.5	41.6	29.7	47.6	7.9	-15.6	-49.3	118.9	79.2	55.7	18.5	-100.4	-60.7
1.43	21.8	16.8	41.9	29.9	47.9	7.1	-17.0	-51.8	119.8	79.0	54.8	16.8	-103.0	-62.2
1.44	19.6	15.0	42.2	30.2	48.2	6.4	-18.4	-54.3	120.6	78.7	53.9	15.0	-105.6	-63.7
1.45	17.4	13.2	42.5	30.4	48.6	5.6	-19.8	-56.9	121.4	78.5	53.1	13.2	-108.2	-65.3

**Table 8** Summary of the outputs obtained (Continued)

Fishing effort	Profits: case 3 (Billion \$)	Profits: case 4 (Billion \$)	Labour rents: case 1 (Billion \$)	Labour rents: case 2 (Billion \$)	Labour rents: case 3 (Billion \$)	Labour rents: case 4 (Billion \$)	Labour rents: case 1 proportional to Effort ('000 €)	Labour rents: case 2 proportional to Effort ('000 €)	Labour rents: case 3 proportional to Effort ('000 €)	Labour rents: case 4 proportional to Effort ('000 €)	Salary: case 1 (case 1 = 100) (%)	Salary: case 2 (case 1 = 100) (%)	Salary: case 3 (case 1 = 100) (%)	Salary: case 4 (case 1 = 100) (%)
1.46	15.1	11.5	42.8	30.6	48.9	4.9	-21.2	-59.5	122.3	78.2	52.1	11.5	-110.8	-66.8
1.47	12.8	9.7	43.1	30.8	49.2	4.1	-22.6	-62.1	123.1	78.0	51.2	9.7	-113.5	-68.3
1.48	10.5	7.9	43.4	31.0	49.6	3.3	-24.0	-64.7	124.0	77.7	50.3	7.9	-116.1	-69.9
1.49	8.1	6.1	43.7	31.2	49.9	2.6	-25.5	-67.4	124.8	77.4	49.4	6.1	-118.7	-71.4
1.50	5.7	4.2	44.0	31.4	50.3	1.8	-26.9	-70.1	125.6	77.2	48.5	4.2	-121.4	-72.9
1.51	3.3	2.4	44.3	31.6	50.6	1.0	-28.3	-72.9	126.5	76.9	47.6	2.4	-124.1	-74.5
1.52	0.8	0.6	44.6	31.8	50.9	0.2	-29.8	-75.7	127.3	76.6	46.6	0.6	-126.7	-76.0
1.53	-1.7	-1.2	44.8	32.0	51.3	-0.5	-31.2	-78.5	128.1	76.4	45.7	-1.2	-129.4	-77.6
0.00	0.0	0.0	0.0	0.0	0.0	0.0								
0.01	0.7	0.0	0.0	1.0	1.6	2.3	33.5	133.6	192.8	177.7	100.0	398.7	575.6	530.3
0.02	1.4	0.0	0.0	2.0	3.1	4.5	33.5	132.3	190.8	176.1	100.0	394.9	569.6	525.8
0.03	2.1	0.0	0.0	2.9	4.7	6.7	33.5	131.1	188.9	174.6	100.0	391.2	563.7	521.3
0.04	2.7	0.0	0.0	3.9	6.1	8.9	33.5	129.8	186.9	173.1	100.0	387.5	557.8	516.8
0.05	3.4	0.0	0.0	4.8	7.6	10.9	33.5	128.6	184.9	171.6	100.0	383.8	552.0	512.3
0.06	4.0	0.0	0.0	5.6	9.0	12.9	33.5	127.4	183.0	170.1	100.0	380.2	546.1	507.8
0.07	4.6	0.0	0.0	6.5	10.3	14.9	33.5	126.1	181.0	168.6	100.0	376.5	540.3	503.3
0.08	5.2	0.0	0.0	7.3	11.6	16.8	33.5	124.9	179.1	167.1	100.0	372.8	534.5	498.8
0.09	5.7	0.0	0.0	8.1	12.9	18.6	33.5	123.7	177.1	165.6	100.0	369.2	528.7	494.3
0.10	6.3	0.0	0.0	8.9	14.2	20.4	33.5	122.5	175.2	164.1	100.0	365.6	522.9	489.8
0.11	6.8	0.0	0.0	9.7	15.4	22.2	33.5	121.3	173.3	162.6	100.0	362.0	517.2	485.3
0.12	7.3	0.0	0.0	10.4	16.5	23.8	33.5	120.1	171.4	161.1	100.0	358.4	511.5	480.8

