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Brexit, common fisheries policy and discard ban: A financial analysis of the Spanish fleet in the Grand Sole

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ABSTRACT

In the last decades, the Spanish Grand Sole fleet has shown a negative evolution both in the number of vessels and in the turnover of its activity. This trend is mainly due to the institutional framework that determines the governance of the Spanish fleet in Community waters. The distribution of quotas, determined by the Relative Stability System, combined with successive European fishing policies, have caused a reduction in the capacity of the fishing fleet. In addition, more recently, these factors have been compounded by the progressive implementation a of the discard ban, which has been extended to all European species and fishing areas since 2019, and Brexit, which has led to the transfer of 25% of the average value of shared stocks quotas to the United Kingdom from 2021 to 2026. The objective of this article is to analyze whether the Spanish shipowning companies whose vessels operate in Gran Sol, will continue to be profitable or will have to cease their activity. For this purpose, an analysis has been carried out using the Real Options Approach and incorporating an abandonment option. The results show that the value of the abandonment option (49.3%) is high.

1. Introduction

The Grand Sole North Atlantic fishing bank is one of the most important locations for commercial fishing in EU waters, with an average annual landings of 420,000 tons in the last decade (Hernvann et al., 2020; ICES, 2021). Vessels operating in this area are mostly flagged in France, Ireland, United Kingdom, Belgium and Spain (Mateo et al., 2017). From the 1950 s to the 1980 s, landings obtained in this fishing ground increased in quantity. The cause is to be found in the policy of national and European government subsidies, aimed at modernizing the fleets and constructing new vessels, which increased fishing capacity. These policies were in place until the 1990 s (Guénette and Gascuel, 2012).

The continuous fishing pressure exerted on the fishing grounds led to a worsening of the state of the stocks, which, for some species, became critical. The Common Fisheries Policy (CFP), established in 1983, only partially mitigated overfishing, since ten years later commercial species reached their historical minimum level (Antelo et al., 2012b; Hernvann and Gascuel, 2020). It was not until the beginning of the 21st century when, with the integration of the ecosystem approach to fisheries management, the concept of Maximum Sustainable Yield (MSY) was incorporated into European fisheries regulations. Today, the sustainable blue economy approach has become established in the European Union (EU) and has been reinforced with the adoption of the European Green Pact and the Economic Recovery Plan for Europe (European Commission, 2021a).

The sustainable blue economy includes the need to control catches under the efficient allocation of quotas and the implementation of discard regulations (European Commission, 2021a; Skerritt et al., 2020). In Spain, since its accession to the European Economic Community (EEC) in 1986, the quota allocation model corresponding to ICES areas VI, VII and VIII a,b,d has generated controversy (Antelo et al., 2012a). The Spanish offshore fleet defends that the allocation of fishing rights, calculated through coefficients applied to fishing capacity (kW) and days of activity, is not equitable. Their arguments focus on the fact that this model, still in force, neither reflects Spain's historical catches in the fishing ground nor reflects the socioeconomic dependence on the resource, and they point out that, consequently, the profitability of the

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fleet has decreased (Aranda and Murillas, 2015; Sobrino Heredia and Oanta, 2019). Likewise, discard regulations also emerge as a factor that negatively affects fleet profitability. Vazquez-Rowe et al. (2011) estimates that more than 15,000 tons will be discarded by the Spanish Grand Sole fleet, highlighting the losses of trawlers (with a discard rate of 43.5%).

In addition, there is another process that directly affects the possibilities of catches in Grand Sole: Brexit. On the one hand, the Spanish fleet fears that rivalry will increase in the Irish part of the Grand Sole as vessels excluded from British waters seek a new fishing ground. On the other hand, since 2021, the EU fleets will have to cede part of their quotas to the United Kingdom (Ford and Stewart, 2021). In addition to all these processes, the price of fuel, one of the main operating costs of the fishing fleet, will rise due to the elimination of the fishing diesel tax exemption (Carvalho and Guillen, 2021). While in 2020 the average price of fishing fuel was 0.30 €/liter, the introduction of the special tax would mean a final price of 0.81 €/liter and, if the national tax is also added, it would reach 0.98 €/liter.

