

Exploring financiers' beliefs and behaviours at the outset of low-carbon transitions: A shipping case study

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ABSTRACT

Ship financiers play an important role in the shipping industry's transition to a low carbon economy as they shape the financing terms provided to shipowners and the type of assets that are financed, but their transition-related beliefs are unclear. This paper proposes a novel theoretical framework which categorises financiers during low-carbon transitions into five archetypes. It also provides novel empirical insights on the beliefs and ambitions of shipping financiers regarding their future role and the risks to their assets using semi-structured interviews with ten financiers and two shipowners. The results show that the majority of interviewees expressed an ambition to support incumbent shipowners in the transition, but expressed the need for regulation to ensure financiers properly measure climate risks (e.g. the EU taxonomy and differentiated capital requirements for green and brown assets). This highlights the potential, but also the limits, of voluntary initiatives from financiers to promote green investments.

1. Introduction

Shipping represents about 3% of the world's greenhouse gas emissions, and emissions are projected to increase by between 90–130% of 2008 emissions by 2050 for a range of long-term economic and energy scenarios (Faber et al., 2020) if it does not rapidly increase the energy efficiency of the fleet and adopt zero/low-carbon fuels. Several technological and operational measures already exist to increase the energy efficiency of ships, such as speed reduction or technology (e.g., wind assistance, air lubrication) but they need to be combined with zero/low-carbon fuels to be aligned with a 1.5° pathway (Smith et al., 2023). Because ships are long-lived assets (about 25 years), most ships ordered this decade will have to shift to alternative fuels over their lifetime or be scrapped early for shipping to remain in line with a 1.5° pathway. However, the zero/low-carbon marine fuel market is nascent with many different candidate zero/low-carbon fuels. For example, hydrogen-based e-fuels such as ammonia, viewed as the most economical option, are still in demo/pilot phase (Scarborough et al., 2022). The immature state of the marine fuel market and the numerous possible low/zero-carbon fuel pathways creates an uncertain investment environment.

The majority of ship finance historically comes from shipowners' private equity and debt provided by commercial banks, although a growing share comes from non-banking sources (e.g., leasing, alternative lending, private equity from funds, public markets and investors, Drobotz et al. 2013; Del Gaudio 2018). The shipping debt market is concentrated, with the top 10 shipping financiers representing around 45% of the banks' shipping debt portfolio (calculated from Petropoulos, 2021). This implies that a small number of financiers dominate financing decisions. Ship financiers shape the financing terms provided to shipowners and the type of assets that

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are financed. More recently, they are facing new risk factors as a result of climate change. These risks stem from both demand-side climate risk – the destruction of seaborne fossil-fuel cargo as land-based sectors decarbonise - and supply-side climate risks from the transition of ships propelled by fossil fuels to alternative low/zero-carbon fuels (Bullock et al., 2020). Demand-side and supply-side climate risks might lead to an unexpected devaluation of the ship assets due to changes in regulation, technology, or consumer demand which has a cascading impact on a shipping financier's profitability. For example, in a conventional bank loan, the financier would assume ownership of the asset in the event that the shipowner defaults and would recover the amount that the ship is valued at the time of default. There is a potential gap in financing the transition to low/zero-carbon shipping due to traditional banks reducing their exposure from the sector following the 2007-2008 financial crisis (Global Financial Crisis) (Gong et al., 2013; Schinas and Bergmann, 2021; Schinas et al., 2018). Financiers' decisions have an impact not only on their profitability but also the ability to transition to low/zero-carbon ships in the future. For example, funding fossil fueled ships could create technology lock-in and make the transition more difficult to low/zero-carbon shipping. In 2019, a group of shipping financiers recognised their role within shipping finance to promote responsible environmental practices and formed the Poseidon Principles, a framework for including climate considerations in shipping finance for assessing and disclosing the climate alignment of ship finance portfolios. The signatory members have grown from 10 founding members to 34 leading banks, representing approximately \$200 billion in shipping finance. While there is a growing but conflicting set of evidence on the pricing of climate risks in financial instruments from the econometric literature (Bingler, 2022; Degryse et al., 2021; Delis et al., 2019; Fatica et al., 2021; Hachenberg and Schiereck, 2018; Seltzer et al., 2022), there is little empirical evidence about the role of shipping financiers in sustainability transitions (e.g., how they view climate risk, the nature and drivers of their financing behaviour, and how they are adapting their tools and instruments). Second, while the Multi-level Perspective (MLP) can be used as a theoretical framework to describe an energy transition and the role of different actors, it characterises the role of financiers as functional, resource-providing and lacking agency (Naidoo, 2020).

The paper therefore aims to fill these gaps by firstly characterising financiers' behaviours in a conceptual framework extending the MLP and building on theoretical insights from the Adaptive Market Hypothesis to describe how financiers adapt their expectations following a breakdown in heuristics. Second, it aims to elicit financiers' transition-related beliefs through qualitative social research methods such as interviews in order to understand the role of shipping financiers in sustainability transitions.

The remainder of the article is structured as follows: Section 2 discusses the transition literature with a focus on the multi-level perspective and the finance industry's role in transitions, drawing from other industries like electric utilities. Section 2.4 provides the extended theoretical framework to describe financiers into 5 archetypes. Section 3 provides the context and methodological approach of the study, while Section 4 presents the results and discussion. Section 5 concludes.

2. Literature review and theoretical background

2.1. Finance in shipping

Because of the reliance of the shipping industry on high-value assets, accessing substantial capital to replace an ageing fleet and funding the second-hand ship market is essential (Alexandridis et al., 2018). The longevity of shipping companies has been historically closely tied to their ability to secure financing with favourable terms, particularly low interest rates (Stopford, 2009). Pangalos (2023) argues that because larger shipowners have stronger bargaining power with fuel providers and clients, higher technical management capacity, and better access to sources of capital, they might be better placed to acquire low/zero-carbon ships. The popularity of bank borrowings among ship-owning companies can be attributed to several factors listed by Alexandridis et al. (2018):

- Lower cost and accessibility.
- Preservation of ownership structure, which is often family-oriented and highly concentrated.
- Confidentiality: raising funds through bank loans does not necessitate public disclosure of strategic, financial, and operational information, unlike methods like IPOs and corporate bond issues (Kavussanos and Tsouknidis, 2014, 2016).
- Relationship banking: historically, shipping bank loans have been granted based on relationship banking principles. This fosters long-term rapport, amicable trust, and information sharing between the borrowing company and the bank (Alexandridis et al., 2018; Gavalas and Syriopoulos, 2015; Mitroussi et al., 2016).

Banks limited their exposure to the shipping industry due to weak market conditions and stricter BASEL III capital requirements imposed by the Basel Committee on Banking Supervision following the Global Financial Crisis (Gong et al., 2013). Despite this trend, lending remains the main source of external shipping finance (Drobtz et al., 2013; Del Gaudio, 2018) and the literature on alternative sources of capital is limited (Alexandridis et al., 2018).

The existing literature on shipping finance covers a large range of topics including the sources of finance and capital structure, valuation methods and risk management (an in-depth review of shipping finance is available in Alexandridis et al. 2018). However, the focus of this literature has been on shipowners rather than the sources of finance itself. Even then, the focus has been on a default risk assessment of financial instruments (see Alexandridis et al. 2018 for a review), which does not consider the agency of the finance providers. Exceptions include Gong et al. (2013)'s survey on banks from the shipping sector after 2009 and Mitchell and Rehmatulla (2016)'s interviews with debt and equity providers on the topic of energy efficiency and stranded assets, and Gavalas and Syriopoulos (2015), Lee and Pak (2018)'s review of banks' decision-making drivers.

2.2. Transitions studies and the multi-level perspective

This article builds on the multi-level perspective (MLP) framework, derived from transition theories. The MLP explains the uptake of technological innovations in markets that are associated with key societal and economic functions such as energy or transport (Geels, 2002; Geels and Schot, 2007; Markard et al., 2012; Markard and Truffer, 2008). According to the MLP framework, there are three layers that interact: exogenous landscape pressure, the socio-technical regime, and niches Fig. 1. Exogenous landscape pressure represents a change in civil society’s awareness about an issue (e.g. environmental) which exerts pressure on the socio-technical regime (e.g. incumbent industry) (Geels, 2002; Geels and Schot, 2007; Markard et al., 2012; Markard and Truffer, 2008). Socio-technical regimes are stable economic and social configurations, however they can be destabilized if exogenous pressure, such as the growing public pressure to decarbonize industry sectors including the shipping industry, create opportunities for niche innovations to break through (Geels, 2002; Geels and Schot, 2007; Markard et al., 2012; Markard and Truffer, 2008). The third layer are niches which develop in protected spaces and can provide innovations. If these niches are successful, they are taken up by incumbents and can replace the previous socio-technical regime (Geels, 2002; Geels and Schot, 2007; Markard et al., 2012; Markard and Truffer, 2008).