**Table 8** Summary of the outputs obtained (Continued)

0.13	7.8	0.0	0.0	11.1	17.7	25.5	33.5	118.9	169.4	159.6	100.0	354.8	505.8	476.3
0.14	8.3	0.0	0.0	11.8	18.8	27.0	33.5	117.7	167.6	158.1	100.0	351.3	500.1	471.8
0.15	8.7	0.0	0.0	12.4	19.8	28.5	33.5	116.5	165.7	156.6	100.0	347.7	494.5	467.4
0.16	9.2	0.0	0.0	13.1	20.8	30.0	33.5	115.3	163.8	155.1	100.0	344.2	488.9	462.9
0.17	9.6	0.0	0.0	13.7	21.8	31.4	33.5	114.1	161.9	153.6	100.0	340.7	483.3	458.4
0.18	10.0	0.0	0.0	14.3	22.8	32.8	33.5	113.0	160.0	152.0	100.0	337.2	477.7	453.9
0.19	10.4	0.0	0.0	14.9	23.7	34.1	33.5	111.8	158.2	150.5	100.0	333.7	472.2	449.4
0.20	10.7	0.0	0.0	15.4	24.6	35.3	33.5	110.6	156.3	149.0	100.0	330.2	466.6	444.9
0.21	11.1	0.0	0.0	16.0	25.4	36.5	33.5	109.5	154.5	147.5	100.0	326.8	461.1	440.4
0.22	11.4	0.0	0.0	16.5	26.2	37.6	33.5	108.3	152.6	146.0	100.0	323.4	455.7	435.9
0.23	11.7	0.0	0.0	16.9	27.0	38.7	33.5	107.2	150.8	144.5	100.0	319.9	450.2	431.4
0.24	12.0	0.0	0.0	17.4	27.7	39.8	33.5	106.0	149.0	143.0	100.0	316.5	444.8	426.9
0.25	12.3	0.0	0.0	17.8	28.4	40.7	33.5	104.9	147.2	141.5	100.0	313.1	439.4	422.4
0.26	12.6	0.0	0.0	18.3	29.1	41.7	33.5	103.8	145.4	140.0	100.0	309.7	434.0	417.9
0.27	12.8	0.0	0.0	18.7	29.7	42.6	33.5	102.6	143.6	138.5	100.0	306.4	428.6	413.4
0.28	13.1	0.0	0.0	19.0	30.3	43.4	33.5	101.5	141.8	137.0	100.0	303.0	423.3	408.9
0.29	13.3	0.0	0.0	19.4	30.9	44.2	33.5	100.4	140.0	135.5	100.0	299.7	418.0	404.4
0.30	13.5	0.0	0.0	19.7	31.4	44.9	33.5	99.3	138.2	134.0	100.0	296.4	412.7	399.9
0.31	13.7	0.0	0.0	20.0	31.9	45.6	33.5	98.2	136.5	132.5	100.0	293.0	407.4	395.4
0.32	13.9	0.0	0.0	20.3	32.4	46.3	33.5	97.1	134.7	131.0	100.0	289.7	402.1	390.9
0.33	14.0	0.0	0.0	20.6	32.8	46.9	33.5	96.0	133.0	129.5	100.0	286.5	396.9	386.4
0.34	14.2	0.0	0.0	20.9	33.2	47.4	33.5	94.9	131.2	128.0	100.0	283.2	391.7	381.9
0.35	14.3	0.0	0.0	21.1	33.6	47.9	33.5	93.8	129.5	126.4	100.0	280.0	386.5	377.4
0.36	14.4	0.0	0.0	21.3	33.9	48.3	33.5	92.7	127.8	124.9	100.0	276.7	381.4	372.9
0.37	14.5	0.0	0.0	21.5	34.2	48.8	33.5	91.6	126.1	123.4	100.0	273.5	376.3	368.4

