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Impact of Paris Agreement on financing strategy: Evidence from global FPSO industry

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ABSTRACT

This study explores the impact of the Paris Agreement on the determinants of firm-level capital structure decisions of listed contractor-owned Floating Production Storage and Offloading (FPSO) companies in the oil and gas (O&G) industry from 2000 to 2019. The study identified various financing structures between contractor-owned FPSO companies due to their individual and institutional characteristics. Tangibility, profitability, market-to-book (growth), size and effective tax rates are critical determinants of capital structure. Overall, the results support applying the pecking-order theory (PoT) from a firm-level and macro-economic context. The 2015 Paris Agreement ratification significantly impacted the capital structure determinants; the dynamic association has changed in the post-Paris period. Besides, the impact of the global financial crisis on leverage ratios was potentially mitigated by the upward trend in Brent crude oil price between 2007 and 2013.

1. Introduction

Climate change is the most significant risk the world is facing today. Since the last decade, economic growth has been continuously defied by the necessary actions to protect the environmental balance (Barbier, 1997). There was a time when policymakers believed in a 'win-win' strategy that focused on improving per capita income, which can contribute to alleviating poverty in the first stage and then cleaning up the environment (Tamazian and Rao, 2010). But, fatefully, the concern of increasing CO_2 emissions and its devastating impact on the environment and human life is demanding immediate actions to stop environmental degradation and mitigate the adverse effects of climate change (see, e.g. Nasir et al., 2021a; Lomborg, 2020; Gupta, 2017; Tamazian and Rao, 2010). The United Nations Framework Convention on Climate Change (UNFCCC) is an international treaty for international cooperation which combats this climate change (Ari and Sari, 2017; UNFCCC, 1992). In 2015, the party countries of UNFCCC entered into an agreement, commonly known as the Paris Agreement, and 197 countries have submitted their pledge to curb greenhouse gas (GHG) emissions in an attempt to mitigate the climate change problems (Liu et al., 2020; UNFCCC, 2015). Interestingly, as opposed to the Kyoto Protocol, the Paris Agreement does not establish emission reduction and limitation targets for individual parties (Ana et al., 2019). Instead, it focuses on aggregate climate change goals and calls on parties to contribute to this goal.

It is obvious that to minimise the carbon footprint and achieve the GHG emission goal, we need to reduce the consumption of fossil fuels and invest more in renewable energies and alternative technologies (see, e.g. Murshed et al., 2021; Megan-Tian and Pan-Mao, 2021; Liu et al., 2020; Algunaibet et al., 2019; Gupta, 2017; Tamazian and Rao, 2010). Because fossil fuel consumption produces roughly 80 % of global GHG emissions in the form of CO_2, it also contributes to the methane (CH_4) and nitrous (N_2O) emissions (see IEA [Clean and Coal Center], 2002). Therefore, due to various carbon reduction initiatives of governments worldwide, including UNFCCC climate summits, we might expect less growth in investment in traditional energies and related industries (see Liu et al., 2019). That means we might see that financial institutions and governments are less interested in patronising this traditional energy sector. With this motivation, we set our objective in this paper to investigate the impact of the Paris Agreement on the financing strategy of a niche, highly specialised and capital-intensive sector of the O&G industry, the FPSO firms, which is heavily dependent on external financing. Recently, the Paris Agreement has been considered an essential factor in environmental and climate research. For example, Shahbaz et al. (2020a) investigated the possible consequences and policy implications of the United States' (US) withdrawal from the Paris Agreement. Interestingly, they find that education becomes a powerful determinant to fight global warming and curb CO_2 emissions in the US

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despite their withdrawal. In an earlier study, Li et al. (2017) suggested to apply the Paris Agreement as a strategic map, which would help to design the global-regional climate policies. Our objective in this paper, therefore, fits with the widespread interest in understanding the comprehensive impact of the Paris Agreement and whether the adoption of the pledge has any firm-level effects, such as on the capital structure. Moreover, whether the world is on track in meeting the pledges (see Gunfaus and Waisman, 2021; Megan-Tian and Pan-Mao, 2021), hence adversely affecting the traditional energy sector.

An FPSO is a permanently positioned vessel (usually a converted tanker or new build) equipped with hydrocarbon processing equipment for separation and treatment of crude oil, gas and water from subsea oil wells via flexible pipelines, crude oil storage capacity and offloading systems, and includes personnel living quarters. The technology advancements in FPSO installation have made FPSOs an effective solution for both deepwater and ultra-deepwater fields due to their cost efficiency and life extension possibilities, thus enabling redeployment to new assignments/oilfields instead of decommissioning.

As a part of the upstream O&G industry, the FPSO industry has grown globally since the first FPSO was introduced in 1979, mainly due to the increased deepwater exploration and pressures to reduce production costs and/or total investment costs amidst the current average oil price of US$60 per barrel. As of mid-2018, the total operating and available FPSO fleet worldwide was 199, with 45 % of the fleet owned by specialised oilfield service companies (hereafter FPSO contractors) (Wood, 2018) and leased by O&G companies. The FPSO industry is highly specialised and highly capital intensive, where the cost of new builds is between US$2.5–3.0 billion, and conversion cost is from US $1.5–2.0 billion (Transparency Market Research, 2018). Therefore, the capital structure decisions in both financing the projects and capital investments are essential to ensure the continued survival of FPSO contractors.

Capital structure refers to distributing funds from different sources, namely debt and equity used by a company to finance its assets, and is one of the most discussed subjects in corporate finance. In an industry where project delays, budget overruns or cancellations are a norm, heightening debt levels may increase repayments default and bankruptcy risks, impacting the prospect of raising additional capital. On the other hand, excessive equity funding may lead to earnings dilution through dividend payments, limiting the availability of cash flows for finance repayments and future investments. Therefore, a key objective of corporate finance managers is to maximise shareholders' wealth with minimal cost of capital without jeopardising the company's future. Although the topic is heavily researched, there is no conclusive evidence on a single theory that can satisfactorily explain a company's capital structure choice and the firm-level determinants (see, e.g. Abeywardhana, 2017; Fama and French, 2002; Myers, 2001).

Existing literature suggests that capital structure decisions are influenced by a trade-off between the benefits and costs of debt (Modigliani and Miller, 1963; Kraus and Litzenberger, 1973); asymmetric information (Myers, 1983; Myers and Majluf, 1984); free cash flow problems (Jensen and Meckling, 1976; Jensen, 1986); and market timing initiatives (Baker and Wurgler, 2002). Besides, concerning the determinants of capital structure, Frank and Goyal (2009) identified six (6) key factors that significantly explain changes in capital structure: industry median leverage, profitability, asset tangibility, market-to-book ratio (growth), firm size and expected inflation. However, these determinants may respond to one or more theories (Myers, 2001). For example, Fama and French (2002) identified shared predictions for determinants between the pecking-order and trade-off theories but could not define the actual cause of the prophecies, suggesting that both theories are complementary in explaining parts of corporate financing behaviour. Therefore, although companies are always seeking to maximise their value, yet they could adopt different approaches in managing their gearing level at different points in time, i.e., optimal debt levels (trade-off theory), accumulation of profits (pecking-order theory) or issuance of equity in favourable market conditions (market-timing theory).

This paper, for the first time, investigates the determinants of capital structure of the FPSO industry and looks at how an environmental consensus, such as the Paris Agreement, modifies the impact. Therefore, the contribution of this study is two-fold. First, this study complements the literature on capital structure of corporate finance. The existing empirical evidence on capital structure considerations and their impacts in the O&G industry have mainly been on international and national oil companies or the O&G industry collectively (Foo et al., 2015; Oladeji et al., 2015; Doku et al., 2016; Boz and Arslan, 2017; Shambor, 2017). To the best of our knowledge, there is limited or no specific literature available on the capital structure choices and its determinants of FPSO contractors, which is a highly specialised sector and heavily capital intensive. Moreover, the number of FPSO contractors has decreased over the years due to financial and commercial contractual compliance pressures. Therefore, a market with reduced players and limited financial specific literature, coupled with a gradual transition to a low-carbon energy future, has raised interest in understanding the capital structure strategy of existing FPSO contractors and the impact of ratification of the Paris Agreement 2015.

Second, our study also contributes to the growing environmental, social and governance (ESG) literature. This is the first evidence on the impact of environmental consensus (i.e. the Paris Agreement) on the firm-level financing decision. The Paris Agreement has drawn the attention of contemporary ESG researchers (e.g. Shahbaz et al., 2020a; Li et al., 2017; Gunfaus and Waisman, 2021; Megan-Tian and Pan-Mao, 2021), yet the influence on capital structure determinants of a traditional energy sector is scant. Therefore, findings help us understand how firms linked with fossil fuel are affected by the pledge of 197 countries in their road map of achieving the emissions goal. Subsequently, the study directly contributes to the debate of achieving the Paris Agreement and the literature of business-environment relationships.

The results show that contractor-owned FPSO companies have higher leverage ratios and consequently higher financial risk compared with samples of global O&G and industrial companies. The primary determinants of leverage, according to the regression results, are tangibility, profitability, growth, size and effective tax rate. The strong negative relationship between tangibility with leverage, in fact, demonstrates one of the unique features of the capital structure dynamics of the contractor-owned FPSO companies, which is the use of project finance arrangements to secure debt and equity financing. Such financing arrangements would necessitate finance managers aligning the underlying risk profile of the project cashflow with the financing structure, suggesting that capital structure varies over time in response to project needs and costs of various sources of finance.