The Grand Sole fishery has been extensively studied from a biological, economic and institutional perspective. ICES supplies a wealth of biological information on this fishery on an annual basis. In addition, ICES provides scientific advice to the European Commission for setting the annual Total Allowable Catch (TAC) for fish species caught in the Celtic Seas ecoregion (ICES, 2020). On the academic side, the relationship between the biological status of stocks and the economic return from their exploitation has also been investigated (Hernvann and Gascuel, 2020; Kitidis et al., 2017; Moore et al., 2019) and bioeconomic models have been applied to several Grand Sole species (Moullec et al., 2017; Pérez-Pérez et al., 2017). Regarding the economic area, the economic performance of fleets fishing in this area has been analyzed by the EU with regular periodicity within the set of European fisheries and countries (European Commission, 2021b). In addition, there have been scientific publications covering topics as relevant as the socioeconomic effects of discard regulations on the Spanish fleet operating in this fishing ground (Calderwood et al., 2020; Mateo et al., 2017). Regarding the institutional approach, academia has analyzed the governance of the Grand Sole fishery (Clarke and Egan, 2017; Domínguez-Torreiro, 2004; O'Hagan et al., 2020) such as the establishment of the principle of relative stability (Varela-Lafuente et al., 2019), the establishment of transferable fishing quotas (Amigo-Dobaño et al., 2012; Dinesen et al., 2018) or property rights (Caballero-Miguez et al., 2008, Caballero-Miguez et al., 2014). However, a multidisciplinary analysis combining the application of financial valuation models with the analysis of sector governance has not yet been performed.

Therefore, the aim of this paper is to carry out a valuation analysis of a fishing company that focuses its activity in the Grand Sole fishing ground. The current circumstances, marked by relevant political, economic and social effects of the efficient resource management and the changes in governance, make it necessary to have a valuation framework that reflects this uncertainty. Therefore, the Real Options (RO) approach has been used to value a Spanish-based company operating in Grand Sole. This methodology is complementary to the traditional Net Present Value (NPV) model, as it incorporates management flexibility into the analysis through an exit option. In addition, due to the current complex and volatile environment, a sensitivity analysis of the valuation is performed.

This article is structured as follows. Section 2 provides an overview of the evolution of the Spanish Grand Sole fleet through the institutional framework. Section 3 describes the real options methodology and its application to our case study, the results of which are presented in Section 4. Finally, the conclusions of this work are listed in Section 5.

2. Evolution of the Spanish fleet in Grand Sole through the institutional framework

The Grand Sole fishing ground is the main fishing area for the Spanish offshore fleet in the EU waters. It is located west and southwest of the British Isles and includes the International Council for the Exploration of the Sea (ICES) areas Vb, VI, VII and VIII a,b,d, where the activity of the Spanish offshore fleet takes place. The most productive zone for the Spanish vessels is the Celtic Sea, off the south coast of Ireland (ICES areas VIIg and VIIh), and the main target species are European hake (*Merluccius merluccius, Merlucciidae*), anglerfish (*Lophius budegassa, Lophiidae* and *Lophius piscatorius, Lophiidae*), megrim (*Lepidorhombus whiffiagonis, Scophthalmidae*) and Norway lobster (*Nephrops norvegicus, Nephropidae*) (Table 1). Trawling and longlining are the main gear types used by the Spanish vessels in this fishing ground (Sanchez, 1998).

The Spanish Grand Sole fleet was known as the "fleet of 300" when Spain entered the EEC in 1986, since a list of 300 Spanish vessels authorized for this area was established. However, in previous years, the Spanish fleet fishing in the Grand Sole had been composed of almost 500 vessels (460 vessels in 1983) (Caballero-Miguez et al., 2014). After this initial significant reduction in the number of vessels, the downward trend continued during the following decades, in order to adapt the size of the fleet to the fishing possibilities granted by the Common Fisheries Policy (CFP). Thus, the Spanish Grand Sole fleet was reduced to 200 vessels in 2001 and, subsequently, to 100 vessels in 2014. Currently, 91 vessels remain active (Table 2) (Ministerio de agricultura, pesca y alimentación, 2021).