**Table 8** Summary of the outputs obtained (Continued)

0.38	14.6	0.0	0.0	21.7	34.5	49.1	33.5	90.5	124.3	121.9	100.0	270.3	371.2	364.0
0.39	14.7	0.0	0.0	21.8	34.8	49.4	33.5	89.5	122.6	120.4	100.0	267.1	366.1	359.5
0.40	14.7	0.0	0.0	22.0	35.0	49.7	33.5	88.4	120.9	118.9	100.0	263.9	361.0	355.0
0.41	14.7	0.0	0.0	22.1	35.2	49.9	33.5	87.4	119.3	117.4	100.0	260.8	356.0	350.5
0.42	14.8	0.0	0.0	22.2	35.3	50.1	33.5	86.3	117.6	115.9	100.0	257.6	351.0	346.0
0.43	14.8	0.0	0.0	22.3	35.4	50.2	33.5	85.3	115.9	114.4	100.0	254.5	346.0	341.5
0.44	14.8	0.0	0.0	22.3	35.5	50.3	33.5	84.2	114.2	112.9	100.0	251.4	341.0	337.0
0.45	14.8	0.0	0.0	22.3	35.6	50.3	33.5	83.2	112.6	111.4	100.0	248.2	336.1	332.5
0.46	14.7	0.0	0.0	22.4	35.6	50.3	33.5	82.1	110.9	109.9	100.0	245.2	331.1	328.0
0.47	14.7	0.0	0.0	22.4	35.6	50.3	33.5	81.1	109.3	108.4	100.0	242.1	326.2	323.5
0.48	14.6	0.0	0.0	22.4	35.6	50.2	33.5	80.1	107.7	106.9	100.0	239.0	321.4	319.0
0.49	14.5	0.0	0.0	22.3	35.5	50.1	33.5	79.1	106.0	105.4	100.0	236.0	316.5	314.5
0.50	14.4	0.0	0.0	22.3	35.5	49.9	33.5	78.0	104.4	103.9	100.0	232.9	311.7	310.0
0.51	14.3	0.0	0.0	22.2	35.3	49.7	33.5	77.0	102.8	102.3	100.0	229.9	306.9	305.5
0.52	14.2	0.0	0.0	22.1	35.2	49.4	33.5	76.0	101.2	100.8	100.0	226.9	302.1	301.0
0.53	14.1	0.0	0.0	22.0	35.0	49.1	33.5	75.0	99.6	99.3	100.0	223.9	297.4	296.5
0.54	14.0	0.0	0.0	21.9	34.8	48.8	33.5	74.0	98.0	97.8	100.0	221.0	292.6	292.0
0.55	13.8	0.0	0.0	21.7	34.6	48.4	33.5	73.0	96.5	96.3	100.0	218.0	287.9	287.5
0.56	13.6	0.0	0.0	21.6	34.4	48.0	33.5	72.0	94.9	94.8	100.0	215.1	283.2	283.0
0.57	13.4	0.0	0.0	21.4	34.1	47.5	33.5	71.1	93.3	93.3	100.0	212.1	278.6	278.5
0.58	13.3	0.0	0.0	21.2	33.8	47.0	33.5	70.1	91.8	91.8	100.0	209.2	273.9	274.0
0.59	13.0	0.0	0.0	21.0	33.5	46.5	33.5	69.1	90.2	90.3	100.0	206.3	269.3	269.5
0.60	12.8	0.0	0.0	20.8	33.1	45.9	33.5	68.2	88.7	88.8	100.0	203.4	264.7	265.0
0.61	12.6	0.0	0.0	20.6	32.7	45.3	33.5	67.2	87.1	87.3	100.0	200.6	260.1	260.5
0.62	12.3	0.0	0.0	20.3	32.3	44.7	33.5	66.2	85.6	85.8	100.0	197.7	255.6	256.1