Most importantly, we find that contractor-owned FPSO companies are individually different in their financing structure, partly due to the complex corporate structures and contractual arrangements undertaken in different institutional settings (legal systems) as well as tax positions. Accordingly, their financing behaviour appears to follow the PoT since their capital structure appears to vary according to requirements.

The results suggest that the 2015 Paris Agreement significantly modified the impact of capital structure determinants of FPSO contractors, i.e. the firm size became a statistically significant factor of capital choices during the post-Paris period. Moreover, the significance of market-to-book ratio heightened post-Paris. Besides, the negative impact of business risk further deepened after the Paris Agreement.

The remainder of this study is organised as follows: Section 2 provides the theoretical framework; Section 3 presents the research design, including the dataset and variables used. The empirical findings of the study and robustness checks are employed in Section 4. Section 5 concludes the study with future research recommendations.

2. Literature review

2.1. Capital structure theories

The three most prevalent theories rationalising corporate financing structure are the trade-off, pecking-order and market-timing theories. The trade-off theory (ToT) assumes that capital structure gravitates towards an optimum leverage, which is determined by the balancing or offsetting of the advantages of borrowings (tax breaks and/or subsidies) against the perceived risks of bankruptcy (Kraus and Litzenberger, 1973; Shyam-Sunder and Myers, 1999; Berk et al., 2015). This implies that profitable firms will gain more from borrowings, but less profitable firms would benefit more from equity financing (Scott, 1976; Fama and French, 2002; Kayhan and Titman, 2007). However, some empirical studies have identified lower leverage ratios in profitable firms (Myers, 1993; Fama and French, 2002). While debt can be advantageous, excessive levels can aggravate the shareholder-debtholder friction due to competing expectations created by over- or under-investment decisions and asset substitution (Jensen and Meckling, 1976; Myers, 1977), particularly in the presence of free cash flow (Jensen, 1986). As a result, firms should select an optimal debt-equity mix that maximises market value by balancing the cost and advantages of both kinds of funding. However, Myers (1983) argued that due to a dynamic operating environment, a firm's debt-equity mix changes throughout its lifecycle. On this premise, Fischer et al. (1989) designed the dynamic ToT by factoring in recapitalisation costs and demonstrated that corporate financing structure evolves over time while remaining within an optimal debt ratio range.

In contrast to the ToT, the PoT asserts information asymmetry between management and investors as market imperfection. It does not define an optimal leverage ratio but suggests that corporate capital structure changes over time according to requirements and costs/risks of different sources of finance (Myers, 1983). According to the PoT, internal funding (retained earnings and reserves) will be the first-choice source of finance due to limited asymmetric information, and when insufficient, external financing will be utilised. A hierarchical selection will be applied on external sources of finance based on the cost/risk of asymmetric information, indicating that in order of preference, low-risk/safe debt, risky debt and, lastly, equity will be used (Myers, 1983; Myers and Majluf, 1984). Although normally associated with information asymmetry, tax, agency or behavioural considerations can influence the PoT (Frank and Goyal, 2009). Empirically, the PoT is more prevalent in smaller firms where information asymmetry is higher, resulting in larger equity issuance (Fama and French, 2002; Frank and Goyal, 2003).

The third theory, market timing theory (MTT), articulates that financing strategy is driven by the most favourable conditions in the debt and equity markets. Accordingly, corporations will first debt-finance projects when their share price is overvalued (low market-to-book value) and equity-finance when their share price is undervalued (high market-to-book value). As a result, capital structure is not based on optimisation but the cumulative result of historical efforts to time the equity market, and the long-term effects of equity transactions on capital structure (Baker and Wurgler, 2002). However, certain studies have evidenced that the effects of equity transactions on capital structure are short-lived (Alti, 2006; Hovakimian, 2006; Kayhan and Titman, 2007).

Significant empirical research has been conducted on the basis of these theories, with the majority concluding that there is no universally acceptable theory that can explain capital structure decisions (Myers, 2001; Graham and Leary, 2011). However, reliable firm-level determinants explaining the deviation in leverage level have been identified (Lemmon et al., 2008; Frank and Goyal, 2009).

2.2. Capital structure determinants

Empirical literature has identified various firm-specific and macroeconomic factors known to impact corporate capital structure, and their significance in relation to the aforementioned three theories is considerable. For this study, we observe some of these variables and other factors deemed relevant to the capital structure of FPSO contractors.

2.2.1. Firm-specific factors

Profitability: Under the ToT, profitability is predicted to have a positive influence on leverage for profitable firms as the cost of financial distress is lower, while the agency perspective suggests that profitable firms tend to raise more debt to mitigate agency conflicts (Jensen and Meckling, 1976). In contrast, the PoT predicts an inverse relationship due to adverse selection costs and asymmetrical information issues, resulting in lower levels of leverage in highly profitable firms. Most empirical studies support the negative relationship under the PoT (Fama and French, 2002; Gaud et al., 2005; Kayhan and Titman, 2007; Drobetz et al., 2013; Moradi and Paulet, 2019).

Corporation size: According to the ToT, large firms are more diversified and so have lower default risks (Titman and Wessels, 1988), easier access to capital markets, stronger interest rate negotiation power and better credit rating (Ferri and Jones, 1979; Ozkan, 2001); as a result, a positive relationship between leverage and size. Conversely, the PoT infers a negative association since larger firms have better information transparency in the capital market, making equity issuance cheaper when compared to smaller firms (Huang and Song, 2006; Rajagopal, 2011). Most empirical studies document a positive relationship between leverage and size, which supports the ToT (de Jong et al., 2008; Frank and Goyal, 2009; Drobetz et al., 2013; Moradi and Paulet, 2019).

Growth opportunities: The market-to-book ratio is the most reliable measure for growth opportunities (Adam and Goyal, 2008) but its effect on borrowings has resulted in inconsistent observations. Holding profitability constant, the PoT predicts a positive relationship between leverage and growth (Fama and French, 2002; Frank and Goyal, 2009). In contrast, because growth firms are deemed to be riskier with higher levels of information asymmetry (Myers, 1977), the ToT posits a negative relationship. The MTT also predicts a negative link as firms will exploit the growth factor by issuing overvalued shares. Empirical studies generally report a negative link, in line with the ToT (Ozkan, 2001; Gaud et al., 2005; Hovakimian, 2006; Frank and Goyal, 2009; Hang et al., 2018; Moradi and Paulet, 2019).

Asset tangibility: The ToT predicts a positive relationship between asset tangibility and leverage because tangible assets are easier to value in times of financial distress (reducing the agency cost of debt) and provide additional benefits of non-debt-related tax deductions. The PoT predicts the opposite, as increased information transparency reduces the

cost of equity financing (Harris and Raviv, 1991). However, when the relationship is examined from the perspective of debt tenure, Berkman et al. (2016) observed a positive link for long-term borrowings and negative relationship for short-term borrowings. Empirical studies have yielded mixed results, with the majority evidencing positive impacts (Drobetz et al., 2013; Shambor, 2017; Moradi and Paulet, 2019), supporting the ToT.

Taxation: According to the ToT, the incentivising effect of debt tax shields encourages firms to select debt over equity financing during periods of high tax rates (Frank and Goyal, 2009; Feld et al., 2013; Faulkender and Smith, 2016). Hence, a positive effect on leverage, although with varying amplifications (Feld et al., 2013). Firms also benefit from non-debt-related tax deductions from fixed assets and investments. These non-debt tax shields can be used in place of tax-debt shields and are negatively related to borrowings (DeAngelo and Masulis, 1980). Shambor (2017) observed similar results for global O&G companies. The PoT and MTT offer no predictions on the effects of taxation on leverage.

Dividend-paying status: The impact of dividends on leverage is uncertain under the PoT since larger dividend distributions reduce retained earnings, increasing the need for external financing. Given that debt is preferred over equity, a positive effect is expected under the PoT; however, a negative effect is expected based on transaction and agency costs arguments (Easterbrook, 1984; Jensen, 1986; Antoniou et al., 2008). The latter prediction is consistent with the ToT, where dividends are an alternative for debt in controlling the free cash flow agency problem. Frank and Goyal (2009) evidenced that debt levels are lower in dividend-paying firms.

Business risks: Under uncertain business conditions, a firm's earnings will be volatile and its ability to service its debts, pay out dividends and secure external financing will be affected by the increased probability of financial distress. Therefore, the ToT predicts a negative relationship between risks and borrowings (Frank and Goyal, 2009; Rajagopal, 2011; Moradi and Paulet, 2019). As information asymmetry will be more pronounced with increased risk (Grossman and Stiglitz, 1980), a positive link is expected under the PoT. However, following the MTT, the link would be negative as a firm's share price would generally decrease with increased risk, making it less willing to issue equity and use more debt.

2.2.2. Macro-economic factors

Given the reliance of the FPSO industry on the upstream O&G industry, financing decisions will be influenced by macro-economic developments affecting the O&G industry. Following the PoT reasoning, less debt would be utilised during periods of economic expansion due to the increased cash flows resulting from higher profitability and earnings retention. Thus, leverage is counter-cyclical to the business cycle. However, the ToT points towards pro-cyclical leverage due to increasing agency issues caused by the availability of free cash flows, and debts will be used to mitigate these issues.

Oil price: Following the PoT and consistent with the results of Dayanandan and Donker (2011), it is expected that oil price would have a negative correlation to leverage due to the long lead time of FPSO projects delaying the effect of the oil price crash in June 2014.

Lagged term spread: Inflation can have a significant impact on financing decisions. Firms will prefer to lower their borrowing levels and repay their obligations during periods of high inflation, resulting in a negative relationship between inflation and leverage.