Pettit et al. (2018) and Stalmokaite and Yliskylä-Peuralahti (2019) both use the MLP framework to describe the shipping industry. They describe the shipping regime as comprised of a large range of industry incumbents including shipowners, charterers and customers, ports and fuel providers and regulators (see Fig. 1) (Pettit et al., 2018; Stalmokaite and Yliskylä-Peuralahti, 2019). Shipping case studies include electric or hydrogen-fuelled coastal shipping in Norway (Bach et al., 2020, 2021; Bergek et al., 2021).

Socio-technical transitions can evolve differently depending on the nature of the innovations and landscape pressures (Geels et al.,

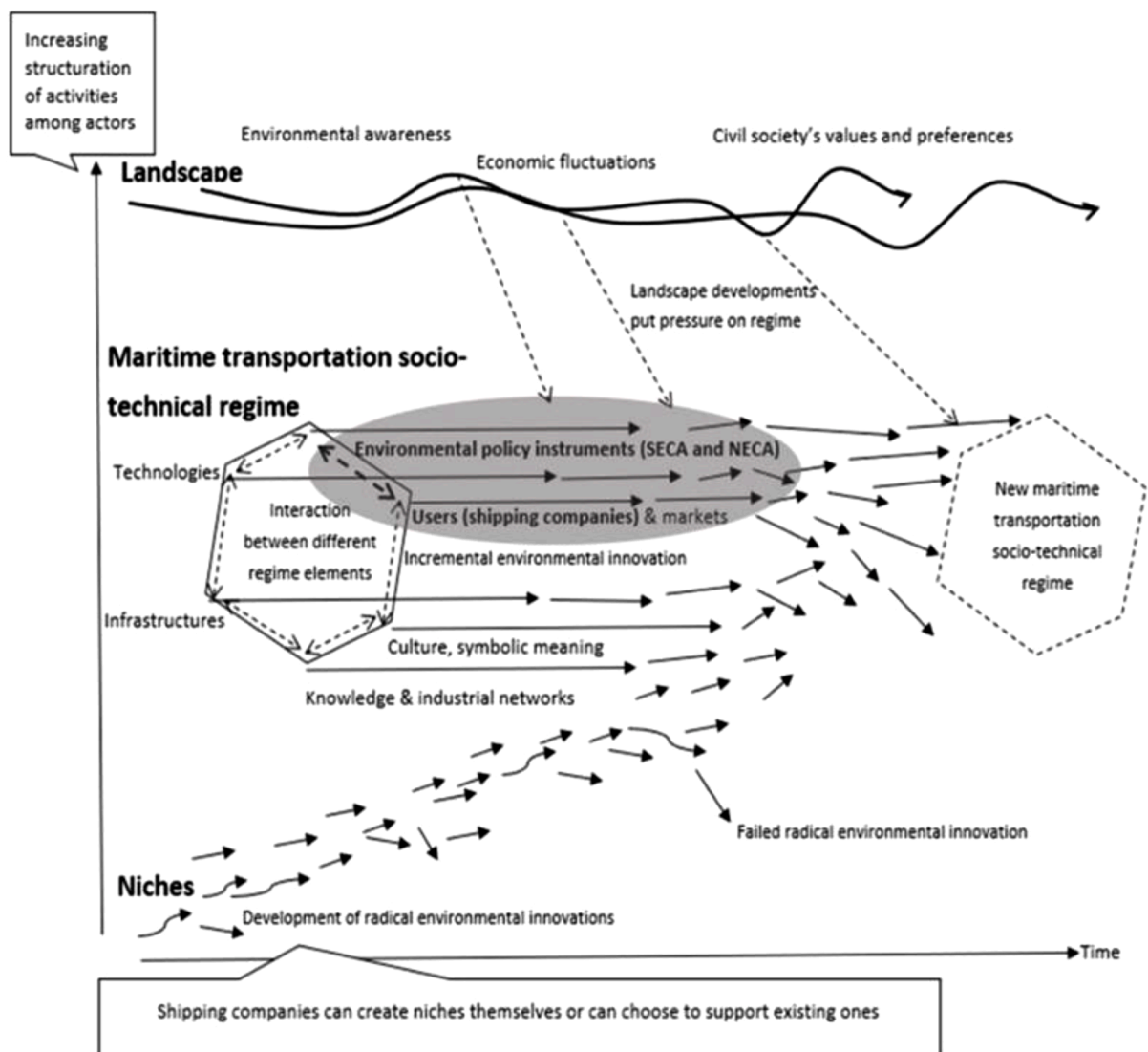


Fig. 1. MLP of shipping low/zero-carbon transitions (Stalmokaite and Yliskylä-Peuralahti, 2019).

Table 1
Interview list.

Name	Type of financier	Location of headquarter	Signatory to Poseidon Principles	Size of shipping portfolio
Interview 1	Commercial bank	North America	Yes	\$5–10bn
Interview 2	Commercial bank	Western Europe	Yes	>\$10bn
Interview 3	Alternative financier	Western Europe	No	\$0–5bn
Interview 4	Commercial bank	Western Europe	Yes	>\$10bn
Interview 5	Commercial bank	Western Europe	No	>\$10bn
Interview 6	Asset manager	Western Europe	No	\$0–5bn
Interview 7	Commercial bank	Asia	Yes	>\$10bn
Interview 8	Shipowner	Western Europe	No	\$0–5bn
Interview 9	Commercial bank	Western Europe	Yes	\$5–10bn
Interview 10	Shipowner	Western Europe	No	\$0–5bn
Interview 11	Commercial bank	Asian branch of a North American bank	Yes	\$5–10bn
Interview 13	Commercial bank	Western Europe	Yes	\$5–10bn

2016; Geels and Schot, 2007). In some cases, incumbents are replaced by niche entrants who introduce *competitive* innovations, i.e. innovations which aim at replacing the existing regime technology (Geels and Schot, 2007) (e.g. the uptake of small-scale renewables in Germany by entrants such as citizens, cooperatives and farmers, Geels et al. 2016). In others, *symbiotic* innovations, i.e. innovations that enhance the current system technology by enabling it to address issues and improve its performance (Geels and Schot, 2007), are adopted by regime incumbents who then adapt to the new socio-technical regime (e.g. the uptake of large-scale onshore and offshore wind by incumbent utilities in the UK) (Geels et al., 2016). Baresic (2020) and Pettit et al. (2018) suggest that because shipping assets are capital intensive and have long lifespans, the industry is conservative to radical innovations and has a strong path dependency. Baresic (2020), who bases his argument on the transition to LNG as a marine fuel, argues that the involvement of industry incumbents, in particular shipowners, and the development of symbiotic innovations (e.g. dual-fuel engines or drop-in fuels) are likely to be necessary conditions for a successful shipping transition to take place.

2.3. Finance in transitions studies

While the transition literature has focused mainly on the behaviour of industry incumbents such as utilities or shipowners, there is increasing empirical evidence on the behaviour of financiers during transitions (Bolton and Foxon, 2015; Bolton et al., 2015; Falcone et al., 2018; Geddes et al., 2020, 2018; Geddes and Schmidt, 2020; Hall et al., 2016, 2017; Hughes and Downie, 2021; Monk and Perkins, 2020; Seyfang and Gilbert-Squires, 2019; Urban and Wójcik, 2019; Yip and Bocken, 2018; Zhang, 2020). This empirical evidence is reviewed here to inform the theoretical framework used in this article for understanding the behaviour of shipping financiers. Some financiers are found, like most industry incumbents, to ignore the risks and opportunities arising from the growing transition and therefore continue financing the incumbent technology before they realize the threat posed by new industry technology. The Royal Bank of Canada or the China Construction Bank continue to finance the extraction of fossil fuels (Urban and Wójcik, 2019), while Japanese bilateral banks continue to finance coal power plants in South East Asia because they perceive the stranding of their assets unlikely and do not include climate risks assessments (Hughes and Downie, 2021). Most German banks and institutional investors originally, and UK banks until today, were reluctant to finance small-scale renewables projects due to lack of knowledge of the technology, inadequate existing financial tools and instruments for the size and type of project, and perceived riskiness of the projects (Geddes et al., 2018). In some cases, not only are financiers unaware of the upcoming socio-technical transition, but they encourage their clients to grow their incumbent technologies. For example, (Ferguson-Cradler, 2022; Kungl, 2018; Kungl and Geels, 2018) document how German power utilities' shareholders exerted pressures from 2005 to 2010 on company management to ambitiously invest in carbon intensive assets and utilities; and in some cases prevented the shift away from coal to protect their regional coal industry (Geels et al., 2016).