**Table 8** Summary of the outputs obtained (Continued)

0.63	12.1	0.0	0.0	20.0	31.9	44.0	33.5	65.3	84.1	84.3	100.0	194.9	251.1	251.6
0.64	11.8	0.0	0.0	19.7	31.4	43.2	33.5	64.3	82.6	82.8	100.0	192.0	246.6	247.1
0.65	11.5	0.0	0.0	19.4	30.9	42.5	33.5	63.4	81.1	81.3	100.0	189.2	242.1	242.6
0.66	11.25	0.0	0.0	19.1	30.4	41.7	33.5	62.5	79.6	79.8	100.0	186.4	237.6	238.1
0.67	10.9	0.0	0.0	18.8	29.9	40.8	33.5	61.5	78.1	78.3	100.0	183.6	233.2	233.6
0.68	10.6	0.0	0.0	18.4	29.3	40.0	33.5	60.6	76.6	76.7	100.0	180.9	228.8	229.1
0.69	10.3	0.0	0.0	18.1	28.8	39.1	33.5	59.7	75.2	75.2	100.0	178.1	224.4	224.6
0.70	10.0	0.0	0.0	17.7	28.1	38.1	33.5	58.8	73.7	73.7	100.0	175.4	220.0	220.1
0.71	9.6	0.0	0.0	17.3	27.5	37.1	33.5	57.8	72.3	72.2	100.0	172.7	215.7	215.6
0.72	9.3	0.0	0.0	16.9	26.9	36.1	33.5	56.9	70.8	70.7	100.0	169.9	211.4	211.1
0.73	8.9	0.0	0.0	16.4	26.2	35.1	33.5	56.0	69.4	69.2	100.0	167.3	207.1	206.6
0.74	8.5	0.0	0.0	16.0	25.5	34.0	33.5	55.1	67.9	67.7	100.0	164.6	202.8	202.1
0.75	8.1	0.0	0.0	15.6	24.8	32.9	33.5	54.2	66.5	66.2	100.0	161.9	198.6	197.6
0.76	7.7	0.0	0.0	15.1	24.0	31.7	33.5	53.4	65.1	64.7	100.0	159.3	194.4	193.1
0.77	7.3	0.0	0.0	14.6	23.3	30.5	33.5	52.5	63.7	63.2	100.0	156.6	190.2	188.6
0.78	6.9	0.0	0.0	14.1	22.5	29.3	33.5	51.6	62.3	61.7	100.0	154.0	186.0	184.1
0.79	6.4	0.0	0.0	13.6	21.7	28.1	33.5	50.7	60.9	60.2	100.0	151.4	181.8	179.6
0.80	6.0	0.0	0.0	13.1	20.8	26.8	33.5	49.8	59.5	58.7	100.0	148.8	177.7	175.1
0.81	5.5	0.0	0.0	12.5	20.0	25.5	33.5	49.0	58.2	57.2	100.0	146.2	173.6	170.6
0.82	5.0	0.0	0.0	12.0	19.1	24.1	33.5	48.1	56.8	55.7	100.0	143.7	169.5	166.1
0.83	4.6	0.0	0.0	11.4	18.2	22.8	33.5	47.3	55.4	54.2	100.0	141.1	165.4	161.6
0.84	4.1	0.0	0.0	10.9	17.3	21.4	33.5	46.4	54.1	52.6	100.0	138.6	161.4	157.1
0.85	3.6	0.0	0.0	10.3	16.3	19.9	33.5	45.6	52.7	51.1	100.0	136.0	157.4	152.7
0.86	3.1	0.0	0.0	9.7	15.4	18.5	33.5	44.7	51.4	49.6	100.0	133.5	153.4	148.2
0.87	2.6	0.0	0.0	9.1	14.4	17.0	33.5	43.9	50.1	48.1	100.0	131.1	149.4	143.7