Gross domestic product (GDP) growth rate: Improvements in GDP growth rates would indirectly affect demand for FPSOs, i.e. increased capital investment by international oil companies (IOC) and national oil companies (NOC) IOCs/NOCs for production of energy, by increasing the cash flow and profitability of FPSO contractors. Thus, under the PoT, leverage would be negatively related to GDP growth rate as opposed to the ToT, which posits a positive relationship.

MSCI world index: In periods of economic expansion, share prices are expected to be high, and from the PoT perspective, increased profitability and retained earnings imply reduced leverage levels, as internal sources of finance are preferred over external borrowings. In contrast, the ToT predicts a negative association due to the alleviation of free cash flow problems.

Real trade weighted US dollar index – major currencies: Given that the US dollar is the main transaction currency of the international O&G industry, any fluctuations in the exchange rate would affect not only the economic position of FPSO contractors, but their cash flow through translation and transaction risks. For a non-US-domiciled contractor, the depreciation of the US dollar implies higher cash flows in their local currency, lowering requirements for external borrowing and higher leverage position (according to the ToT and vice versa for PoT).

2.3. Effect of the global financial crisis

The 2008 global financial crisis (GFIN), triggered by the collapse of the US housing market, resulted in a major economic downturn on a global, regional and national scale, eroding investor returns and firm profitability. However, its impact varied in degrees and intensity in different economies (Nasir et al., 2021b). Thus, in order to survive, firms have had to change their operations.

The GFIN has been demonstrated in studies to have a major impact on corporate capital structure decisions and leverage determinants. According to Dayanandan and Donker (2011), the GFIN had a negative impact on oil price and firm performance when compared to the Asian financial crisis and the 9/11 tragedy, which had no impact on the profitability of O&G companies. Shambor (2017) concluded that the GFIN had a significant impact on all capital structure determinants (tangibility, profitability, growth, size, liquidity and non-debt tax shields) of O&G companies. While Halling et al. (2016) documented that most predictions of theoretical frameworks were constrained during a period of recession, and that counter-cyclical patterns were more pronounced during an economic recession with a banking crisis. Therefore, in this study, we examine whether the capital structure decisions of FPSO contractors and determinants of leverage were influenced by the GFIN.

2.4. The Paris Agreement and 2015 as the climate awareness focal year

This study assumes that the impact of climate change on corporate financing decisions is more prominent in the post-2015 period, as international focus on climate challenges has since been growing.

The Paris Agreement (hereafter COP21) was adopted internationally at the 21st United Nations Climate Change Conference in December 2015 and focused on reducing global average temperature increases to 1.5 °C and below 2 °C above pre-industrial levels, adapting to the effects of climate change and supporting developing countries in their response to climate change threats. As part of their pledge to the objectives of the Agreement, countries are submitting regular reports on the implementation of their individual nationally determined contributions or climate action plans and emission levels. In the same year, the Task Force on Climate-Related Financial Disclosures was set up by the Financial Stability Board to develop voluntary climate-related financial disclosures for companies to ensure that global capital markets have consistent and reliable information on the impacts of climate change on those companies.

These key initiatives have prompted companies and investors to reassess the value of their assets and/or investments and capital allocation efficiency, and include climate risk as part of long-term strategies. However, the influence of foreign direct investments, economic activity, R&D spending and energy use on environmental degradation demonstrate that assessing and controlling climate risk exposure is difficult (see e.g. Nasir et al., 2019; Doğan et al., 2020; Huynh et al., 2020; Pham et al., 2020; Shahbaz et al., 2020b; Nasir et al., 2021b; Nguyen et al., 2021). To which Shahbaz et al. (2018) aptly surmise, financial stability

Table 1
FPSO companies and firm-year observations by country.

Country	Companies	Firm years
Japan	2	40
Malaysia	4	80
Netherlands	6	120
Norway	3	60
United States	3	60
Total	18	360

Note: The table summarises the distribution of companies and firm-year observations by country of incorporation for the sample companies. Annual data are obtained from the Thomson Reuters Datastream database from 2000 to 2019. The companies are classified into their country of incorporation based on Datastream item 'market'.

Table 2
Definition of variables.

Variables	Definition	Source
Panel A: Firm-level variables		
Book leverage	Ratio of long- and short-term debt to total book assets.	Datastream
Tangibility	Ratio of net value of property, plant and equipment (net PPE) to total book assets.	Datastream
Market-to-book (Growth)	Ratio of market value of assets to book value of assets.	Datastream
Size	Natural logarithm of total book assets.	Datastream
Profitability	Ratio of earnings before interest, taxes, depreciation and amortization (EBITDA) to total book assets.	Datastream
Effective tax rate	Effective tax rate.	Datastream
Dividend payer	Indicator dummy variable equal to one (1) if the company pays dividends in the given year and zero (0) if no payments are made.	Datastream
Business risks	The variance of stock return.	Datastream
Panel B: Macro-economic variables		
Financial crisis (GFIN)	An indicator variable equal to one (1) for the crisis period (2007–2009) and zero (0) for the non-crisis periods (2002-2006 and 2010-2017).	
Term spread	One-year lagged term spread between the 10-year and 1-year US treasury bills.	Federal Reserve
GDP growth rate	The real GDP growth rates (%) of the individual countries.	Worldbank
Oil price	Annual Brent crude oil price.	MWV
Stock market return	Natural logarithm of the annual stock market return of MSCI World Index.	Datastream
FX USD	Annual change in the real-trade weighted USD index 'Major Currencies'.	Federal Reserve
Panel C: Paris Agreement (COP21) variable		
Paris Agreement (COP21) period	Indicator dummy variable equal to one (1) for the post-COP21 period (2016–2019) and 0 for the pre-COP21 period (2000–2015).	
Alternative leverage measures and additional variables (robustness test)		
Book leverage (2)	Ratio of total (non-equity) liabilities to total book asset.	Datastream
Law	Indicator dummy variable equal to one (1) in countries with a common law regime and zero (0) for non-common law regimes.	World Factbook

and environmental sustainability are "two sides of the same coin".

Addressing environmental risks in the O&G industry is complex and challenging as it depends on their activities, the legal regimes and the geographical location in which they operate, making it a key decision element in financing any project in this industry. Most financial institutions active in financing the industry are adopters of the Equator Principles[1] and are, therefore, accustomed to the process of assessing and managing environmental risks. However, the monitoring and compliance costs will be priced into the interest rates to be borne by borrowers, which may be disadvantageous to smaller or financially constrained companies. Hence, the COP21 ratification should generally have a negative impact on leverage.

3. Data and methodology

3.1. Sample of globally listed FPSO contractors

The sample comprises all globally listed FPSO contractors from the Thomson Reuters Datastream database for 20 years between 2000 and 2019. However, we excluded companies with fleet ownerships less than three vessels. We chose the starting point of 2000 as international recognition of environmental concerns started after adopting the Kyoto Protocol[2] in 1997. The sample in this paper continued till 2019 with two objectives, first, to capture the long-run capital structure behaviour. Second, availability of the firm-level financial data of the FPSO sector, which is readily available until 2019. There are several missing observations after 2019. The data are on an annual basis and converted into US dollars. Accordingly, the final sample consisted of 360 firm-year observations from five countries between 2000 and 2019. Table 1 reports the number of FPSO companies and firm-year observations by country of incorporation for the selected FPSO contractors in our study.

3.2. Variables defined

3.2.1. Firm-level leverage

The definition of leverage used in empirical research is not always straightforward due to the myriad types of debts, equity and hybrid securities (Welch, 2011), and the opinions on the best measures are diverse. Therefore, in this paper, we follow Rajan and Zingales (1995), Lemmon et al. (2008) and Drobetz et al.'s (2013) definitions and use the ratio of total debt (i.e. sum of short- and long-term interest-bearing debts) to total book value of assets as the primary dependent variable (i.e. book leverage). However, alternative definitions of book leverage also suggested in Rajan and Zingales (1995) are used for the robustness test. Table 2 provides the definitions of leverage used in this study.

3.2.2. The firm-specific, macro-economic, financial crisis and COP21 variables

We summarise all the explanatory and control variables, and their respective data sources in Table 2. These lists of variables have been selected based on earlier literature, such as Shambor (2017), Drobetz et al. (2013), Frank and Goyal (2009), and Adam and Goyal (2008). Our primary interest is to see the impact of the Paris Agreement (post-COP21) on the determinants of firm-level leverage of the FPSO sector. Therefore, we have identified tangibility, market-to-book value ratio, size, profitability, effective tax rate, dividend payer and business risk as the explanatory variables. In addition, we run various robustness checks of the baseline regressions by including macro-economic variables (as suggested in Halling et al., 2016; Korajczyk and Levy, 2003; Korteweg and Strebulaev, 2015; Drobetz et al., 2013), the parent country's legal system (suggested in Fan et al., 2012; Halling et al., 2016), and comparing with the O&G industry. Finally, we use GDP growth rate to control the difference in country-level characteristics across all our models.

[1] The Equator Principles is a risk management framework launched in 2003, providing minimum guidelines to support environmental and socially responsible financing by financial institutions (Equator Principles Association, 2020)

[2] For details on the Kyoto Protocol, please refer to the following website: https://unfccc.int/kyoto_protocol

Table 3
Descriptive statistics and firm-level variables comparisons.