In many cases however, financiers are found to support the transition when they realize the threat and/or opportunity brought by the technology innovation. While this support might be a driver of the uptake of the new technology, we do not suggest that it is the only one nor that it is sufficient to drive the transition alone. In particular, the design of government support – including through the UK and German State banks GIB and KfW - has also played a large role in shaping the transition to large-scale or small-scale decentralised renewables in the UK and Germany, respectively (Geddes et al., 2018; Geels et al., 2016). Because regime industry incumbents and financiers share path-dependent beliefs and the financial regime is aligned to industry incumbents, it could be assumed that regime financiers would be more willing to finance industry incumbents rather than niche entrants. An example of this behaviour is the early support of commercial banks in the development of combined cycle power plants by UK electricity utilities (Bolton and Foxon, 2015; Kern, 2012) and of large-scale onshore and offshore wind projects since the 1990s (Bolton and Foxon, 2015; Geddes et al., 2018), both of which are symbiotic innovations. Commercial banks have however refrained from investing in small-scale renewables in the UK promoted by small niche entrants, due to the perceived risk of the investment and the inadequacy of their financing instruments to those actors (Geddes et al., 2018; Stenzel and Frenzel, 2008).

However, there are also examples in the literature of financiers supporting industry niche entrants. This suggests that regime financiers are not intrinsically loyal to industry incumbents. Examples include the support of the UK Green Investment Bank (GIB) which was formerly owned by the UK government, and later on commercial banks for the uptake of bioenergy in the UK (Geddes et al., 2018).

In Germany there was support from KfW, and later on the German Savings and Cooperative Banks, for small-scale solar PV and onshore wind in Germany (Geddes et al., 2018; Zhang, 2020).

The development of financial innovations is often necessary for financiers to support the new technology. Examples of symbiotic financial innovations include the creation and uptake of green bonds since 2006 and of ESG metrics in the last few decades to evaluate corporates, developed by a few incumbent financiers as a response to landscape pressure from a reputation crisis and shift in customer preferences (Monk and Perkins, 2020; Seyfang and Gilbert-Squires, 2019; Urban and Wójcik, 2019). Alternatively, financial innovations can be competitive and carried by financial entrants, leading, if successful, to a substitution of the financial regime in favour of financial entrants. Examples of the former include the creation of value-based banks such as GSL, Triodos, Ecology (Falcone et al., 2018; Seyfang and Gilbert-Squires, 2019; Urban and Wójcik, 2019; Yip and Bocken, 2018); of new banks replicating the example of local German banks in the UK to support small-scale investments in renewables (Abundance, Pure Leapfrog, Hampshire community bank) (Hall et al., 2016; Zhang, 2020) and of Fintech (Sánchez, 2022).

2.4. Extended theoretical framework

There are two main attempts to conceptualize finance within the MLP framework. For Geddes and Schmidt (2020), finance sits at the level of the regime, along with others such as the technology regime or the energy regime. Urban and Wójcik (2019) characterise finance as comprised of the 3 levels itself (financial landscape, financial regime, and financial niche where financial innovations develop) and the financial regime can undergo a transition. We build on the latter conceptualization of finance proposed by Urban and Wójcik (2019) (see Fig. 2).

Geddes and Schmidt (2020) and Urban and Wójcik (2019) framing failed to address certain limitations in the original depiction of finance within the MLP, which frames finance as a passive and neutral resource without agency. However, Naidoo (2020, 2020) demonstrated that finance is not neutral, but should be analysed through a behavioural lens. Moreover, neither of these frameworks adequately explain the diverse range of behaviours observed in empirical literature, nor do they account for the role of shipping financiers observed in our study. As a result, we propose an extended theoretical framework to explain the various roles financiers can take during a transition and the relationships between the industry and the financial MLP.

This diagram suggests a financial transition where new entrants carrying competitive niche financial innovations (level (3)) replace incumbent financiers (level (2)). In this proposed framework, as for industry transition, transitions might also unfold by the incumbent financiers (level (2)) adopting symbiotic financial niche innovations and therefore surviving into the new regime.

To do so, we build on the theoretical insights from the Adaptive Market Hypothesis (AMH) proposed by Hall et al. (2017) and Lo (2004) The AMH is grounded on path dependency and is helpful to understand the bounded rationality and decision-making of financiers. It assumes that the investment environment and financiers' behaviour change over time. In this framework, during times of

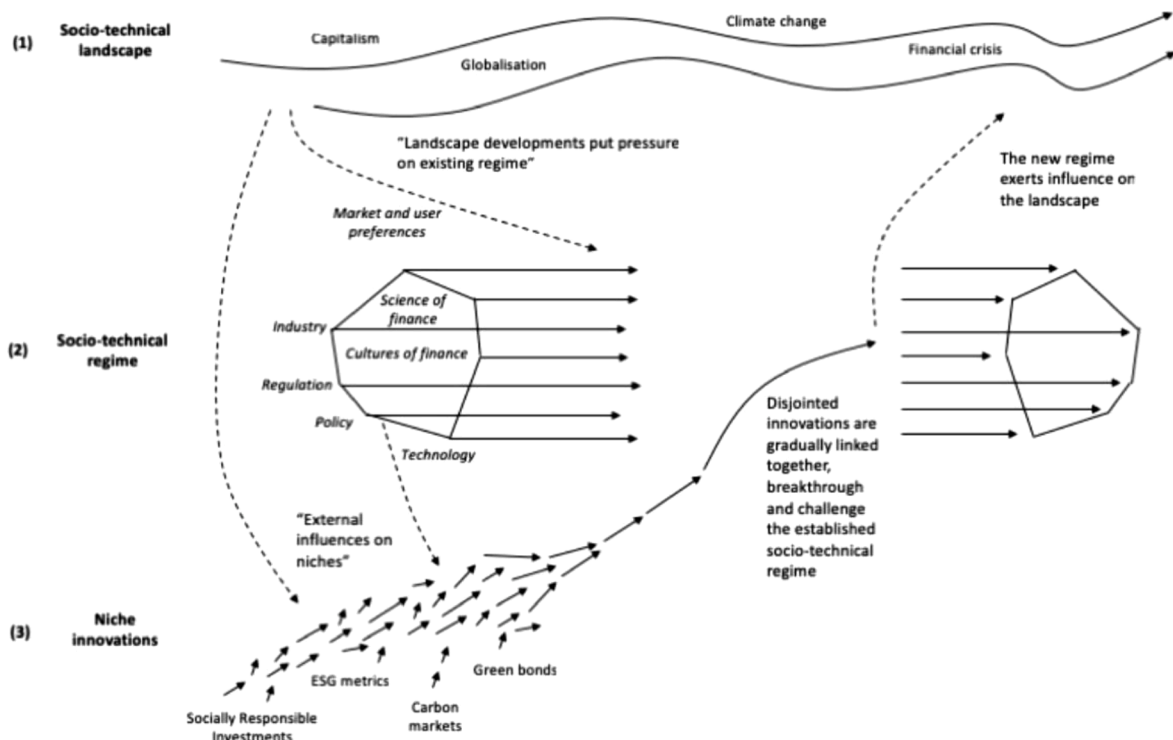


Fig. 2. Finance in the MLP framework. Taken from Urban and Wójcik (2019).

stability, financiers' investment decision process ("heuristics") are adapted to their environment and near-optimal, so that the Efficient Market Hypothesis, which is characterised by perfect information and rational expectations in the market (Lucas, 1978), broadly holds true. However, those heuristics become ill-suited when the environment changes, so that we observe "behavioural biases". Eventually, financiers adapt themselves to new realities in periods of turbulence or change, such as the Global Financial Crisis, which forces investor heuristics and behaviours to evolve gradually.

The concept of a heuristic is used both in the AMH and in the MLP literature, as they are both grounded in evolutionary literature. The MLP literature view heuristics as cognitive rules which are socially constructed and shared by the members of a socio-technical regime (Geddes and Schmidt, 2020; Geels and Raven, 2006; Geels and Schot, 2007; Safarzyńska et al., 2012). The AMH literature focuses at the individual level on the function of the heuristic, i.e. for an individual firm or person to make decisions under uncertainty (Lo, 2004). In this work, we build on both of these strands of literature and define heuristics as an adaptive set of tools, rules and beliefs which are socially constructed and shared among the members of a socio-technical regime who use them to make decisions under uncertainty. Those heuristics are sticky and evolving, i.e. they are fairly stable and cannot be changed overnight but they can evolve with time under landscape pressure.

However, we further propose 5 types of archetypal behaviours, depending on whether financiers are aware of the risks and opportunities of the transition, and on whether they can adapt to the new technology:

Inert: financiers anticipate stability of the existing industry socio-technical regime. For example, German banks and institutional investors were originally wary of financing renewables before KfW pro-actively gave positive signals towards those technologies (Geddes et al., 2018).