While the reduction in fishing opportunities is the main cause of the decline in the number of vessels, more recently other causes have been added. The increase in fuel costs (whose tax exemption will soon be eliminated), the lack of financing, the fall in prices, the application of the discard regulations and the new fisheries management implemented in the northwestern waters of the EU as a consequence of Brexit have reduced the profitability of the Spanish fleet in Grand Sole (Carvalho and Guillen, 2021). In addition, the institutional framework established by the European fisheries policy has resulted in the reduction, or even elimination, of funding for the renewal or modernization of the fishing fleet and an increase in funding for the scrapping of vessels and the stoppage of fishing activity (Froese et al., 2018; Princen et al., 2021).

In general terms, the latest CFP reforms tend to eliminate fishing subsidies that contribute to overcapacity and overfishing. The Financial Instrument for Fisheries Guidance (FIFG 2000–2006) allocated 13% of its budget to the construction of new vessels, 4% to the modernization of existing vessels and 15% to the scrapping of vessels. The European Fisheries Fund (EFF 2007–2013) allocated 0% of its budget to the construction of new vessels, 4% to investments on board (modernization), 18% to permanent cessation and 8% to temporary cessation (Symes and Hoefnagel, 2010). The European Maritime and Fisheries Fund (EMFF 2014–2020) allocated 0% of its budget to new vessel construction, 1% to aid for replacement or modernization and 6% to temporary and permanent cessation of fishing activities. Finally, the current European fisheries fund (FEMP 2021–2027) supports modernization and engine renewal only for vessels less than 24 m in length (which excludes almost all Spanish Grand Sole vessels) and maintains compensation for temporary cessation and scrapping (Baudron et al., 2020; Earle, 2021; Orach et al., 2017; Princen et al., 2021; Skerritt et al., 2020).

In terms of fishing opportunities, the CFP includes a criterion for allocating fishing opportunities to EU Member States (MS), known as the Relative Stability System. This system was established in 1983, when the basic CFP regulation was implemented, and assigns to each MS a fixed percentage of the Total Allowable Catch (TAC) of respective fish stocks. The TAC calculation for every MS is based on historical catches from 1973 to 1978 (Hoefnagel et al., 2015). For the Spanish fleet, historically, smaller quotas have been allocated in relation to its fishing capacity, which has resulted in a significant resizing of the sector. In fact, the percentages of ICES zone VII allocated to the Spanish fleet were 29.47% for hake, 3.67% for monkfish, 30.0% for megrim and 6.0% for Norway lobster, while the quotas allocated to the French fleet, with a smaller capacity, for the same zone and species, were 45.58%, 59.32%, 36.38%

Table 1
Catches by species for Spanish Association vessels in Grand Sole in 2021.

Vessels Spanish Associations in Grand Sole	Anglerfish *(Lophius budegassa and Lophius piscatorius)*	European hake *(Merluccius merluccius)*	Megrim *(Lepidorhombus whiffiagonis)*	Ling *(Molva molva)*	Norway lobster *(Nephrops norvegicus)*	European pollock *(Pollachius pollachius)*	Whiting *(Merlangius merlangus)*	Total Association
ANASOL (Galicia)	78,325573	45,515640	78,320164	26,733622	78,320164	49,828906	9,358558	366,402627
ARPACAN (Cantabria)	0	2,0123	0	0	0	0	0	2,0123
ARPESCO (Galicia)	2,88164	2	3	1,00032	3	2,38355	2,38355	16,39922
OPECA (Cantabria)	9,21772	6,3901	9,2177	3,23995	9,2177	7,68112	7,39972	52,36403
OPP FRESCA DEL PUERTO DE LA CORUÑA (Galicia)	32,71067	20,73157	32,71069	11,10315	32,21067	22,14686	10,02163	161,63524
OPP-LUGO (Galicia)	23,613857	22,976688	23,619246	7,785178	24,119266	15,488754	7,824792	125,427781
OPPAO (Basque Country)	68,3542	48,34034	68,35417	23,2525	68,35417	51,79594	42,7095	371,1608
PUERTO DE CELEIRO (Galicia)	84,89637	52,04650	84,89637	26,88528	84,89637	50,67487	20,30225	404,59801
Total species	300	200	300	100	300	200	100	1500

Source: Own elaboration based on BOE (2021).

Table 2
Effort and fishing opportunities for the Vessels Spanish Associations in Grand Sole in 2021.