Descriptive statistics								Firm-level variables comparison		
	Mean	SD	Median	Percentiles		Min	Max	[1]	[2]	[3]
				25th	75th			Frank and Goyal (2009), Mean	Drobetz et al. (2013), Mean	Shambor (2017), Mean
Leverage measure										
Book leverage	0.4541	0.1432	0.4562	0.3911	0.5444	0.0549	1.0459	0.2900	0.4070	0.2457
Firm-specific variables										
Book assets (US$ billion)	4.6700	3.7000	3.3600	2.0500	6.7000	0.0234	13.1000			
Tangibility	0.5067	0.2610	0.5954	0.2761	0.7114	0.0075	0.8451	0.3400	0.6300	0.5233
Market-to-book	0.8602	0.3871	0.8334	0.6761	1.0474	0.0000	2.0000	1.7600	1.1650	0.1622
Profitability	0.0879	0.0616	0.0831	0.0545	0.1252	−0.1440	0.2361	0.0200	0.1130	0.0920
Size	14.8999	1.2012	15.0278	14.5322	15.7170	10.0619	16.3852	4.5800	6.4830	15.9889
Dividend payer	0.5333	0.4996	1.0000	0.0000	1.0000	0.0000	1.0000		0.7780	
Effective tax rate	32.5459	59.2843	18.5600	7.3300	35.3200	0.3800	438.4600	45.0000		
Business risks	0.0617	0.4519	0.0495	−0.2169	0.3316	−0.8424	1.4488	0.2700		
Macro-economic variables										
GDP growth rate	2.3827	2.3112	2.1703	1.2229	3.7728	−5.4164	8.8589			
Brent crude oil price	64.5580	28.4676	62.9350	40.8850	88.2300	24.4500	111.6300			
Stock market return	7.2190	0.2590	7.1978	7.0103	7.4352	6.7482	7.6417			
Term spread	1.5560	1.0229	1.7200	0.6250	2.5150	−0.1400	2.8900			
FX USD	85.1528	10.2382	83.8763	75.9210	91.4923	70.8683	107.8505			

3.3. Empirical models

To understand the impact of COP21 on the firm-level capital structure determinants of the FPSO sector, we apply panel-based multivariate models.[3] The baseline regression is as follows:

$$LEV_{it} = \alpha + \beta_1 X_{it} * Post\ COP21_i + \beta_2 Y_{it} + \beta_3 Z_{it} + TIME + FIRM + \varepsilon_{it} \quad (1)$$

where LEV_{it} represents the leverage measure of an observed FPSO company or firm, i at time, t; X_{it} is the vector of firm-level capital structure determinants (tangibility, market-to-book ratio, profitability, size, dividend payer, effective tax rate and business risk); *Post COP*21 is the Paris Agreement period (i.e. from 2016 to 2019).[4] The coefficients of interactions of X_{it} and *Post COP*21 should help us to understand the possible impact of COP21 on the determinants of FPSOs' capital structure. Y_{it} and Z_{it} are firm-level control variables and GDP growth rates, respectively. α is the intercept or constant; and β is the vector of regression coefficients on the estimated values with ε being the error term. *TIME and FIRM* are time and firm fixed effects to account for unobserved heterogeneity across time and firm level.

As mentioned in the earlier section, we extend our baseline model and check the robustness by including additional explanatory variables. The regression models we use for robustness are as follows:

$$LEV_{it} = \alpha + \beta_1 X_{it} * \text{Post COP21}_i + \beta_2 Y_{it} + \beta_3 Z_{it} + MEV_{ct} + TIME + FIRM + \varepsilon_{it} \quad (2)$$

$$LEVOES_{it} = \alpha + \beta_1 X_{it} + \text{Post COP21}_i * \text{FPSO}_i + \beta_2 Y_{it} + \beta_3 Z_{it} + TIME + FIRM + \varepsilon_{it} \quad (3)$$

$$LEV_{it} = \alpha + \beta_1 X_{it} * \text{Legal}_i + \text{Legal}_i * \text{Post COP21}_i + \beta_2 Y_{it} + \beta_3 Z_{it} + TIME + FIRM + \varepsilon_{it} \quad (4)$$

where LEV_{it} represents the leverage measure of an observed FPSO company or firm, i at time, t; $LEVOES_{it}$ is the leverage measure of the global O&G industry; MEV_{ct} is the country-level macro-economic variables (i.e. oil prices, stock market returns, term spreads and exchange rates); and *Legal* represents the legal system of an economy, and we apply a dummy variable 1 for the common law system and 0 for the civil law. The definitions of all other components across these three equations are similar to Eq. (1). Our object in Eq. (2) is to check the robustness of baseline regression after controlling additional macro-economic variables which are closely related to the firm's capital structure choices. Eq. (3) helps to understand the impact of COP21 on the global O&G industry and the sensitivity of the FPSO subsector compared to the others. The inclusion of a legal system sheds light on the comparative effect of COP21 between firms located in common versus civil law countries. In eq. (4), our model also compares the capital structure determinants between these two legal systems. This paper has used more models for robustness (see Appendix A1). The standard errors are clustered at the firm level to account for heteroscedasticity and autocorrelation errors in our regressions. The dataset was winsorized at the upper and lower one percentile to reduce outliers' effects.

3.4. Descriptive statistics and correlation coefficients

Table 3 presents the descriptive statistics for leverage and all the variables applied in this study. For a broader perspective, we compared the firm-level descriptive statistics of FPSO contractors against the results from Frank and Goyal (2009) for listed non-financial US companies, Drobetz et al. (2013) for globally listed shipping companies and Shambor (2017) for a sample of global O&G firms.

The mean book leverage ratio for the contractor-owned FPSO industry (45.4 %) is significantly higher than those for listed non-financial

[3] We use the panel-based multivariate models since the approach has several advantages explained in Bou and Satorra (2018) and Hsiao (1985). It allows the analysis of dynamic effects (i.e. effects among variables over time); provides a way to control for unmeasured stable variables (i.e. the so-called unobserved heterogeneity in the econometric literature); and can address some sources of endogeneity of regressors that prevent estimates from being interpreted as causal effects.

[4] We use the dummy variable approach following earlier literature, such as Uddin et al. (2022), Egana-delSol et al. (2022), Uddin and Chowdhury (2021), Uddin et al. (2021), to investigate the impact of the Paris Agreement on FPSOs' firm-level capital structure.

Table 4
Pairwise correlation matrix and variance inflation factors.

	Book leverage	Tangibility	Market-to-book	Profitability	Size	Dividend payer	Effective tax rate	Business risks	VIF
Book leverage	1.0000								
Tangibility	0.4230	1.0000							1.4100
Market-to-book (growth)	−0.2478	0.0923	1.0000						1.2900
Profitability	−0.1535	0.1948	0.2385	1.0000					1.5400
Size	0.0388	0.0802	0.1261	−0.2183	1.0000				1.1000
Dividend payer	−0.1873	−0.2443	−0.0277	0.0918	0.0001	1.0000			1.1500
Effective tax rate	0.0915	−0.0250	−0.2322	−0.3053	−0.1838	−0.1011	1.0000		1.1800
Business risks	−0.0850	−0.0072	0.2932	0.2724	−0.1472	0.0962	−0.2137	1.0000	1.1600

Note: This table presents the pairwise correlation coefficients for book leverage and the firm-specific determinants of leverage as well as the variance inflation factors (VIF) for the sample period from 2000 to 2019. All variables are winsorized at the upper and lower one (1) percentile.

Table 5
Baseline regression.

	(1)	(2)	(3)	(4)	(5)
Dependent variable: Book leverage					
Post-COP21 × Tangibility		−0.1211	−0.0862	−0.0484	−0.0785
		(0.0927)	(0.1099)	(0.0608)	(0.0650)
Post-COP21 × Market-to-book (growth)		0.3455**	0.2707**	0.2179**	0.2496**
		(0.1514)	(0.1370)	(0.0994)	(0.1017)
Post-COP21 × Profitability		0.4538	−0.1201	0.2752	1.2261
		(1.2659)	(1.6912)	(0.8082)	(1.0100)
Post-COP21 × Size		0.0938***	0.0963***	0.0950***	0.0891***
		(0.0300)	(0.0321)	(0.0234)	(0.0225)
Post-COP21 × Dividend payer		−0.0390	−0.0558	−0.0077	−0.0024
		(0.0493)	(0.0516)	(0.0313)	(0.0304)
Post-COP21 × Effective tax rate		0.0002	0.0005	0.0006	0.0008*
		(0.0007)	(0.0007)	(0.0004)	(0.0004)
Post-COP21 × Business risks		−0.1530**	−0.1429*	−0.1575***	−0.1069**
		(0.0605)	(0.0736)	(0.0414)	(0.0496)
Post-COP21		−1.6504***	−1.6055***	−1.0196***	−1.1239***
		(0.5003)	(0.5935)	(0.3755)	(0.3950)
Tangibility	−0.2475***	−0.3259***	−0.3036***	−0.2372***	−0.2966***
	(0.0434)	(0.0549)	(0.0719)	(0.0628)	(0.0713)
Profitability	−1.4247***	−1.4254***	−1.1925***	−1.0702***	−1.5892***
	(0.3350)	(0.3449)	(0.4066)	(0.2337)	(0.2484)
Market-to-book (growth)	0.1053**	0.1350***	0.1215**	0.1116***	0.0786**
	(0.0420)	(0.0448)	(0.0558)	(0.0322)	(0.0392)
Size	0.0099	0.0021	0.0038	0.0119	0.0485***
	(0.0078)	(0.0085)	(0.0121)	(0.0080)	(0.0133)
Dividend payer	0.0217	0.0269	0.0428	0.0142	0.0133
	(0.0241)	(0.0264)	(0.0298)	(0.0174)	(0.0179)
Effective tax rate	−0.0000	−0.0001	−0.0003	−0.0006***	−0.0008***
	(0.0002)	(0.0002)	(0.0002)	(0.0001)	(0.0002)
Business risks	−0.0242	−0.0186	−0.0175	−0.0075	−0.0416
	(0.0260)	(0.0348)	(0.0450)	(0.0225)	(0.0302)
Financial crisis		0.0765**	0.1558*	0.0652***	0.0948
		(0.0323)	(0.0867)	(0.0210)	(0.0599)
GDP growth rate	0.0197***	0.0180***	0.0307***	0.0048	0.0084
	(0.0056)	(0.0064)	(0.0100)	(0.0045)	(0.0088)
Observations	109	109	109	109	109
Year fixed effects	No	No	Yes	No	Yes
Firm fixed effects	No	No	No	Yes	Yes
R-squared	0.4358	0.5963	0.6745	0.8468	0.8958
JB test (*p*-value)	0.225	0.189	0.194	0.233	0.316
Breusch-Pagan (p-value)	0.166	0.197	0.298	0.213	0.304
Wald test (p-value)	0.112	0.183	0.167	0.191	0.324