**Table 8** Summary of the outputs obtained (Continued)

088	2.0	0.0	0.0	8.4	13.4	15.5	33.5	43.1	48.7	46.6	100.0	128.6	145.5	139.2
089	1.5	0.0	0.0	7.8	12.4	13.9	33.5	42.2	47.4	45.1	100.0	126.1	141.6	134.7
090	1.0	0.0	0.0	7.1	11.4	12.3	33.5	41.4	46.1	43.6	100.0	123.7	137.7	130.2
091	0.4	0.0	0.0	6.5	10.3	10.7	33.5	40.6	44.8	42.1	100.0	121.2	133.8	125.7
092	-0.2	0.0	0.0	5.8	9.2	9.1	33.5	39.8	43.5	40.6	100.0	118.8	130.0	121.2
093	-0.7	0.0	0.0	5.1	8.1	7.4	33.5	39.0	42.3	39.1	100.0	116.4	126.1	116.7
094	-1.3	0.0	0.0	4.4	7.0	5.7	33.5	38.2	41.0	37.6	100.0	114.0	122.3	112.2
095	-1.9	0.0	0.0	3.7	5.9	4.0	33.5	37.4	39.7	36.1	100.0	111.7	118.6	107.7
096	-2.5	0.0	0.0	3.0	4.8	2.3	33.5	36.6	38.5	34.6	100.0	109.3	114.8	103.2
097	-3.1	0.0	0.0	2.3	3.6	0.5	33.5	35.8	37.2	33.1	100.0	106.9	111.1	98.7
098	-3.7	0.0	0.0	1.5	2.4	-1.3	33.5	35.0	36.0	31.6	100.0	104.6	107.4	94.2
099	-4.3	0.0	0.0	0.8	1.2	-3.1	33.5	34.3	34.7	30.1	100.0	102.3	103.7	89.7
1.00	-5.0	0.0	0.0	0.0	0.0	-5.0	33.5	33.5	33.5	28.5	100.0	100.0	100.0	85.2
1.01	-5.6	0.0	0.0	-0.8	-1.2	-6.8	33.5	32.7	32.3	27.0	100.0	97.7	96.4	80.7
1.02	-6.2	0.0	0.0	-1.6	-2.5	-8.7	33.5	32.0	31.1	25.5	100.0	95.4	92.7	76.2
1.03	-6.9	0.0	0.0	-2.4	-3.7	-10.6	33.5	31.2	29.9	24.0	100.0	93.2	89.1	71.7
1.04	-7.5	0.0	0.0	-3.2	-5.0	-12.6	33.5	30.5	28.7	22.5	100.0	90.9	85.6	67.2
1.05	-8.2	0.0	0.0	-4.0	-6.3	-14.5	33.5	29.7	27.5	21.0	100.0	88.7	82.0	62.7
1.06	-8.9	0.0	0.0	-4.8	-7.6	-16.5	33.5	29.0	26.3	19.5	100.0	86.5	78.5	58.2
1.07	-9.6	0.0	0.0	-5.6	-9.0	-18.5	33.5	28.2	25.1	18.0	100.0	84.3	75.0	53.7
1.08	-10.3	0.0	0.0	-6.5	-10.3	-20.6	33.5	27.5	24.0	16.5	100.0	82.1	71.5	49.2
1.09	-11.0	0.0	0.0	-7.3	-11.7	-22.6	33.5	26.8	22.8	15.0	100.0	79.9	68.1	44.8
1.10	-11.7	0.0	0.0	-8.2	-13.0	-24.7	33.5	26.1	21.7	13.5	100.0	77.8	64.6	40.3
1.11	-12.4	0.0	0.0	-9.1	-14.4	-26.8	33.5	25.3	20.5	12.0	100.0	75.7	61.2	35.8
1.12	-13.1	0.0	0.0	-9.9	-15.8	-28.9	33.5	24.6	19.4	10.5	100.0	73.5	57.8	31.3