Vessels Spanish Associations in Grand Sole	Number of vessels in 2021 census	Fishing possibilities per zone			Effort coefficient per zone		
		CIEM Vb and VI	CIEM VII	CIEM VIII abde	CIEM Vb and VI	CIEM VII	CIEM VIII abde
ANASOL (Galicia)	20	150,225274	161,881402	54,295951	27,411586	39,342956	8,491728
ARPACAN (Cantabria)	3	0	0	2,0123	0	0	1,55105
ARPESCO (Galicia)	1	2,59656	0	13,80266	0,45389	0	1,8527
OPECA (Cantabria)	2	8,38813	1,1256	42,8503	1,05526	0,19933	5,80472
OPP FRESCA DEL PUERTO DE LA CORUÑA (Galicia)	7	54,60015	48,00094	59,03415	10,23202	11,9077	9,37603
OPP-LUGO (Galicia)	15	39,936116	31,155878	54,335787	6,805184	7,087804	12,073242
OPPAO (Basque Country)	17	83,54337	36,3457	251,271722	18,29293	9,64014	40,97603
PUERTO DE CELEIRO (Galicia)	26	160,7104	121,49048	122,39713	35,74913	31,82207	19,8745
Total	91	500	400	600	100	100	100

Source: Own elaboration based on BOE (2021).

and 24.30%, respectively (Hoefnagel et al., 2015; Leite and Pita, 2016).

In addition, the discard ban has represented an important economic impact for the Spanish Large Sole fleet. Regulation (EU) No. 1380/2013 of the European Parliament and of the Council on the Common Fisheries Policy (EU, 2013) established a gradual discard ban, by species and area, from 2014 to 2018, and a total ban from 2019. Regarding the main target species of the Spanish Grand Sol fleet, the discard ban was implemented in the following periods: Norway lobster, 2015; European hake, 2016; megrim, 2018; anglerfish, 2019. The landing obligation has had a noticeable effect on the economic performance of small and micro enterprises of Big Sole, even causing the closure of many of them (Vázquez-Rowe et al., 2011).

With respect to the present moment and the near future, the fishing opportunities for the Spanish fleet in Grand Sole have been considerably reduced following the United Kingdom's departure from the European Union. The Brexit negotiations between the UK and the EU reached a new partnership agreement on December 24, 2020. Regarding fishing in the waters remaining under British sovereignty, the agreement establishes that the EU fishing sector will give 25% of the average value of the quotas of 32 species caught in British waters (€160 million out of a total of €640 million) to the UK annually during a transitional period of five and a half years, until June 2026 (Ministerio de agricultura, pesca y alimentación, 2020). After this period, the cession will be total, and the parties will establish the fishing possibilities in annual negotiations. Spain will have to cede quota in a total of 17 species, some of them fundamental for the Grand Sole fleet, such as European hake, anglerfish, megrim, Norway lobster, skate (*Raja sp., Rajidae*) and blue whiting (*Micromesistius poutassou, Gadidae*), being this last one a key species for quota swaps. The total loss during the transitional period will exceed a volume of 15,500 tons and a value of €36 million (Afundación, 2021).

3. Materials and methods

3.1. Data

The database from which the economic-financial data of the company was obtained is Orbis. This database, belonging to the Bureau van Dijk group, contains information on ownership, finance, subsidies, acquisitions, takeovers, or stock market data of companies in Europe.

In order to ensure that the analysis carried out in this article was as representative as possible, the firm chosen was the company whose variables were closest to the average values of the Grand Sole fleet sector in Spain. These sector average values are: €1,696,000 of operating income, €2,842,000 of total assets and 17 employees on board the vessel (ORBIS, 2021). Nonetheless, of the 64 Spanish shipowning companies operating in Grand Sole, 56 of these companies own only one vessel, while 4 of them own two vessels, and another 4 companies own three or more vessels. This results in a market structure composed of 87.50% by small companies, 6.25% by medium-sized companies and 6.25% by large companies.

Once the criteria described above have been implemented, the chosen company is a shipowner located in A Coruña and a member of the association of Grand Sole OPP *Fresca del Puerto de La Coruña* (Secretaria general de pesca. Gobierno de España, 2021). The firm has more than 30 years of experience in the sector, has no foreign activity and its economic activity is focused exclusively on deep-sea fishing in the Grand Sole by exploiting a single trawler (Table 3).