Creative self-destruction: financiers anticipate growth opportunities in the industry regime and steer industry incumbents to increase investments in the incumbent technology. This echoes the notion of Creative Self-Destruction proposed by Wright and Nyberg (2015) that the response to a problem arising from the continuous expansion of the industry incumbents is to further extend their reach. For example, E.ON and to a lesser extent RWE invested in the late 2000s' into fossil fuel electricity generation under the pressure of their shareholders (Ferguson-Cradler, 2022; Kungl, 2018; Kungl and Geels, 2018).

Loyal enabler: financiers anticipate the upcoming socio-technical transition and support the industry incumbents to invest in technology innovations (e.g. large support from the UK banks to the incumbent UK electricity utilities during the "dash for gas" to build gas-power plants, Bolton and Foxon 2015; Kern, 2012). The term Loyal Enabler is chosen because they support the transition by investing in the new technology but remain loyal to their existing customers. Several conditions are necessary for them to be able to do so:

- Either industry incumbents are already first movers, or financiers have the power to steer them in this direction; and
- They are able to finance the new technological innovation by adapting their heuristics.

Redirecting enabler: financiers anticipate the upcoming socio-technical transition and redirect their investments from industry incumbents towards industry niche entrants (e.g. support from the German Savings and Cooperative Banks to small-scale solar and wind in Germany, Geddes et al. (2018), Zhang (2020)). This type of financier also supports the transition by investing in the new technology but contrary to Loyal Enablers, they redirect their capital from one industry player (incumbent) to another (niche) in its ideal-typical form. Financiers are able to do so because they can adapt their heuristics to those new entrants and/or the new entrants able to fit into their requirements, for example by aggregating small-scale projects to fit into the transaction size desired by the financiers (those processes are described in Geddes and Schmidt (2020)).

Winding down: financiers anticipate the upcoming socio-technical transition, but they are incapable of financing the new technology, so they reduce exposure altogether from the sector. That leaves the door open for other types of financiers to fill in the space.

This typology of behaviours can apply to both the regime and the niche levels of the MLP framework, i.e. to both incumbent financiers and financier new entrants, when they face financial and industry landscape pressure. One could assume that new entrant financiers would be more willing to finance industry niche entrants, i.e. play a Redirecting Enabler role in the typology (bottom right behaviour on Fig. 3). Similarly, one could assume that an incumbent financier would be more loyal to industry incumbents (e.g. existing shipowners), i.e. play an Inert, Creative Self-Destruction or Loyal Enabler role (two most left behaviours and top right on Fig. 3). However, there are examples in the literature of financiers supporting industry new entrants as discussed in the previous section, and there is no a priori reason why new entrant financiers would not also be resistant to changing their behaviour in an upcoming transition (Inert), so we assume here that both levels of the MLP can adopt all types of behaviour.

The above figure should be read from top left to bottom right. The black boxes represent the possible behaviours that financiers (either niche or regime) can adopt while an industry transition unfolds.

3. Methods

3.1. Case study selection

We conduct case studies of the incumbent financiers of shipping at the outset of two distinct socio-technical transitions:

A transition towards low/zero-carbon shipping, to reduce the carbon impact of the ships themselves (supply-side risks").

Several socio-technical transitions of the land-based sectors, in particular the electricity generation and road transportation sectors, away from fossil fuels and towards renewables. This would translate into a decrease of transportation of fossil fuels such as coal and oil,

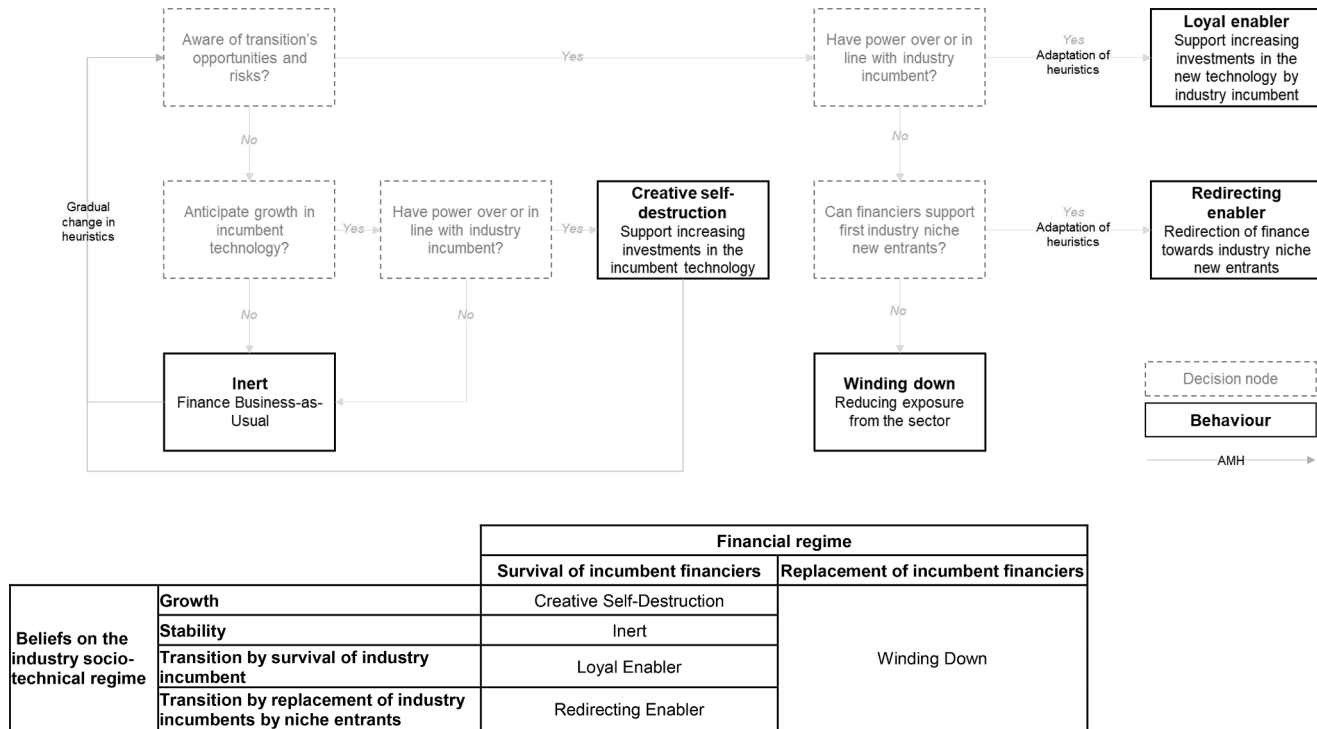


Fig. 3. Schematic representation of the extended MLP framework.

possibly LNG as well; and potentially new shipping demand for the operation of offshore wind farms, the transport of CO₂ and bio-energy (“demand-side risks and opportunities”).

The majority of ship finance historically comes from shipowners’ balance sheet and debt provided by commercial banks, and more recently by Asian leasing agencies (Fig. 4). Debt issued by banks have tenors typically ranging from 5 to 12 years. Loan profiles are longer due to the economic lifetime of ships so that shipping loans include a balloon payment and are refinanced, often by the same bank. The Global Financial Crisis and the subsequent banking regulations changed the shipping financial regime, as they led European commercial banks to reduce their exposure from the sector because of the large scale of non-performing loans in shipping, in particular in Germany. In a sector characterised by a high volatility of revenues and asset values (see Fig. 5; see Alexandridis et al. 2018) for an in-depth review of the literature on the topic, remaining banks now focus on the largest and top-tier shipowners, which are perceived to be safer, resulting in intense competition in this segment.

The demand and supply-side shipping transitions that this paper investigates are just starting to unfold, and their outcomes are uncertain. It is not within the scope of this article to predict how they will unfold, but rather to look at the heuristics and ambitions of financiers at the beginning of them. The case studies therefore focus on whether they anticipate opportunities or specific risks to their portfolios from the demand-side and supply-side transition to low/zero-carbon shipping.

3.2. Methodological approach

We follow a qualitative research design, using the thematic analysis method proposed by Braun and Clarke (2006) and Clarke and Braun (2013). Since the research questions concern financiers’ beliefs and perceptions of their environment, the principal source of data for this work are interviews. The understanding of heuristics and ambitions draws on data from 12 in-depth interviews with financiers, covering together around a quarter of the shipping debt, conducted between May and November 2022 (see Table 1). Eight interviews have been conducted with commercial banks active in shipping – including one State-backed bank with a mandate from the State – and 4 with asset managers, two of which are alternative lenders dedicated to the decarbonization of the shipping industry. It is worth noting that financiers 8 and 10 are effectively shipowners or ship managers who get some of their capital from asset managers. They provide a perspective on how asset managers and institutional investors view climate risks and make decisions. All interviewees but those two were mostly providing shipping debt to the industry, although some would also provide a range of products in addition to debt. Interviews were guided along a general interview guide but were semi-structured to allow the interviewer to alter questions depending on the interviewee’s responses.