**Table 8** Summary of the outputs obtained (Continued)

1.13	-13.8	0.0	0.0	-10.8	-17.2	-31.0	33.5	23.9	18.3	9.0	100.0	71.4	54.5	26.8
1.14	-14.5	0.0	0.0	-11.7	-18.7	-33.2	33.5	23.2	17.1	7.5	100.0	69.3	51.1	22.3
1.15	-15.3	0.0	0.0	-12.6	-20.1	-35.4	33.5	22.5	16.0	6.0	100.0	67.2	47.8	17.8
1.16	-16.0	0.0	0.0	-13.5	-21.6	-37.6	33.5	21.8	14.9	4.5	100.0	65.2	44.5	13.3
1.17	-16.8	0.0	0.0	-14.5	-23.0	-39.8	33.5	21.1	13.8	2.9	100.0	63.1	41.3	8.8
1.18	-17.5	0.0	0.0	-15.4	-24.5	-42.0	33.5	20.5	12.7	1.4	100.0	61.1	38.0	4.3
1.19	-18.3	0.0	0.0	-16.3	-26.0	-44.3	33.5	19.8	11.7	-0.1	100.0	59.1	34.8	-0.2
1.20	-19.1	0.0	0.0	-17.3	-27.5	-46.6	33.5	19.1	10.6	-1.6	100.0	57.1	31.6	-4.7
1.21	-19.8	0.0	0.0	-18.2	-29.0	-48.8	33.5	18.4	9.5	-3.1	100.0	55.1	28.4	-9.2
1.22	-20.6	0.0	0.0	-19.2	-30.5	-51.2	33.5	17.8	8.5	-4.6	100.0	53.1	25.3	-13.7
1.23	-21.4	0.0	0.0	-20.1	-32.1	-53.5	33.5	17.1	7.4	-6.1	100.0	51.1	22.2	-18.2
1.24	-22.2	0.0	0.0	-21.1	-33.6	-55.8	33.5	16.5	6.4	-7.6	100.0	49.2	19.0	-22.7
1.25	-23.0	0.0	0.0	-22.1	-35.2	-58.2	33.5	15.8	5.3	-9.1	100.0	47.2	16.0	-27.2
1.26	-23.8	0.0	0.0	-23.1	-36.8	-60.5	33.5	15.2	4.3	-10.6	100.0	45.3	12.9	-31.7
1.27	-24.6	0.0	0.0	-24.1	-38.3	-62.9	33.5	14.5	3.3	-12.1	100.0	43.4	9.9	-36.2
1.28	-25.4	0.0	0.0	-25.1	-39.9	-65.3	33.5	13.9	2.3	-13.6	100.0	41.5	6.9	-40.7
1.29	-26.2	0.0	0.0	-26.1	-41.5	-67.8	33.5	13.3	1.3	-15.1	100.0	39.6	3.9	-45.2
1.30	-27.0	0.0	0.0	-27.1	-43.2	-70.2	33.5	12.7	0.3	-16.6	100.0	37.8	0.9	-49.7
1.31	-27.9	0.0	0.0	-28.1	-44.8	-72.6	33.5	12.0	-0.7	-18.1	100.0	35.9	-2.0	-54.2
1.32	-28.7	0.0	0.0	-29.1	-46.4	-75.1	33.5	11.4	-1.7	-19.6	100.0	34.1	-5.0	-58.6
1.33	-29.5	0.0	0.0	-30.2	-48.1	-77.6	33.5	10.8	-2.6	-21.2	100.0	32.3	-7.9	-63.1
1.34	-30.4	0.0	0.0	-31.2	-49.7	-80.1	33.5	10.2	-3.6	-22.7	100.0	30.5	-10.7	-67.6
1.35	-31.2	0.0	0.0	-32.3	-51.4	-82.6	33.5	9.6	-4.5	-24.2	100.0	28.7	-13.6	-72.1
1.36	-32.0	0.0	0.0	-33.3	-53.0	-85.1	33.5	9.0	-5.5	-25.7	100.0	26.9	-16.4	-76.6
1.37	-32.9	0.0	0.0	-34.4	-54.7	-87.6	33.5	8.4	-6.4	-27.2	100.0	25.1	-19.2	-81.1