3.2. Methodology

Classical financial valuation techniques are based on discounted cash flow (DCF) models, especially NPV approach (Najafi and Talebi, 2021; Zhou et al., 2021). DCF models are extensively applied, both in academia and the private sector, due to their ease of understanding and implementation (Locatelli et al., 2020). Despite the advantages they show, these models present deficiencies, which have been filled by a complementary valuation method, the Real Options theory. The lack of flexibility of DCF models pushed academia to evolution towards new, more complex and holistic financial option valuation approaches, since DCF models are static methods that do not consider uncertainty in valuation (Banda, 2021; Araya et al., 2021; Regan et al., 2015). Thus, the RO theory arises to respond to the methodological shortcomings of the classical valuation models (Myers, 1977).

Real Options approach employs several models to define the valuation of options, which are the rights to abandon, expand or extend a business project. These models are Black-Scholes, Binomial Model or Monte Carlo simulation, used as a tool to calculate the present and future valuation of an investment project.

The binomial model, which incorporates different scenarios, has become the most widely used because it is a flexible and intuitive model for decision-makers. Information about new scenarios is introduced through the valuation of implicit options, which affects the company's future decisions (Fedorov et al., 2021). The flexibility to incorporate alternative investment scenarios can have a high impact on the valuation of an investment project (Henao et al., 2018). Therefore, RO theory is currently being applied in sectors with high uncertainty where the incorporation of flexibility is essential in valuation, a circumstance that traditional models do not consider (Araya et al., 2021).

Real options present analogies with the concept of financial options. Therefore, the approach used for the valuation of financial options is adapted for application in RO theory (Table 4). Considering the basic strategies of financial options, a call option can be compared to an investment opportunity and, in turn, a put option can be treated as a divestment opportunity (Fedorov et al., 2021). Similar to call options, the investor has the right, but not the obligation, to realize an investment that generates certain cash flows (Odening et al., 2005).

RO theory has become a new methodology that has complemented classical financial valuation techniques. RO methodology includes the rigid valuation of classical models and the flexibility of option valuation. This statement is since the RO theory uses the discounted cash flow model, adding an additional financial value that DCF models do not incorporate (Lai and Locatelli, 2021). This implies that RO theory adds the value of strategic decisions by incorporating flexibility through the integration of options (Liu et al., 2021). Thus, the Strategic NPV is defined as:

Table 3
Characterization of the fishing vessel of the company under study.

	Vessel
Year of build	2001
Length	34.2 m
Tonnage (GT)	314.0
Engine power	429.53 kW (584.0 CV)
Hull material	Steel
Home port (2020)	A Coruña (Galicia)
Flag	France
Fishing gear	Bottom trawling fishing
Fishing area	CIEM VB, VI, VII y VIIIabde.

Source: own elaboration based on Ministerio de agricultura, pesca y alimentación (2021).

Table 4
Analogy between financial and real options.

Financial Option	Symbol	Real option
Underlying asset value	S	Present value of cash flows
Exercise price	X	Cash received or invested when the option is exercised
Volatility of underlying asset	σ	Volatility of cash-flows (uncertainty of project value)
Risk-free interest rate	r	Risk-free discount rate
Option exercise time	T	Time in which decision making is active

Source: Own elaboration.

$$Strategic \quad NPV = NPV + Option \quad value \tag{1}$$

Where, NPV is defined by the following formula:

$$NPV = -I + \sum_{t=1}^{T} \frac{CF_t}{(1+i)^t} \tag{2}$$

I: initial investment.
CF: cash-flows.
i = discount rate.
t = number of periods.

In our case study we analyze an exit option, which will be valued as a put option. Abandonment options are especially relevant in scenarios in which the company has negative results or has information about events that adversely affect its activity (Hernández-García et al., 2018). For the company analyzed in this article, the reduction of quotas due to Brexit, the full implementation of the discard ban and the policy of reducing EU fishing effort have established an adverse institutional framework. Therefore, the uncertainty that exists in the socio-economic environment of the company makes valuation using Real Options appropriate (Hu et al., 2021; Regan et al., 2015). In addition, these variables generate a scenario where volatility is a fundamental variable in the valuation. Therefore, a sensitivity analysis is performed.