Note: This table presents the results of the standard leverage regression for the sample companies from 2000 to 2019. All variables are winsorized at the upper and lower one (1) percentile. Cluster-robust standard errors at the firm level are reported in parentheses. Year and firm-fixed effects indicate the type of fixed effects included in the specification. We report the Jarque-Bera (JB) and Breusch-Pagan to confirm that there is no autocorrelation and heteroscedasticity in the residuals. The Wald test is performed to test the non-linear hypotheses after estimation, and the *p*-values suggest we could not reject the null of linearity.
***, ** and * are statistical significance at 1 %, 5 % and 10 % level respectively.

US (29.0 %) and global O&G (24.6 %) companies, but on average consistent to the shipping industry (40.7 %). The higher ratio may be due to the nature of the FPSO market which requires higher financial and operating leverage.

The contractor-owned FPSO industry exhibited a high average tangibility ratio of 50.1 %, following similar trends in other capital-intensive industries like O&G (52.3 %) and shipping (63.0 %). In contrast, non-financial US companies recorded a lower average of 34.0 %.

As an indication of a company's worth, the market-to-book ratio accounts for investors' estimates of future profitability/growth. The mean market-to-book ratio for FPSO contractors (0.86) is significantly lower compared to the US and shipping companies benchmarks of 1.76 and 1.17 respectively, indicating an overall low market valuation. This may be due to the higher level of risk exposure faced by these companies as FPSOs are rarely redeployed without additional conversions.

The specialist nature of the contractor-owned FPSO industry and the stiff competition is reflected through the uniqueness of commercial arrangements. Unlike O&G companies who generate profits from oil/gas trades, profits of FPSO contractors are fixed through charterparty (lease) and operations and maintenance (operate) arrangements. Hence, profit maximisation is achieved through efficient project management to avoid project delays, cost overruns and completion risks. As such, a slightly lower mean profitability (8.8 %) in this industry as compared to O&G companies (9.0 %) is expected. Profitability is also observed to range from −14.4 % to 23.6 %, reflecting the competitiveness within the industry and the importance of proper project management to maximise profits for the contractor segment.

A high level of total book assets (TBA) is the norm for the capital intensive FPSO industry. However, the wide TBA spread of between US $0.02-US$13.1 billion for our sample population is possibly due to the size and value of individual vessels owned. The mean company size is 14.90, which is significantly higher than the general average of the US (4.58) and shipping (6.48) companies.

Approximately 53.3 % of the sampled companies have made dividend payments; this may be to maintain investor confidence. The effective tax rate of FPSO contractors is lower than US companies. This is expected as they do not generally benefit from special tax schemes, unlike O&G companies. However, the wide spread between the minimum and maximum values after adjusting for extreme values will be a point of consideration in interpreting the results.

Finally, the pairwise correlation coefficient for book leverage and its determinants are shown in Table 4. As expected, leverage is positively correlated with tangibility and size, as physical assets can be used as collateral to secure borrowing, while being sizable enables easier access to capital markets and better interest rates. However, we have found different associations between these variables in the multivariate structure, which we discuss in the subsequent sections.

Companies with higher profitability, a market-to-book ratio and business risks, and those paying dividends, generally have lower leverage. There is also a strong correlation between profitability, size and business risk. As higher risk generates higher rewards, larger FPSO contractors have the resources to secure bigger and more profitable projects. The presence of multicollinearity in the variables was rejected on the basis of low variance inflation (VIF) test results.

4. Empirical results and discussion

Results of the baseline regression analysis for firm-level determinants are discussed in Section 4.1. The robustness tests are presented and reviewed in Section 4.2.

4.1. Firm-level determinants and Paris Agreement

Table 5 presents the results related to our primary objective, the impact of factors of the COP21 ratification on capital structure determinants of FPSO contractors.

Column 1 results indicate that all the standard determinants are statistically significant between the 1 % and 5 % level except for size; with signs consistent with previous studies (Drobetz et al., 2013; Frank and Goyal, 2009; Rajan and Zingales, 1995). Tangibility evidenced a negative relationship with leverage, indicating that high asset price risk supports a lower leverage level. Tangible assets drive leverage to the extent that they can be redeployed (Campello and Giambona, 2013), and determining the collateral value of an FPSO vessel is difficult due to its uniqueness and inability to be easily transferred to another field without refurbishment or conversion.

Furthermore, this observation supports one of the distinctive features in the capital structure dynamics of FPSO contractors, which is the use of project finance structures to secure debt and equity financing. Often, the security arrangements in project finance structures are complex and extensive, involving, for example, existing entities, different borrowing entities and/or unincorporated structures. Clews (2016) emphasised that the ability to match the financing structure with the underlying risk profile of the project cash flows is critical to the success of a project finance transaction. The negative coefficients on profitability and business risks further support this notion.

Additionally, the inverted relationship between profitability and leverage supports the PoT where internal funds are the preferred choice of finance, followed by debt and equity. This may be the case for FPSO contractors which, during good economic conditions, may have accumulated high levels of profits, and the concept that most upstream companies tend to internally fund their capital investments (Clews, 2016).

The positive market-to-book correlation and size (albeit statistically insignificant) coefficients also support the PoT. Growth means more opportunities for FPSO contractors to secure new FPSO projects/contracts, and while the FPSO industry is high risk, the O&G industry has very stringent health, safety and environmental (HSE) regulatory requirements (e.g. each country has different requirements), reducing lenders' environmental risk exposures. Because larger organisations are believed to have more steady cash flows and a reduced risk of default, lenders are more inclined to lend to them.

Furthermore, financial institutions which are accustomed to the riskiness of the FPSO industry are able to further reduce information asymmetry through their long-term lending relationships and monitoring by employing industry experts to ensure that FPSO contractors are in compliance with requirements.

None of the supplemental variables were statistically significant. The positive coefficient for dividend-paying status seems to infer that external financing is required due to the utilisation of internal financing resources. As the sample companies are listed, stable and consistent dividend payouts are generally made to maintain investor confidence.

Consistent with the ToT on non-debt tax shields, the negative coefficient on effective tax rate implies that FPSO contractors benefit more from the depreciation and capital allowances arising from their large asset base than deductions arising from interest expenses. However, the overall impact of tax is not often easily understood or identified (see Section 2.2.2).

In Column 2, the direct effect of COP21 and the GFIN on leverage were assessed, and the results show that the COP21 ratification had a significantly negative impact (−1.6504) on leverage. Conversely, the GFIN variable was positively significant.

When compared to the pre-COP21 period, the coefficient results of the interaction terms between the firm-level capital structure were relatively consistent in terms of directional sign but with changes in significance level and magnitude in some cases. For example, in the post-COP21 period, both growth and size increased to 1 % significance, with their influence on leverage increasing from 0.14 points to 0.48 points, and 0.002 points to 0.10 points, respectively. A probable explanation could be the increasing average oil price from US$43 per barrel in 2016 to US$71 in 2018, which increased the willingness of financial

Table 6
Macro-economic determinants of leverage.