We further collected data from a range of secondary sources to give some context to the case study and triangulate the interview findings, which provides some observations of past investment decisions of shipping financiers and explores the public communication of the financiers concerning their role in climate mitigation. We collected data for the top 20 shipping banks according to Petropoulos (2021) and for all the financiers interviewed. News articles were collected by searching for the name of the bank and the keyword

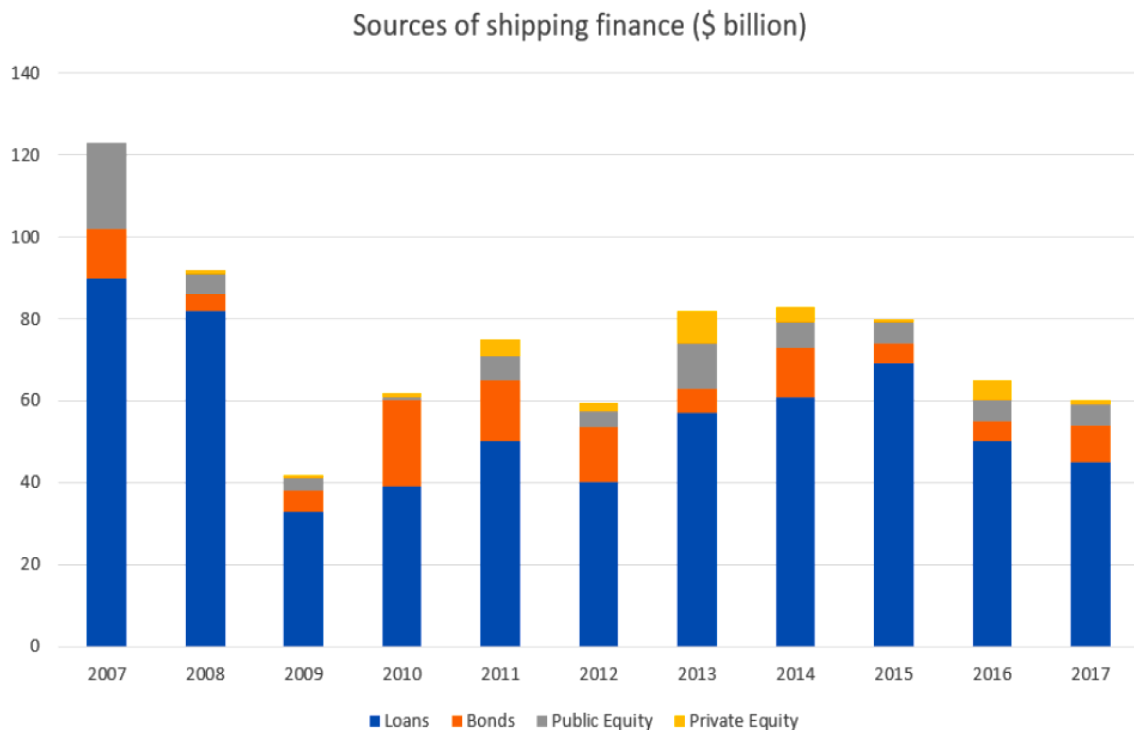


Fig. 4. Sources of shipping finance (from Tsianakidis, 2019).

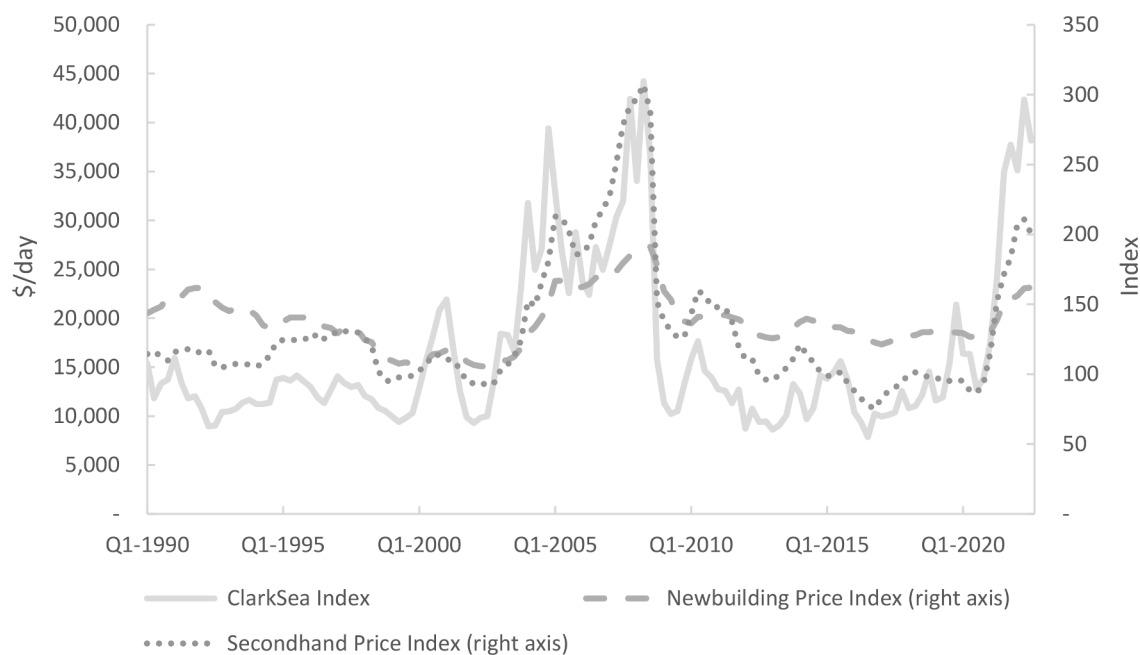


Fig. 5. Prices on shipping markets, 1990–2022 (Clarksons Shipping Intelligence Network (SIN)).

“shipping”, “marine”, “maritime” or “Poseidon Principles” for all articles published after 2007. Only articles which were related to shipping low-carbon transitions and to a specific financial deal, when mentioning the ship(s) or type of ship financed, were selected. In addition, we collected ad hoc news articles to confirm and expand the understanding of specific points mentioned by the interviewees during the interviews when the context was not clear. We further collected public ESG/environmental/shipping reports and official communications related to shipping low-carbon transitions relating to those financiers, and the Poseidon Principles reports, using Google search. Finally, one financier agreed to provide non-public reports which they shared with their shareholders. We collected and analysed 113 company reports and official communications, 235 newspaper articles and 11 company reports shared with the companies’ shareholders. Finally, quantitative data on past shipping investments were collected to provide context to the narrative.

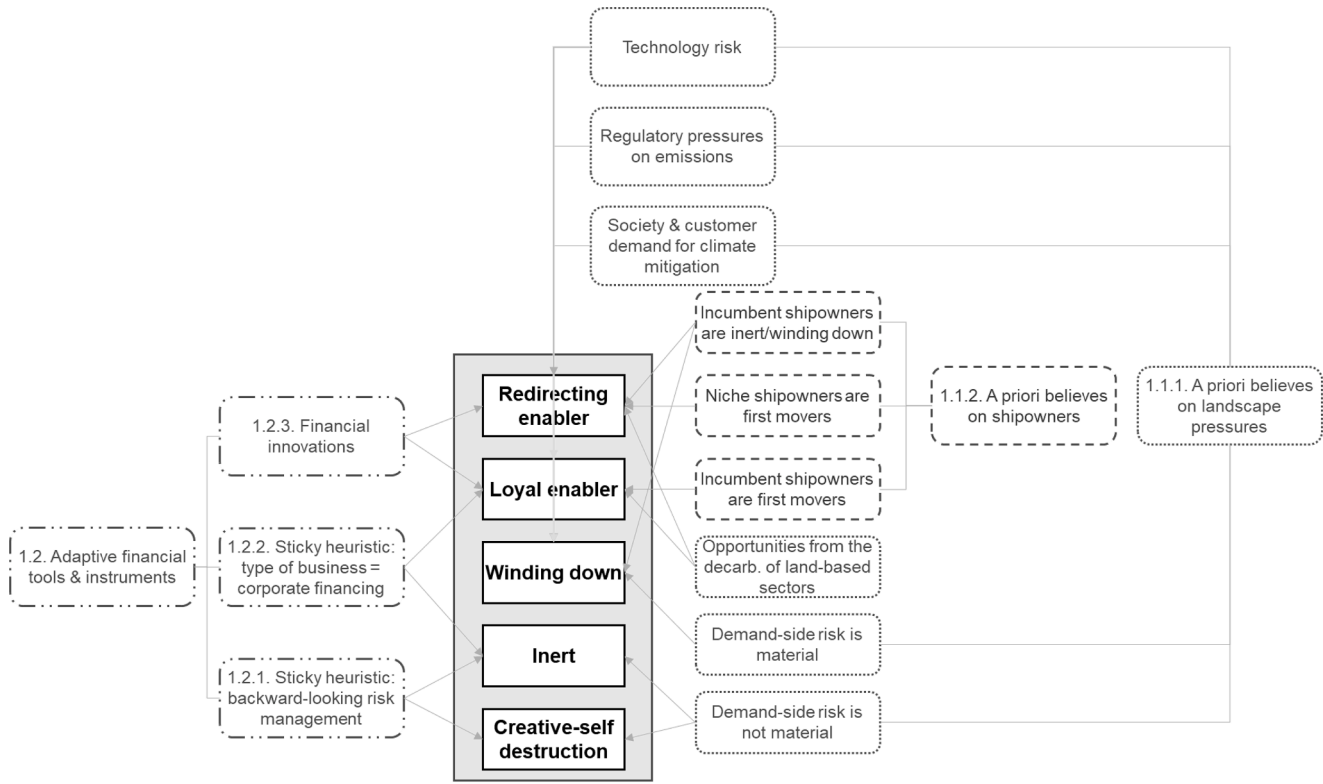
Our data analysis uses the thematic analysis method proposed by Braun and Clarke (2006) and Clarke and Braun (2013) and is conducted in two steps. First, high-level themes were built using the proposed theoretical framework proposed in Section 2.4. Second, interviews transcripts and collected secondary data were mapped to those high-level themes by “coding” them using NVivo software¹ (top-down approach), but high-level themes were inductively adjusted to the internal logic of the data and detailed codes falling under each high-level theme were generated inductively (bottom-up approach). This second step is iterative, such the text is recoded as the detailed codes are iteratively developed. This method, also used in Kungl and Geels (2018), avoids artificial results which simply reproduce the theoretical categories. Both interview transcripts and secondary data were coded along the same high-level themes and detailed codes. The simplified structure of themes and dependent codes is presented in Fig. 6, and the detailed description of each code is presented in Table A1 in the appendix. For example, the codes “Customer and charterer demand for low or zero-carbon shipping”, “ESG as legitimacy demand from society to financiers”, “Shareholder demand for ESG” are grouped under the sub-theme “Society & customer demand for climate mitigation”. Relevant text parts were coded along each subcode.