The Real Options valuation approach has four steps: (i) projection of the financial statements; (ii) estimation of cash flows (Table 6); (iii) calculation of NPV; (iv) application of the Real Options approach.

In implementing the Real Options approach to our case study, the Cox, Ross and Rubinstein Binomial model is employed (Ross et al., 1979). The following parameters are required for its application:

$$u = e^{\sigma\sqrt{dt}} \tag{3}$$

$$d = e^{-\sigma\sqrt{dt}} = \frac{1}{u} \tag{4}$$

$$\sigma = ln\left(\frac{\sum_{i=1}^{n} S_i}{\sum_{i=0}^{n} S_i}\right) \tag{5}$$

$$S_{i,j} = u^i d^{|i-j|} S_{0,0} \tag{6}$$

$$p_u = \frac{e^{r_f dt} - d}{u - d} \tag{7}$$

$$p_d = 1 - p_u \tag{8}$$

Where: u = upward movement of the underlying asset; d = downward movement of the underlying asset; σ = volatility of the underlying asset;

Table 5
Variation of the main economic variables of the company.

	2020	2019	2018	2017
Asset variation	-7.40%	-10.14%	-9.11%	-9.7%
Income variation	-40.89%	-6.88%	0.23%	43.4%
EBIT variation	-65.21%	-126.73%	-61.68%	-37.04%

Table 6
Cash flows estimates.

Year	Cash Flow (€)
2020	-356,962.14
2021	839,972.37
2022	825,356.24
2023	825,356.24
2024	825,356.24
2025	643,951.57
2026	643,951.57
2027	643,951.57
2028	643,951.57
2029	643,951.57
2030	2,009,264.91

$S_{i,j}$ = value of the underlying asset of each node of the binomial tree; p_u = neutral risk probability linked to the increase of the underlying asset; p_d = neutral risk probability linked to the decrease of the underlying asset.

The value of the abandonment option for each node of the binomial tree is calculated by applying the following formula (Fernández-González et al., 2021):

$$C_{i,j} = \left\{ \begin{array}{cc} max(Si,j; VL(j)) \quad if \quad j = n \\ max\left(VL(j); S_{i,j}; \dfrac{p_u C_{i+1,j+1} + p_d C_{i,j+1}}{(1+r_f)^{\Delta t}}\right) \quad if \quad j \in \{0,1,2,\dots,n\} \end{array} \right\} \tag{9}$$

$C_{i,j}$ where $i,j = 0,1,2,\dots,n$ y $j \geq iVL(j)$ represents the liquidation value of the company and is defined by:

$$VL(j) = Total \quad assets(j) - External \quad debt(j) \tag{10}$$

4. Results

The objective of this article is to value an average Spanish company operating in the Gran Sol. Economic and political circumstances significantly affect the business decisions of this company. Thus, the 25% reduction of the quota to Spanish companies due to the Brexit, as well as the increase in the price of fuel or the compliance with the discard regulations can affect the economic-financial analysis in a significant way.

In order to identify the economic-financial evolution of the company, an analysis of the most relevant variables of its financial statements has been performed. For this purpose, the values of the company's assets, revenues and profits in the period 2016–2020 have been obtained from the ORBIS database. Through these values, variations have been calculated, show a downward trend, the most significant being EBIT (Table 5). This reduction in EBIT is preceded by a decline in sales. Comparing the three variations, it is observed that the total assets of the company show a continued negative evolution, decreasing by 7.4% from 2016 to 2020, although the impact on sales is much higher (−40.89%), with the drop in sales affecting the EBIT very significantly (−65.21%).

In the negative evolution of the principal variables of the company, the flexibility to abandon the market is added to the financial valuation. To implement this valuation, the stages described in Section 3.2 are applied.

In the first and second stages, the projection of the income statement included the 25% reduction in the quota from 2021 onwards. In the year 2030, a continuation cash flow is estimated. As a result, the cash flows generated were obtained (Table 6).

Then, in the third stage, the valuation of the company is performed through the NPV. For this, the formula (2) is applied. The result obtained is €5,575,261.55.