**Table 8** Summary of the outputs obtained (Continued)

1.38	-33.7	0.0	0.0	-35.4	-56.4	-90.1	33.5	7.8	-7.4	-28.7	100.0	23.4	-22.0	-85.6
1.39	-34.6	0.0	0.0	-36.5	-58.1	-92.7	33.5	7.3	-8.3	-30.2	100.0	21.7	-24.7	-90.1
1.40	-35.5	0.0	0.0	-37.5	-59.8	-95.2	33.5	6.7	-9.2	-31.7	100.0	19.9	-27.5	-94.6
1.41	-36.3	0.0	0.0	-38.6	-61.5	-97.8	33.5	6.1	-10.1	-33.2	100.0	18.2	-30.2	-99.1
1.42	-37.2	0.0	0.0	-39.7	-63.2	-100.4	33.5	5.5	-11.0	-34.7	100.0	16.6	-32.9	-103.6
1.43	-38.1	0.0	0.0	-40.8	-64.9	-103.0	33.5	5.0	-11.9	-36.2	100.0	14.9	-35.5	-108.1
1.44	-38.9	0.0	0.0	-41.9	-66.7	-105.6	33.5	4.4	-12.8	-37.7	100.0	13.2	-38.2	-112.6
1.45	-39.8	0.0	0.0	-42.9	-68.4	-108.2	33.5	3.9	-13.7	-39.2	100.0	11.6	-40.8	-117.1
1.46	-40.7	0.0	0.0	-44.0	-70.1	-110.8	33.5	3.3	-14.5	-40.7	100.0	10.0	-43.4	-121.6
1.47	-41.6	0.0	0.0	-45.1	-71.9	-113.5	33.5	2.8	-15.4	-42.2	100.0	8.3	-46.0	-126.1
1.48	-42.5	0.0	0.0	-46.2	-73.6	-116.1	33.5	2.3	-16.2	-43.7	100.0	6.7	-48.5	-130.6
1.49	-43.4	0.0	0.0	-47.3	-75.4	-118.7	33.5	1.7	-17.1	-45.3	100.0	5.2	-51.0	-135.1
1.50	-44.2	0.0	0.0	-48.4	-77.1	-121.4	33.5	1.2	-17.9	-46.8	100.0	3.6	-53.5	-139.6
1.51	-45.1	0.0	0.0	-49.6	-78.9	-124.1	33.5	0.7	-18.8	-48.3	100.0	2.0	-56.0	-144.1
1.52	-46.0	0.0	0.0	-50.7	-80.7	-126.7	33.5	0.2	-19.6	-49.8	100.0	0.5	-58.5	-148.6
1.53	-46.9	0.0	0.0	-51.8	-82.5	-129.4	33.5	-0.3	-20.4	-51.3	100.0	-1.0	-60.9	-153.1



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### Authors' contributions

All authors contributed to the paper. JG designed the study and the bio-economic model, contributed to the analysis and writing. JB, NC, KF and OG participated in the collection of remuneration systems information and made contributions to the analysis and the writing. CM and FM participated in the collection of remuneration systems information and made contributions to the bio-economic methodology, analysis and the writing. All authors read, edited and approved the final manuscript.

### Competing interests

The authors declare that they have no competing interests.

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