The data coded was primarily interpreted qualitatively, by looking at the context in which an assertion was made, the past history of the company of the interviewee, how certain or nuanced the interviewee is when making this assertion – for example several interviewees would state that “I believe that X is unlikely to happen, but if it does happen, then I believe Y”, or whether it was made spontaneously by the interviewee or to answer a follow-up question of the interviewer. When relevant, this was complemented by some quantitative analysis on the number of interviewees who mentioned a statement coded under a theme, and by the number of times (words) an interviewee spent discussing this topic, which might reflect their interest or knowledge of the question. This quantitative approach is secondary to the purely qualitative approach.

The themes used to code the interview and the collected data are derived from the theoretical framework proposed in Section 2.4. A schematic representation of the themes is showed on Fig. 6, as follows:

1. A first set of themes cover the stickiness and evolution of the financiers’ *heuristics*. We distinguish here between two types of heuristics, based on the coded data:

¹ NVivo is a software which allows the user to tag (“code”) sections of texts with themes, and collate together all the text sections coded to a particular theme.



2. Behaviours
Fig. 6. Thematic analysis schematic representation.

- 1.1 *Beliefs*: Those cover financiers’ beliefs of the drivers of the transitions (in blue on Fig. 6), such as the availability and risk of the incumbent and new technology and the strength of landscape pressures (policy, customer demand for example) behind the transition; and their beliefs on the role of incumbent shipowners (in green).
- 1.2 *Financial tools and instruments* (in blue on Fig. 6): those include the tools and rules of thumbs used by financiers (e.g. the credit risk methodology adopted by each financier; the rule of thumb used to judge the quality of a transaction; and the financial instruments available to financiers).
2. The roles of financiers in the transition to low/zero-carbon shipping are organised along the 5 ideal-typical *behaviours* proposed in Fig. 3 (central greyed area on Fig. 6).

The description of the themes and their underlying codes is detailed in Table A1. The following sections further explain the findings for both types of shipping transitions – demand-side and supply-side, and are organised along those three broad themes: *beliefs* on landscape pressures, financiers’ *behaviour* in the transition and adaptation of the *financial tools & instruments*.

The numbering of themes is consistent with the one used in Table A1.

4. Results and discussion

4.1. Supply-side transition

4.1.1. Beliefs of the upcoming transition

All financiers interviewed acknowledged the need to decarbonize the shipping industry, which has been driven by landscape pressures for all regime actors to invest in energy efficient ships and low/zero-carbon ready ships. All interviewees mentioned that landscape pressures have already started to materialize through various channels and that they expect that trend to increase in the coming decade.

The type of supply-side transition driver perceived to be critical varied from financier to financier (see Fig. 7). Most financiers were particularly sensitive to changes in customer demand and increasing demand from charterers for cleaner ships. This customer and charterer pressure is linked to the adoption of the Sea Cargo Charter initiative in 2020, which establishes a framework for assessing and disclosing the climate alignment of ship chartering activities (Sea Cargo Charter, 2022). This initiative seems to have shifted beliefs of banks in particular, but also some alternative lenders, so that they now view the possibility of a two-tier market in favour of low-emission ships as credible in the future. Most financiers viewed regulation (at the regional level, in particular the EU, and in some cases IMO) concerning shipowners and financiers as an important driver. In particular, they anticipated further EU regulation on shipping emissions and increased capital requirements for financing carbon-intensive activities. Several anticipated increased IMO regulations in the long term, but many also mentioned that the institution was too slow or not ambitious enough. In particular, they anticipated further EU regulation on shipping emissions and increased capital requirements for financing carbon-intensive activities.

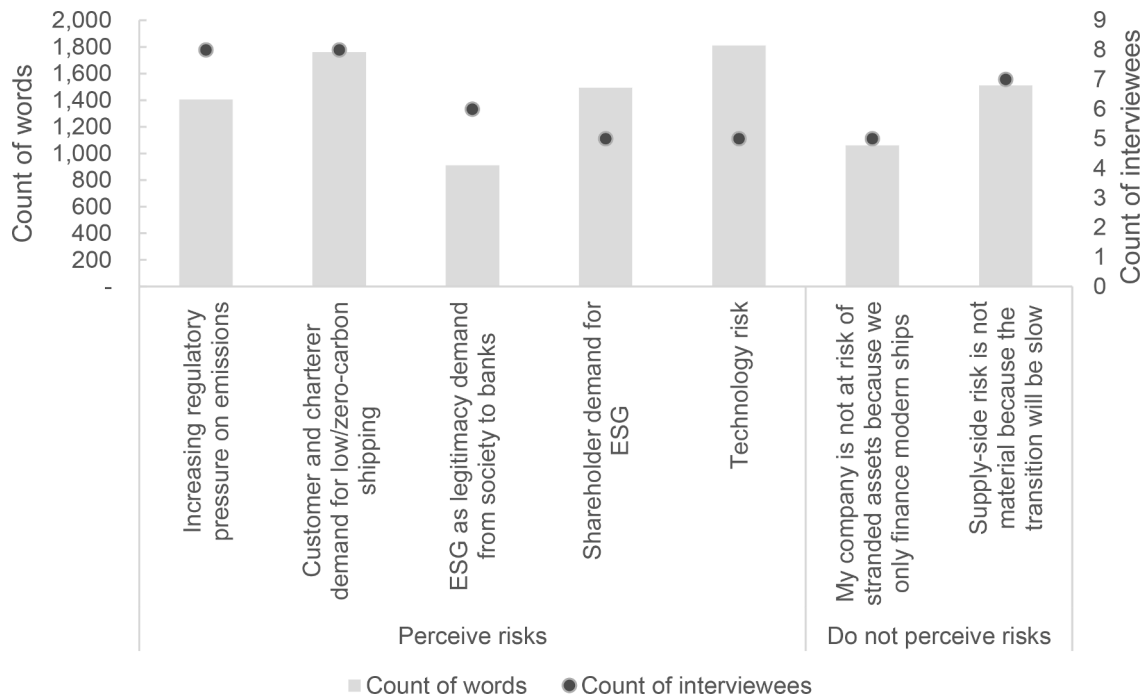


Fig. 7. Coded words and coding presence in codes related to beliefs of supply-side landscape pressures.

Concrete policies mentioned by the interviewees include the EU Emission Trading System (a cap-and-trade program that aims to limit greenhouse gas emissions implemented in 2005), the EU taxonomy (a classification system designed to define environmentally sustainable economic activities implemented in 2020), the CII/EEI regulations (Carbon Intensity Indicator and Energy Efficiency Existing Ship Index), which are performance standards international maritime regulations that entered into force in November 2022 and are designed to reduce greenhouse gas emissions from existing ships. This suggests that recent regulations and announcements have shifted some financiers' beliefs about increased regulatory pressure. These financiers were optimistic overall of these potential policy changes and highlighted that such regulations are needed for shipping markets and financial markets to properly price in the climate impacts of shipping.