Finally, in the fourth stage, management flexibility is added to the valuation through an abandonment option. For this purpose, the liquidation values of the company for each year are calculated (Table 7). As a result, the NPV binomial tree is obtained by applying formulas 3 and 4 to the NPV (Fig. 1). Subsequently, the binomial tree for the value of the abandonment option is calculated (Fig. 2). For this analysis, the formula 9 is applied.The value of the abandonment option is defined by:

$$\begin{aligned} Option \quad abandon \quad value &= 8,324,303.05 - 5,575,261.55 \\ &= €2,749,041.49 \end{aligned}$$

The evaluation of the scenarios analyzed reveals that the abandonment option is a decision to be considered by the decision-makers. The reduction of quotas causes a decrease in the valuation of the company and, consequently, the value of the abandonment option increases the value of the business project by 49.3%. Therefore, the application of this option is a valid possibility for the future of this company.

The characteristics of the economic, political and social scenario in which the company operates provide an environment where volatility is a fundamental factor. Therefore, a sensitivity analysis is performed (Table 8). The results obtained, applying the abandonment option to a RO valuation, indicate that the value of the company is higher in the presence of significantly elevated volatility. Considering these results, the abandonment option presents an increasing value trend.

5. Conclusions

In recent years, fisheries management in the northwestern waters of the European Union started a new period characterized by important institutional changes with significant socio-economic consequences of great relevance. The landing obligation policy and the situation created by the Brexit create a scenario of uncertainty for the fleets operating in the fishing grounds of the Grand Sole. The first factor results in a decrease in operating income due to the ban on discarding species of low economic value, which saturates the storage capacity of vessels and prevents them from catching more valuable species. The second factor entails a considerable loss of fishing opportunities in the British EEZ, as a quarter of them must be ceded to the United Kingdom for 5 years under the new partnership agreement signed in 2020. Once the transition period is over, the UK will have full control of the resources in its waters, so fishing opportunities will have to be established in annual negotiations. This has increased uncertainty for the fleets that traditionally operated in the fishery. Fleet operating costs will also be altered in the short term due to the elimination of the fuel tax exemption.

Spain is one of the countries with the largest presence in the Grand Sole fishing grounds and, therefore, one of the most affected by the factors described above. The discard ban has significantly affected the profitability of smaller companies, resulting in the closure of several of them. The objectives of increasing selectivity in catches pursued by this regulation are difficult to achieve for a large part of the fleet using trawl gear. Furthermore, the expected impact of Brexit is also very significant given the importance of the fishing species whose quota is reduced and the number of fishing areas that remain under the control of the United Kingdom. Moreover, the fuel tax exemption affects Spain to a greater

Table 7
Liquidation value company.

Year	Liquidation value (€)
2020	4,021,645.64
2021	4,493,272.44
2022	5,016,722.32
2023	5,460,330.99
2024	5,903,939.67
2025	6,347,548.34
2026	6,791,157.02
2027	7,234,765.69
2028	7,678,374.37
2029	8,121,983.04
2030	8,565,591.72

2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
										17,428,152.76
									15,550,800.39	
								13,875,675.53		13,875,675.53
							12,380,994.33		12,380,994.33	
						11,047,319.47		11,047,319.47		11,047,319.47
					9,857,307.45		9,857,307.45		9,857,307.45	
				8,795,482.95		8,795,482.95		8,795,482.95		8,795,482.95
			7,848,037.69		7,848,037.69		7,848,037.69		7,848,037.69	
		7,002,650.78		7,002,650.78		7,002,650.78		7,002,650.78		7,002,650.78
	6,248,328.55		6,248,328.55		6,248,328.55		6,248,328.55		6,248,328.55	
5,575,261.55 €		5,575,261.55		5,575,261.55		5,575,261.55		5,575,261.55		5,575,261.55
	4,974,697.02		4,974,697.02		4,974,697.02		4,974,697.02		4,974,697.02	
		4,438,825.01		4,438,825.01		4,438,825.01		4,438,825.01		4,438,825.01
			3,960,676.88		3,960,676.88		3,960,676.88		3,960,676.88	
				3,534,034.64		3,534,034.64		3,534,034.64		3,534,034.64
					3,153,350.10		3,153,350.10		3,153,350.10	
						2,813,672.72		2,813,672.72		2,813,672.72
							2,510,585.22		2,510,585.22	
								2,240,146.17		2,240,146.17
									1,998,838.68	
										1,783,524.73

Fig. 1. NPV binomial tree (€).