	(1)	(2)	(3)	(4)	(5)
Dependent variable: Book leverage					
Post-COP21 × Tangibility		−0.1609	−0.0862	−0.0773	−0.0785
		(0.1014)	(0.1093)	(0.0555)	(0.0580)
Post-COP21 × Market-to-book (growth)		0.3789***	0.2707**	0.2654***	0.2496***
		(0.0878)	(0.1081)	(0.0857)	(0.0728)
Post-COP21 × Profitability		0.1419	−0.1201	0.6554	1.2261
		(0.6933)	(0.7963)	(0.7528)	(1.0231)
Post-COP21 × Size		0.0998***	0.0963***	0.0952***	0.0989***
		(0.0164)	(0.0172)	(0.0307)	(0.0375)
Post-COP21 × Dividend payer		−0.0446	−0.0558	−0.0061	−0.0024
		(0.0393)	(0.0384)	(0.0273)	(0.0272)
Post-COP21 × Effective tax rate		0.0006*	0.0005*	0.0006*	0.0008*
		(0.0003)	(0.0003)	(0.0003)	(0.0004)
Post-COP21 × Business risks		−0.0378**	0.0429*	−0.0887**	−0.1069**
		(0.0190)	(0.0244)	(0.0426)	(0.0500)
Post-COP21		−1.7528***	−1.6601***	−1.1784***	−1.1040***
		(0.2801)	(0.2869)	(0.4639)	(0.5903)
Tangibility	−0.2511***	−0.3680***	−0.3036***	−0.2154**	−0.2966***
	(0.0444)	(0.0900)	(0.1018)	(0.0842)	(0.0745)
Profitability	0.1032**	0.0405	0.0215	0.0483	0.0786
	(0.0508)	(0.0544)	(0.0683)	(0.0505)	(0.0499)
Market-to-book (growth)	−1.3760***	−1.1974***	−1.1925***	−1.1479***	−1.5892***
	(0.3648)	(0.3974)	(0.4273)	(0.2651)	(0.2904)
Size	0.0098	0.0093	0.0038	0.0320**	0.0485***
	(0.0108)	(0.0121)	(0.0137)	(0.0137)	(0.0163)
Dividend payer	0.0226	0.0326	0.0428	0.0142	0.0133
	(0.0225)	(0.0316)	(0.0341)	(0.0194)	(0.0181)
Effective tax rate	−0.0000	−0.0001	−0.0003**	−0.0006***	−0.0008***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Business risks	−0.0244	0.0073	−0.0175	−0.0461*	−0.0416
	(0.0277)	(0.0426)	(0.0578)	(0.0263)	(0.0320)
Oil price	−0.0003	−0.0006	0.0009	−0.0009*	−0.0004
	(0.0006)	(0.0010)	(0.0015)	(0.0005)	(0.0008)
FX USD	−0.0017	−0.0031	−0.0027	−0.0025**	−0.0020
	(0.0018)	(0.0023)	(0.0051)	(0.0012)	(0.0049)
Stock market returns	0.0000	0.0001	−0.0003*	−0.0000	0.0000
	(0.0001)	(0.0001)	(0.0002)	(0.0001)	(0.0002)
Term spread	0.0061	0.0051	−0.0924	−0.0221	0.0143
	(0.0166)	(0.0158)	(0.0750)	(0.0163)	(0.0661)
GDP growth	0.0203***	0.0093	0.0307**	0.0041	0.0084
	(0.0058)	(0.0070)	(0.0121)	(0.0044)	(0.0075)
Observations	109	109	109	109	109
Year FE	No	No	Yes	No	Yes
Country FE	No	No	No	Yes	Yes
R-squared	0.4414	0.5902	0.6745	0.8505	0.8958
JB test (p-value)	0.122	0.135	0.186	0.174	0.211
Breusch-Pagan (p-value)	0.233	0.258	0.321	0.384	0.369
Wald test (p-value)	0.191	0.201	0.156	0.187	0.234

Note: This table presents the results of the standard leverage regression for the sample companies from 2000 to 2019, augmented by a set of macro-economic factors. All variables are winsorized at the upper and lower one (1) percentile. Cluster-robust standard errors at the firm level are reported in parentheses. Year and firm-fixed effects indicate the type of fixed effects included in the specification. We report the Jarque-Bera (JB) and Breusch-Pagan to confirm that there is no autocorrelation and heteroscedasticity in the residuals. The Wald test is performed to test the non-linear hypotheses after estimation, and the *p*-values suggest we could not reject the null of linearity.
***, ** and * are statistical significance at 1 %, 5 % and 10 % level respectively.

institutions who are already accustomed to the environmental risk management in the industry to undertake the financing risk. While business risk could reduce leverage by 0.17 points at the 5 % significance level, this was not unexpected, as with the pressure of reducing GHG emissions, the viability of the industry going forward is affected. The higher risk perception is in line with the negative coefficient result of COP21.

According to Lemmon et al. (2008), the explanatory strength of the standard ordinary least squares (OLS) regression may be increased by including firm-fixed effects, and this is supported by the significant increase in the R-square in Column 4. This indicates that the capital structure of FPSO contractors is affected by unobserved company-specific components. The model's explanatory strength only slightly improved with the inclusion of year-fixed effects (see Column 5), implying that the determination of capital structure of the sampled companies is more affected by individual differences within companies than by time (further evidenced by the lower R-square increase in Column 3 with year-fixed effects only).

Across Columns 3 to 5, the effect of COP21 on leverage remained consistently negative at the 1 % significance level. Most coefficients still have the same sign, but their magnitude and significance level have increased in several cases when compared to the standard OLS regression in Column 2.

In Column 5, the previously negative and insignificant coefficient for effective tax became significantly positive with COP21, but the magnitude remained constant at 0.0008. The shift from negative to positive could be attributed to tax breaks from various governments for making capital investments and adhering to regulatory requirements (e.g. local

Table 7
Comparing the impact of capital structure determinants.

	(1)	(2)	(3)	(4)
Dependent variable: Book leverage				
Post-COP21	0.0276***	0.0014	0.0312***	0.0085***
	(0.0066)	(0.0014)	(0.0062)	(0.0033)
FPSO contractors	0.1424***	0.1414***	0.0931***	0.0913***
	(0.0195)	(0.0195)	(0.0205)	(0.0205)
Post-COP21 × FPSO contractors	−0.0142***	−0.0143***	−0.0206***	−0.0218***
	(0.0037)	(0.0037)	(0.0034)	(0.0034)
Tangibility	0.2917***	0.2914***	0.3274***	0.3272***
	(0.0101)	(0.0101)	(0.0104)	(0.0104)
Market-to-book (Growth)	0.0155***	0.0159***	0.0192***	0.0200***
	(0.0023)	(0.0023)	(0.0022)	(0.0023)
Profitability	−0.1805***	−0.1731***	−0.2147***	−0.2139***
	(0.0307)	(0.0313)	(0.0303)	(0.0306)
Size	0.0270***	0.0273***	0.0267***	0.0267***
	(0.0014)	(0.0015)	(0.0015)	(0.0016)
Dividend payer	−0.0048	−0.0047	−0.0075	−0.0069
	(0.0054)	(0.0054)	(0.0052)	(0.0053)
Effective tax rates	−0.0000	−0.0000	−0.0000	−0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Business risks	−0.0003	−0.0000	−0.0003	−0.0001
	(0.0011)	(0.0012)	(0.0011)	(0.0011)
Financial crisis	−0.0009	−0.0212	−0.0052	−0.0215
	(0.0069)	(0.0149)	(0.0066)	(0.0147)
GDP growth rate	−0.0002	0.0003	−0.0001	0.0015
	(0.0010)	(0.0011)	(0.0012)	(0.0016)
Observations	4741	4741	4741	4741
Year fixed-effects	No	Yes	No	Yes
Firm fixed-effects	No	No	Yes	Yes
R-squared	0.2670	0.2696	0.3743	0.3771
JB test (p-value)	0.156	0.254	0.198	0.238
Breusch-Pagan (p-value)	0.241	0.265	0.391	0.374
Wald test (p-value)	0.182	0.226	0.199	0.207

Note: This table presents the regression results for the sample companies from 2000 to 2019 and OES companies. All variables are winsorized at the upper and lower one (1) percentile. Cluster-robust standard errors at the firm level are reported in parentheses. Year and firm-fixed effects indicate the type of fixed effects included in the specification. We report the Jarque-Bera (JB) and Breusch-Pagan to confirm that there is no autocorrelation and heteroscedasticity in the residuals. The Wald test is performed to test the non-linear hypotheses after estimation, and the p-values suggest we could not reject the null of linearity.
***, ** and * are statistical significance at 1 %, 5 % and 10 % level respectively.

content). In contrast, the positive coefficient for GDP growth has shrunk to insignificance from 1 %. A higher GDP growth rate suggests economic expansion, and a positive coefficient indicates that FPSO contractors will take on greater loans with increased orders during expansion periods. GFIN, on the other hand, became insignificant from the 5 % level. A possible explanation for this is that between 2007 and 2013, Brent crude oil price was generally on an upward trend, and capital investments by the upstream O&G industry would have continued despite the global financial crisis.

Although changes were observed with the various fixed effects permutations, the results still support our analysis of the results in Column 1 and the negative impact of the COP21 ratification on leverage.

4.2. Extension of baseline model and its robustness

4.2.1. Impact of COP21 and macro-economic factors on leverage

The findings in Table 5 demonstrate that capital structure in the contractor-owned FPSO market is mostly driven by company-specific characteristics, with firm-level variables influencing funding decisions over time. Given that demand for FPSO vessels is driven by worldwide demand for oil, the conjecture that macro-economic conditions affect FPSO contractors' capacity to raise capital seems particularly important. As a result, in order to determine if this time element is caused by macro-economic conditions, we included macro-economic components in the regression.

The results of the extended regression, as shown in Table 6, corroborate the strong negative influence of COP21 on leverage, which is consistent with the earlier reported relationship. The coefficients on the interaction and non-interaction terms remained relatively constant. None of the macro-economic variables were statistically significant (Column 5).

Despite its insignificance, the negative coefficient of the Brent crude oil price demonstrates that loan dependency decreases during periods of high oil prices. Pre-existing FPSO contracts are often unaffected by changes in oil prices. With rising oil prices, FPSO contractors will benefit from cash flows from both present and future contracts, reducing the need for borrowings as cash flows and profitability increase. This result is consistent with both PoT and MTT, which suggest that during expansionary periods, internal financing and equity issuance are favoured over debt (and vice versa). Furthermore, because the FPSO industry is highly 'dollarized', the exchange effects may have been negated through US-dollar-denominated contractual arrangements and funding currency, as well as the use of foreign exchange hedge to mitigate the significant impact of fluctuations between local currencies and the US dollar.