Many also highlighted societal pressure due to increased concerns about climate change, particularly since the Global Financial Crisis. Several interviewees highlighted the consequential demand from financiers' shareholders to improve their ESG policies, a demand which is also highlighted in their public communication, so that appearing to be a leader in climate change was cited as a competitive advantage by some of the interviewed financiers.

This apparent strong awareness of the coming transition to low/zero-carbon shipping needs to be nuanced by the scepticism expressed by all but two interviewees about the speed of the transition (see Fig. 7). Only one financier interviewed mentioned the decrease of shipping activity as a solution to reducing shipping emissions would potentially threaten the profitability of the shipping industry. Academic studies have shown that, if shipping activity is to continue growing as in the previous decade and shipping to remain in line with a 1.5° pathway, ships' carbon intensity needs to be reduced by at least 50 % by 2030 (Science Based Targets, 2022; Traut et al., 2018) and low/zero-carbon alternative fuels to be rapidly scaled up in the 2030s (Lloyd's Register and UMAS, 2019; Osterkamp et al., 2021). This ambition was deemed unrealistic by many financiers "There was a discussion in Poseidon [Principles] about this new potential new trajectory based on top-down (...) carbon budgeting, implying that (...) we need to take 50% of the reduction in the carbon intensity (...) before 2030. That's totally unrealistic." (Interviewee 9). When directly asked, many would acknowledge the existence of a technology risk but would often consider it as less important as it was felt that the technology for low/zero-carbon ships was uncertain and immature while it would take a long time to renew a whole fleet "It's in the pace of the creation of future fuels that may well determine whether a particular asset is viable forever till the end of its useful life or you know its life it's fore-shortened and in the sense that it comes too expensive to retrofit and stuff. So these are fortunately not decisions that I will be making. (...) But I think the risk of stranded assets in shipping is quite low. 'cause I think if ships don't get finance they don't get built, so no one wants to order them. But of course they could get stranded if the pace of technological change turns out to be much faster" (interview 1). Furthermore, several interviewees expressed technology lock-in for LNG, since LNG as a marine fuel has been shown to have limited GHG benefits (Balcombe et al., 2022; Pavlenko et al., 2020) and its drop-in low/zero-carbon fuels such as bio-LNG and e-LNG are not expected to be available at scale nor cost-competitive compared to other low/zero-carbon fuels (DNV GL, 2020; IRENA, 2019, 2021; Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping, 2021; Smith et al., 2019). Interviewed banks, all of which have already invested in LNG-fuelled ships (including LNG carriers) were however putting faith in drop-in fuels such as bio-methane or e-LNG. Arguments mentioned by interviewees for continuing to back this technology included the trust in the shipowners' judgement, belief in the availability of drop-in zero-emission fuels, lower SOx, NOx and CO2 emissions compared to LSHFO, and confidence that engine improvement will solve the issue of methane slip.

Only a few financiers on the other hand expressed concerns that the assets they finance – both conventional and low/zero-carbon – would face early obsolescence due to the uptake of new propulsion technologies: "Today we're approached a lot of projects to finance (...) LNG-fuelled or methanol, that we didn't see before. Tomorrow we'll be approached on ships to finance with hydrogen or ammonia

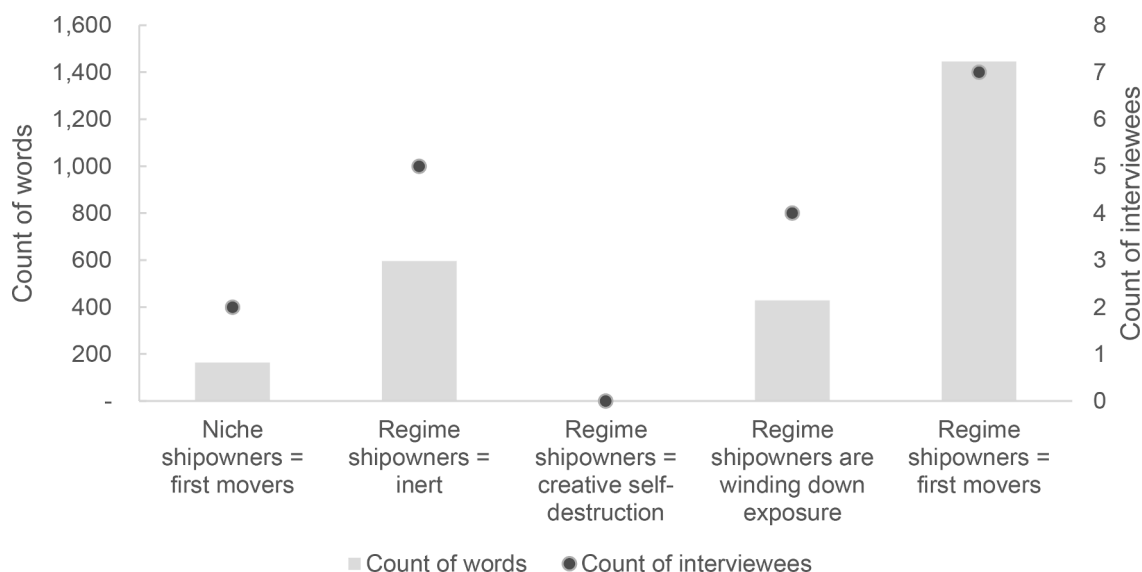


Fig. 8. Words coded and coding presence in the codes related to beliefs on shipowners.

and that means that the current fleet will lose value faster than we could expect. And then these new ships, well, we don't really know what their value will be (...) in 10, 15, 20 years because they will probably be out of date too. So it's a real period of uncertainty" (Interview 7).

Interviewees are counted if the interviewee has expressed a statement in line with the code.

Most of the financiers believed that the top-tier incumbent shipowners, which constitute the bulk of their clients, are aware of the need to decarbonize and are first movers in the transitions (see Fig. 8). This finding is valid whether measured by count of words or by count of interviewees who expressed an opinion on the shipowners in line with one of the 5 types of behaviours proposed in the extended theoretical framework. The Poseidon Principles reports are full of such statements: "We thank our shipowner clients who have been very cooperative for this first "harvesting" data campaign concluded in a very tight schedule. This is the clear demonstration of their commitment to a greener shipping and their willingness to be actors of the energy transition for shipping" (CIC, *Poseidon Principles 2020*, 26). This view is largely supported by the interview data, although many interviewees would nuance this statement by stating that some shipowners are reducing their investments in any ship due to uncertainties about their future viability ("regime shipowners are Winding Down exposure" on Fig. 8) or that some shipowners are ready to move earlier than others ("Regime shipowners = Inert" in Fig. 8). In particular, it was felt that public shipowners and shipowners operating on shipping segments closer to customers (ferries, containers, offshore) were more advanced, which is in line with the findings of *Stalmokaite and Yliskylä-Peuralahti (2019)*. With regards to the beliefs that their clients are first movers and that the decarbonization will be gradual, many financiers believe that in case of the materialization of climate risks, their clients' ships will not be stranded because they are the most modern on the market and because the loan period is relatively short (around 7 years) so that they will have the time to adapt to the new regime, while other ships will be stranded first. It is therefore noteworthy that no incumbent financier considered that their clients were making value-destructive decisions ("regime shipowners = Creative Self-Destruction" on Fig. 8) or that new entrants would be better placed to take on the opportunities of the low-carbon transition ("Niche shipowners = first movers", on Fig. 8).

For most interviewees, investment in low/zero-carbon ships requires access to a varied and secure source of capital and the involvement of a large range of stakeholders to share the financial risk and additional costs – for example customers, charterers, fuel providers, public authorities and ports. Most banks interviewed believed that only large shipowners – which are also generally their target clients – will have the financial, relational and experience capabilities to do so. Some expected – and welcome – a consolidation of the market around the few top-tier shipowners they are financing. In particular, financiers – whether commercial banks or asset managers shipowners – were keen to pass some of the risks associated with new technologies to the charterers. This identified need has not translated so far into a financial innovation from banks, but two asset managers have highlighted that their business model was based on long time-charterers and one of them is trying to add a clause in the contract which stipulates that the charterer would have to buy the ship back at the end of the charter period, which essentially displaces the residual risk from the shipowner/financier onto the charterer.

The counts corresponding to "niche shipowners = first movers" come from interviewees 8 and 10 who referred to themselves when saying that niche entrant shipowners were first movers.

4.1.2. Role in the transition

Given the previously mentioned beliefs about supply-side risk, interviewees expressed an ambition to play a Loyal Enabler role, i.e. supporting incumbent shipowners in the transition. Shipping financiers have publicly communicated this ambition, in particular since 2019, in their annual reports and public communication but also through their involvement in various initiatives such as the Sustainable Shipping Initiative, Ship Recycling initiative, the Global Maritim Forum or the Poseidon Principles.