2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
										17,428,152.76
									15,550,990.28	
								13,876,014.40		13,875,675.53
							12,381,447.89		12,381,145.51	
						11,148,902.53		11,047,589.27		11,047,319.47
					10,203,367.27		10,058,054.27		9,857,427.81	
				9,516,187.81		9,382,657.09		9,193,095.47		8,795,482.95
			9,034,851.06		8,940,247.44		8,816,881.15		8,636,238.31	
		8,704,759.11		8,654,575.21		8,596,938.94		8,536,801.81		8,565,591.72
	8,479,622.02		8,468,479.83		8,461,043.69		8,466,825.72		8,523,400.88	
8,324,303.05		8,343,306.14		8,370,058.14		8,411,413.94		8,481,417.86		8,565,591.72
	8,254,430.60		8,302,962.60		8,363,254.51		8,439,641.64		8,523,400.88	
		8,248,551.37		8,318,758.01		8,398,071.19		8,481,417.86		8,565,591.72
			8,276,162.11		8,356,705.49		8,439,641.64		8,523,400.88	
				8,315,543.55		8,398,071.19		8,481,417.86		8,565,591.72
					8,356,705.49		8,439,641.64		8,523,400.88	
						8,398,071.19		8,481,417.86		8,565,591.72
							8,439,641.64		8,523,400.88	
								8,481,417.86		8,565,591.72
									8,523,400.88	
										8,565,591.72

Fig. 2. Binomial tree of NPV+option abandon (€).

Table 8
Sensitivity analysis.

Volatility	NPV + abandon option (€)
5%	8,154,104.66
10%	8,261,082.197
15%	8,543,290.62
20%	8,827,241.23
25%	9,191,639.87
30%	9,576,950.59
35%	9,943,401.76
40%	10,290,793.16
45%	10,618,663.24

extent than the other countries operating in the area, given its distance from the fishing grounds. During 2020 and 2021, the Covid-19 pandemic reduced the demand for fresh fish products and therefore their price, which had a negative impact on the economic performance of this fleet. All these factors have aggravated the decreasing trend in the number of vessels in this fleet, from 300 vessels in 1986 to the current 91 vessels. As a result, the expectations of the sector are not positive and the request for subsidies for vessels scrapping has increased.

The critical situation of the fleet operating in this area justifies a valuation analysis applied to a standard company in this sector. Thus, the valuation of this company has been carried out using two complementary methodologies, the NPV and the Real Options approach. This analysis, by adding management flexibility, quantified using an abandonment option, provides a more complete valuation of the company.

The results of the analysis indicate that the possibility of abandonment by these companies is a decision to be taken into account by the decision-makers. The value of the abandonment option, which increases the valuation of the company by 49.3%, assigns relevant information to appropriately consider the fact of leaving the market. In addition, the sensitivity analysis performed on the volatility variable shows the effect that this parameter has on the value of the project. As the results show, the abandonment option increases its value in scenarios where volatility is increased. Precisely, the scenario where the Grand Sole fleet operates presents a process of institutional change that increases the degree of volatility.

The economic, political and social change in which the Grand Sole fishery is immersed is a highly challenging process as different actors, objectives and institutional processes converge in the governance of the resource. The sustainable governance imposed by the European blue economy guidelines is juxtaposed both with the process of income transfer from the EU to the United Kingdom, due to Brexit, as well as with energy decarbonization policies. While the objective of achieving a higher degree of sustainability of fishing activity is feasible, its harmonization with the interests of the industry is rather complex. This is because the socio-economic impact of these measures may intensify the negative trend in which the Spanish Grand Sole fleet already operates. The reduction of quotas, the increase in the cost of fuel, the increase in rivalry for the resource or the prohibition of discarding catches may make fishing activity unviable for a large part of the companies in the sector.

CRediT authorship contribution statement

Raquel Fernández-González: Conceptualization, Validation, Formal analysis, Investigation, Writing – original draft, Writing – review & editing, Visualization. **Raisa Pérez-Vas**: Methodology, Validation, Resources, Writing – review & editing, Visualization. **Marcos I. Pérez-Pérez**: Validation, Formal analysis, Data curation, Writing – review & editing, Visualization. **María Dolores Garza-Gil**: Validation, Formal analysis, Resources, Writing – review & editing, Visualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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