Overall, the results indicate that the capital structure choice is independent to macro-economic variables, i.e. influenced primarily by the firm-level variables.

4.2.2. Comparative effects with the O&G industry

The directions of the predicted coefficients for FPSO contractors, according to the regressions in Table 5, are not significantly different from those discovered in earlier research on other industries. While it is unlikely that this segment of the FPSO industry will have entirely different corporate leverage drivers than the broader O&G industry, it appears necessary to evaluate the potential differences in the degree to which leverage ratios are affected by the various capital structure components. We expanded the regression to include a sample of oil equipment and services (OES) companies, and the results are summarised in Table 7.

While we found that the key capital structure drivers for OES firms (tangibility, expansion, profitability and size) are similar to those for FPSO contractors, there are notable differences in the capital structure dynamics of FPSO contractors. The first observation is that, in the FPSO industry, the influence of these individual factors on leverage is stronger, i.e. the leverage of FPSO contractors increased up to 0.14 points more compared to other OES firms in our sample. Second, debt utilisation is reported to be higher in FPSO contractor companies compared to that of OES firms.

A third observation is the coefficient for tangibility, which was estimated to increase leverage by 0.33 points in OES enterprises, while decreasing it by 0.30 points in FPSO contractor firms. This lends support to the argument that only physical assets that are easier to dispose of in the secondary market sustain larger borrowing. The fourth observation in Table 7 is that the COP21 ratification had a decreasing effect on leverage level (−0.02 points) for FPSO firms, yet the net effect remains significantly higher as opposed to the OES firms.

Accordingly, our results seem to support the notion that the capital structure dynamics of FPSO contractors are different from OES firms, as debt utilisation is higher and dependent on its project and operating risk exposures.

4.2.3. Legal system and Paris Agreement

The final robustness check is the consideration of biases arising from cross-country differences. La Porta et al. (1998, 2000) concluded that the extent of external finance availability is dependent on a country's legal origin and that security values are higher in countries with a common law system due to better investor protection and accounting

Table 8
Leverage and law regimes.

	(1)	(2)	(3)	(4)	(5)
Dependent variables: Book leverage					
Common law × Post-COP21		−0.1201	−0.1394	−0.0250	−0.0651
		(0.1858)	(0.2289)	(0.1054)	(0.1097)
Common law × Tangibility	0.4905	0.0027	0.7990	0.2693	2.2529***
	(0.9735)	(1.2272)	(1.5672)	(0.6922)	(0.7608)
Common law × Market-to-book	−0.6362	−0.4919	−0.3196	−0.2162	−0.8038
	(0.8799)	(0.8744)	(1.1745)	(0.4953)	(0.5495)
Common law × Profitability	2.5854**	2.2515*	2.1788*	1.7039**	1.7122**
	(1.0151)	(1.3469)	(1.1400)	(0.7682)	(0.8588)
Common law × Size	0.2739***	0.2484**	0.2403**	0.2049**	0.2758***
	(0.1041)	(0.1019)	(0.1156)	(0.0974)	(0.1032)
Common law × Dividend payer	−0.0298	−0.0007	−0.0122	−0.0117	−0.0345
	(0.0855)	(0.0889)	(0.0920)	(0.0502)	(0.0431)
Common law × Effective tax	0.0023	0.0070	0.0134	0.0044	0.0165***
	(0.0071)	(0.0090)	(0.0124)	(0.0051)	(0.0059)
Common law × Business risks	0.1102	0.1212	0.1676	0.0901	0.3561***
	(0.1847)	(0.1823)	(0.2366)	(0.1033)	(0.1119)
Common law	−0.4016	−2.1244	−2.7885	−1.9209	−5.6342**
	(2.7296)	(4.0078)	(5.1017)	(2.2627)	(2.4330)
Post-COP21		−1.0331***	−1.0737***	−1.0075***	−1.0112***
		(0.0286)	(0.0616)	(0.0166)	(0.0301)
Tangibility	−0.2453***	−0.2543***	−0.2557***	−0.2116***	−0.3764***
	(0.0512)	(0.0501)	(0.0604)	(0.0508)	(0.0673)
Growth	0.1117***	0.1092**	0.1635**	0.1438***	0.0765**
	(0.0424)	(0.0435)	(0.0661)	(0.0303)	(0.0355)
Profitability	−1.9181***	−2.1385***	−2.1776***	−1.7544***	−1.5790***
	(0.4530)	(0.4568)	(0.5526)	(0.2780)	(0.2829)
Size	0.0025	0.0041	0.0133	0.0076	0.0784***
	(0.0084)	(0.0095)	(0.0165)	(0.0080)	(0.0174)
Dividend payer	−0.0017	−0.0005	−0.0115	−0.0110	−0.0328**
	(0.0276)	(0.0270)	(0.0301)	(0.0154)	(0.0144)
Effective tax rate	−0.0000	−0.0002	−0.0003	−0.0006***	−0.0008***
	(0.0002)	(0.0002)	(0.0002)	(0.0001)	(0.0001)
Business risks	−0.0252	−0.0221	−0.0282	−0.0222	−0.0060
	(0.0287)	(0.0294)	(0.0377)	(0.0177)	(0.0198)
Financial crisis		0.0891**	0.2473**	0.0754***	0.1329**
		(0.0366)	(0.1047)	(0.0213)	(0.0545)
GDP growth rate	0.0182***	0.0234***	0.0391***	0.0080*	0.0070
	(0.0058)	(0.0064)	(0.0106)	(0.0042)	(0.0073)
Observations	109	109	109	109	109
Year fixed effects	No	No	Yes	No	Yes
Firm fixed effects	No	No	No	Yes	Yes
R-squared	0.4844	0.5266	0.5912	0.8548	0.9144
JB test (p-value)	0.185	0.251	0.347	0.232	0.365
Breusch-Pagan (p-value)	0.113	0.192	0.234	0.333	0.254
Wald test (p-value)	0.188	0.283	0.276	0.301	0.391

Note: This table presents the results of the standard leverage regression where the firm-level leverage determinants supplemented with an indicator dummy factor set equal to one (1) for common law regime countries and zero for non-common law regime countries. The sample companies are from 2000 to 2019. All variables are winsorized at the upper and lower one (1) percentile. Cluster-robust standard errors at the firm level are reported in parentheses. Year and firm-fixed effects indicate the type of fixed effects included in the specification. We report the Jarque-Bera (JB) and Breusch-Pagan to confirm that there is no autocorrelation and heteroscedasticity in the residuals. The Wald test is performed to test the non-linear hypotheses after estimation, and the *p*-values suggest we could not reject the null of linearity.
***, ** and * are statistical significance at 1 %, 5 % and 10 % level respectively.

framework, as compared to those with civil law regimes. It is also believed that common law systems encourage wealth creation as compared to civil law systems (Drobetz et al., 2013; Halling et al., 2016).

Fan et al. (2012) suggested that common law regimes had lower leverage ratios than civil law regimes, and that legal systems can fundamentally explain leverage cross-sectional disparities. To assess the impact of common and civil law regimes on FPSO contractor leverage, we introduced an indicator variable designating a country with a common law system. According to the comparative analysis in Table 8, common law is negative and significant in Column (5), suggesting that the FPSO firms located in common law regimes are less leveraged compared to the firms located in civil law markets. Moreover, the negative sign of interaction of COP21 and common law indicates that COP21 is further reducing the leverage in capital structure of the FPSO sector in common law regimes. Combined, it means that the debt utilisation is lower in common law regimes, as Fan et al. (2012) indicated. The sign and significance of our primary variables are consistent with earlier findings – tangibility, profitability, size and effective tax rates remained the key determinants of leverage at the 1 % and 5 % significance level. These results indicate that legal systems have an impact on the choice of capital structure and key debt drivers of FPSO contractors. This indirectly supports the earlier observation that these companies are individually different.

4.3. Additional tests

This section outlines the additional robustness checks on our findings by employing a different leverage metric and lagged variables. To determine whether our results were influenced by our initial definition of leverage, we employed one of the three alternative book leverage measures proposed by Rajan and Zingales (1995). The findings in Table 9 show that the primary drivers of leverage are tangibility,

Table 9
Regression results with alternate leverage measure.

	(1)	(2)	(3)	(4)	(5)
Dependent variable: Alternate leverage measure - Book leverage (2)					
Post-COP21 × Tangibility		0.1428**	0.1701**	0.1514**	0.1252**
		(0.0669)	(0.0743)	(0.0651)	(0.0613)
Post-COP21 × Market-to-book (growth)		0.1224	0.1696	0.1375	0.1385
		(0.1092)	(0.1174)	(0.1065)	(0.0959)
Post-COP21 × Profitability		1.8471**	2.1279*	2.2387**	2.2805**
		(0.9127)	(1.1431)	(0.8662)	(0.9528)
Post-COP21 × Size		0.0882***	0.0917***	0.0313	0.0374*
		(0.0216)	(0.0217)	(0.0250)	(0.0213)
Post-COP21 × Dividend payer		0.0028	−0.0138	0.0109	−0.0133
		(0.0356)	(0.0349)	(0.0335)	(0.0287)
Post-COP21 × Effective tax rate		0.0007*	0.0008**	0.0010**	0.0007*
		(0.0004)	(0.0004)	(0.0005)	(0.0004)
Post-COP21 × Business risks		−0.1093**	−0.1768***	−0.1607***	−0.1661***
		(0.0436)	(0.0497)	(0.0443)	(0.0468)
Post-COP21		−1.6582***	−1.7308***	−0.8289**	−0.8791**
		(0.3607)	(0.4011)	(0.4024)	(0.3726)
Tangibility	−0.1528***	−0.1225***	−0.1851***	−0.1916***	−0.1762***
	(0.0318)	(0.0396)	(0.0486)	(0.0673)	(0.0672)
Profitability	0.0055	0.0346	0.0462	0.0323	0.0562
	(0.0307)	(0.0323)	(0.0377)	(0.0345)	(0.0370)
Market-to-book (growth)	−1.6442***	−1.6272***	−1.8619***	−1.8712***	−1.9026***
	(0.2454)	(0.2487)	(0.2748)	(0.2505)	(0.2343)
Size	0.0185***	0.0182***	0.0192**	0.0124***	0.0421***
	(0.0057)	(0.0061)	(0.0082)	(0.0086)	(0.0126)
Dividend payer	0.0110	0.0059	0.0174	0.0036	0.0149
	(0.0177)	(0.0191)	(0.0201)	(0.0186)	(0.0169)
Effective tax rate	−0.0003**	−0.0004***	−0.0004***	−0.0005***	−0.0003**
	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0001)
Business risks	−0.0269	−0.0618**	−0.0390	−0.0649***	−0.0062
	(0.0190)	(0.0251)	(0.0304)	(0.0241)	(0.0285)
Financial crisis		0.0508**	0.0204	0.0587**	0.0597
		(0.0233)	(0.0586)	(0.0225)	(0.0565)
GDP growth rate	0.0001	0.0015	−0.0033	0.0043	0.0154*
	(0.0041)	(0.0046)	(0.0068)	(0.0048)	(0.0083)
Observations	109	109	109	109	109
Year fixed effects	No	No	Yes	No	Yes
Firm fixed effects	No	No	No	Yes	Yes
R-squared	0.4429	0.6138	0.7264	0.6763	0.8294
JB test (p-value)	0.157	0.168	0.326	0.252	0.328
Breusch-Pagan (*p*-value)	0.148	0.199	0.206	0.214	0.281
Wald test (p-value)	0.188	0.211	0.244	0.322	0.296

Note: This table presents the results of the standard leverage regression for the sample companies from 2000 to 2019 using an alternative leverage measure proposed by Rajan and Zingales (1995) defined in Table 2. All variables are winsorized at the upper and lower one (1) percentile. Cluster-robust standard errors at the firm level are reported in parentheses. Year and firm-fixed effects indicate the type of fixed effects included in the specification. We report the Jarque-Bera (JB) and Breusch-Pagan to confirm that there is no autocorrelation and heteroscedasticity in the residuals. The Wald test is performed to test the non-linear hypotheses after estimation, and the *p*-values suggest we could not reject the null of linearity.
***, ** and * are statistical significance at 1 %, 5 % and 10 % level respectively.

profitability, size, effective tax rates and business risks. The impact of COP21 on leverage remained strongly negative.

Considering that independent variables can influence each other over time, we followed previous empirical studies (Drobetz et al., 2013; Fan et al., 2012; Frank and Goyal, 2009; Rajan and Zingales, 1995) and lagged all independent variables by one period before including them in our regression model. Except for growth, size and effective tax rate, which shifted from a positive to a negative impact on leverage, the results in Column 5 of Table 10 were relatively consistent when utilising lagged independent variables. The impact of COP21 on leverage remained strongly negative.

5. Conclusion

The capital structure management is a critical challenge that all companies face because poor decisions can lead to firm value erosion. Given the highly specialised and capital-intensive nature of the FPSO industry, selecting the right financing option is crucial, especially for contractor-owned FPSO companies working in a competitive niche sector with increasing demands, regulatory standards and technological advancements.

In line with the view that the upstream O&G sector is capital intensive and highly leveraged, we report that the listed FPSO contractors exhibit a higher leverage ratio. The study identified various financing structures among the companies due to their individual and institutional (legal systems) characteristics. The determinants with a key association to capital structure decisions are profitability, market-to-book and effective tax rate. From the macro-economic context, the counter-cyclical behaviour supported the PoT. However, the results showed no strong evidence of the effect of the global financial crisis (2007–2009), as its impact would have been cushioned by the continued capital spending by the upstream O&G industry in line with the upward oil price trend between 2007 and 2013. The ratification of the 2015 Paris Agreement had a major influence on all capital structure determinants, with a significant negative impact on leverage.

To the best of our knowledge, this is the very first study to directly identify the key determinants driving the financing decisions of major globally listed contractor-owned FPSO companies and the corresponding capital structure theory that best explains their behaviour. Furthermore, our study contributes to the ongoing literature on

Table 10
Regression results with lagged independent variables.

	(1)	(2)	(3)	(4)	(5)
Dependent variable: Book leverage					
Post-COP21 × Tangibility		−0.0607	−0.0653	−0.0752	−0.0271
		(0.0954)	(0.1148)	(0.0657)	(0.0698)
Post-COP21 × Market-to-book (growth)		0.3175***	0.2989**	−0.2195***	−0.2294***
		(0.1070)	(0.1163)	(0.0786)	(0.0748)
Post-COP21 × Profitability		−1.8150**	−1.5103*	−1.8582**	−1.3243*
		(0.8674)	(0.8019)	(0.8082)	(0.7055)
Post-COP21 × Size		−0.0419	−0.0468	−0.0399	−0.0646**
		(0.0318)	(0.0349)	(0.0252)	(0.0262)
Post-COP21 × Dividend payer		−0.0821	−0.0698	−0.0253	−0.0149
		(0.0537)	(0.0565)	(0.0361)	(0.0344)
Post-COP21 × Effective tax rate		−0.0004	−0.0006	−0.0000	−0.0001
		(0.0007)	(0.0008)	(0.0005)	(0.0005)
Post-COP21 × Business risks		−0.0782	−0.0516	−0.0637	−0.1591**
		(0.0631)	(0.0972)	(0.0455)	(0.0675)
Post-COP21		−0.6438	−0.7269	−0.7443*	−1.0893**
		(0.5668)	(0.6370)	(0.4337)	(0.4642)
Tangibility	0.2594***	0.3040***	0.3145***	−0.3025***	−0.3214***
	(0.0489)	(0.0588)	(0.0661)	(0.0772)	(0.0817)
Profitability	0.0665	−0.0522	−0.0920	0.0962**	−0.0081
	(0.0478)	(0.0496)	(0.0605)	(0.0409)	(0.0449)
Market-to-book (growth)	−1.0803***	−0.7023**	−0.5102	−0.5413**	−0.9701***
	(0.3492)	(0.3458)	(0.4193)	(0.2487)	(0.2869)
Size	0.0116	0.0132	0.0271*	0.0196**	0.0534***
	(0.0086)	(0.0095)	(0.0146)	(0.0088)	(0.0145)
Dividend payer	0.0298	0.0494*	0.0440	0.0284	0.0210
	(0.0262)	(0.0278)	(0.0307)	(0.0196)	(0.0193)
Effective tax rate	0.0000	0.0001	0.0003	−0.0004**	−0.0005***
	(0.0002)	(0.0002)	(0.0002)	(0.0001)	(0.0002)
Business risks	−0.0167	0.0157	0.0029	−0.0443**	0.0045
	(0.0291)	(0.0299)	(0.0434)	(0.0219)	(0.0292)
Financial crisis		0.0949***	0.2490**	0.0241	0.0258
		(0.0356)	(0.1019)	(0.0253)	(0.0787)
GDP growth rate	0.0253***	0.0276***	0.0433***	−0.0004	−0.0079
	(0.0062)	(0.0066)	(0.0110)	(0.0057)	(0.0102)
Observations	99	99	99	99	99
Year fixed effects	No	No	Yes	No	Yes
Firm fixed effects	No	No	No	Yes	Yes
R-squared	0.4403	0.6203	0.7010	0.8424	0.8990
JB test (p-value)	0.252	0.266	0.331	0.291	0.336
Breusch-Pagan (p-value)	0.116	0.163	0.194	0.310	0.390
Wald test (p-value)	0.120	0.189	0.326	0.227	0.271

Note: This table presents the results of the standard leverage regression with one period lagged independent variables for the sample companies from 2000 to 2019. All variables are winsorized at the upper and lower one (1) percentile. Cluster-robust standard errors at the firm level are reported in parentheses. Year and firm-fixed effects indicate the type of fixed effects included in the specification. We report the Jarque-Bera (JB) and Breusch-Pagan to confirm that there is no autocorrelation and heteroscedasticity in the residuals. The Wald test is performed to test the non-linear hypotheses after estimation, and the p-values suggest we could not reject the null of linearity.
***, ** and * are statistical significance at 1 %, 5 % and 10 % level respectively.

corporate finance and ESG related to climate change, particularly in a specialised industry like the FPSO.

Our study has practical implications for FPSO finance managers. Given the importance of financing in securing new and ensuring continuity of existing FPSO projects, as well as the restricted redeployability of the FPSO vessels, it is important for contractor-owned FPSO companies to understand the complexities of the explanatory variables as well as the impact of different legal systems in order to improve their financial management and firm value through strategic capital structure decisions. Furthermore, as the Paris Agreement had raised investors' and lenders' awareness towards climate risk, FPSO finance managers would also need to consider the impact of transition and physical risks on future FPSO projects. However, our study suffers from data limitation after 2019, which would give us better estimation of the causality. In addition, this study could be extended in the future by including the impact of regulatory changes after the Paris Agreement.

Data availability

Data will be made available on request.

Appendix. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.techfore.2022.122266.

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