The Loyal Enabler behaviour seems to derive directly from the historical links between the financial regime and the industry regime through relationships with their clients which are often personal, in which they have invested in incumbent technologies, and common beliefs about the future availability of fuels. All banks interviewed considered ship finance as corporate finance rather than asset finance, i.e. finance to the shipowner as opposed to an individual ship asset. As a result, the importance of the ship as collateral often comes as a second or third priority. The focus on client was driven by credit worthiness of the borrower and in some cases to also ensure that the company fits into the financier's business strategy. A particularity of ship finance is that banks attach a large importance to the reputation, performance in past shipping cycles and the relationship with their clients, at least as much as to the current financial health of the shipowner company. This behaviour is corroborated by previous findings in the literature (*Gavalas and Syriopoulos, 2015; Lee and Pak, 2018*), and interviews support that this is still one of the main drivers of a financing decision. Several banks stated that those links would allow them to positively influence the evolution of the industry, through engaging with their clients and through making capital available for cleaner ships. On the other hand, many banks seemed cautious to support niche entrant shipowners, but the interview with interviewee 10, a shipowner operator who has entered the ship-owning space a few years ago and who differs from other incumbent shipowners by their mandate to only invest in ships exceeding the climate ambitions of the Paris Agreement, contradicts this statement, as they have been able to access finance from traditional shipping banks. However, the interviewee highlighted that the fact that their company's management entrant had decades of experience in the shipping industry and were personally known to the bank employees helped build the relationship.

The belief of incumbent shipowners as first movers, and the fact that all banks interviewed viewed their business as relationship-driven means that banks largely trusted their clients' judgement on the selection of ships in their fleet and their ability to transition to a low/zero carbon fleet. Although some have highlighted some reservations in the interviews, this trust remained strong: "So your question as to what we look at for new vessels [*in terms of carbon efficiency*], I would have said we listened to our client (...). But now we know that if we agree this science-based target, we can't make that assumption any longer. If it's an LNG-fuelled vessel, we know actually that it will make our results worse. That won't necessarily stop us financing them there because we're taking the

decision to support our clients who are making the assumption that they will be able to run these LNG fuelled vessels on bio or synthetic LNG in years to come, which is a big... It's a mighty assumption, but it's one which a lot of these the sector is taking" (interviewee 2).

This approach of shipping finance as relationship-driven corporate finance was largely shared by the banks, but not necessarily by the other types of financiers interviewed, due to the difference in business model. Institutional investors were found to attach a large importance to transparency, corporate financial and increasingly ESG metrics, but not to relationships. The financing behaviour of these interviewees can be characterised as a Redirecting Enabler, i.e. anticipating the upcoming socio-technical transition and redirecting their investments from industry incumbents towards industry niche entrants. On the other hand, the alternative lender 3, despite a much more ambitious climate agenda, had a business model similar to traditional banks based on secured debt lending and with a large attention to the reputation of the shipowner, although a major difference is that they put the ship characteristics, in particular climate-related ones, before the company.

For some financiers, their ambition to play a Loyal Enabler role has started to translate into investment decisions in low carbon shipping assets. Two financiers reported having financed pilot projects of low/zero-carbon ships to improve their own knowledge of niche technologies and provide proof of concepts to the broader industry. It is worth noting that for both of those projects, the role of the State mandate and public finance was prominent. Several other banks mentioned they were wary of providing finance for unproven technology and would rather step in once the proof of concept has been established. The impact of this shift in investment decisions on the shipping portfolio is however marginal for all financiers interviewed but the two alternative financiers at the time of writing. Furthermore, many of the interviewees have provided finance to LNG-fuelled ships. The case of LNG-fuelled ships is insightful because it illustrates how financiers – in particular shipping banks – can play a Loyal Enabler role to support the uptake of this new technology by their incumbent clients; but also good case demonstrating inertia and technology lock-in. Interviewed banks which have already invested in LNG-fuelled ships were reluctant to move away from those investments despite the risks (Balcombe et al., 2022; Pavlenko et al., 2020).

4.1.3. Adaptation of financial tools and instruments to supply-side climate risk

Traditionally, most of the commercial banks' and financier 3's activity is debt secured by the ship asset with longer profile than tenor, i.e. the ship is depreciated along a longer period than the loan duration so that there is a balloon payment at the end of the loan period. Credit rating and investment decisions are mostly based on backward-looking financial (non-climate related) data such as profitability or leverage; where corporate metrics are prevalent while the asset characteristics remain secondary. Most financiers' risk management approach is to finance newbuildings over refinancings, or ships up to 10 years old. This way of working was found to persist in the interviews, but banks have started to collect environment-related data over the last few years under the landscape pressure to decarbonise.

First, interviewees highlighted that while fuel efficiency was originally not taken into account in investment decisions by financiers – validated by previous literature which found that the most relevant metrics for fuel efficiency were not taken into account in 2016 (Mitchell and Rehmatulla, 2016), they have now started to collect data on the environmental characteristics of the ship assets they finance. The main data collected is the Annual Efficiency Ratio (AER, a proxy of energy efficiency which assumes ships are fully laden on each voyage) of second-hand ships because it is the metric used in the Poseidon Principles, but some financiers mentioned looking at the design fuel efficiency, the fuel used, the age of the ship, the capacity to retrofit to alternative fuels and for a few the risk that a ship becomes stranded using qualitative assessment or basic desktop analysis. For example, one interviewee's approach was to have a distribution of ages, including older ships as these would leave the fleet in the short-term. They were wary of newer ships because technological and regulatory uncertainty might cause these ships to be outcompeted in the market with ships which will be more technologically advanced (e.g. in terms of fuel and machinery onboard) and compliant with regulations.

Second, the perceived landscape pressure to decarbonise the shipping industry also translated into an increasing attention to the decarbonization strategy and ESG characteristics of the shipowners. As a result, banks have continuously been putting efforts over the last few years to develop tools to measure the ESG performance of the corporates. Those tools might incorporate, among other variables, the carbon intensity of the total fleet, but would not reflect the particular risk attached to an asset: "It's not that we won't finance assets above the pathway, but we want to make sure that our owners have a strategy to decarbonize their fleet and particularly the ships that we're financing" (Interviewee 4).

How this newly collected data influences financier's actual behaviour and investment decisions is ambiguous. First, this data-driven approach is combined with the belief that the top owners (who they provide finance to) are most resilient to the energy transition and own the most fuel efficient ships. Second, for all interviewees but the two alternative financiers, those ship-level characteristics did not seem to be formally included in the financial assessments and credit rating used to inform the pricing and financing decisions. In particular, they did not incorporate carbon prices or future CAPEX investments for low/zero-carbon fuel switching retrofits. As a result, the way the environmental performance of the ship assets feeds into the credit rating and the pricing was not formally and explicitly defined, even when this environmental performance is measured and quantified in a scenario analysis. As a result, debt pricing did not reflect the climate risk of the ship, but rather the competition between banks to provide debt finance to the few top-tier shipowners they are after.

Although the ships' environmental performance did not influence the conventional financial instrument's pricing, many financiers highlighted that the perceived greenness of the ship would influence the engagement with the shipowner, and in some case the decision to provide finance to a ship, in particular after signing the Poseidon Principles. For one bank and for the alternative financiers, climate risks were incorporated into guidelines on the carbon intensity of the ship above which they would not invest, but that position seemed to be marginal within the sample banks, which seemed to have a more qualitative and flexible approach and they would not refuse to finance a ship to their existing clients on the basis of its carbon intensity. As mentioned, a central characteristic of ship finance

is the importance of the relationship with the shipowner corporate, this characteristic has been simply reconfigured to accommodate growing landscape pressure, and has not been overruled by the need to finance low/zero-carbon ship assets.

To formally incorporate the shipowners' and/or the ships' environmental performance into a financial deal, many financiers interviewed have started to utilise various types of green finance, where the margin fluctuates depending on the operational efficiency of the ship financed or other environmental characteristics of the borrower or the ship (e.g. sustainability-linked loans or green bonds). However, green finance in shipping suffers from the same criticisms as other industries. First, they only represent a small part of the bank activity: environmentally-linked bonds represent 5 % of released bond amount between 2019 and 2022 reported in Clarksons Shipping Intelligence Network (SIN), while \$10.5bn of shipping environmentally-linked loans have been issued so far, i.e. roughly 4 % of the bank shipping debt portfolio². Second, those issuances are always released in agreement with the shipowners and several interviewees admitted that the effects on the margins are fairly small so far, making them only marginally more attractive from a commercial point of view. Third, there is no agreed definition of what a green shipping transaction is. In particular, less than 5 % of the green issuances reported in Clarksons SIN have been approved by the Climate Bond Initiative, the International Capital Market Association (ICMA) or the Loan Market Association (LMA), which casts doubts on how actually environmentally-friendly the remaining issuances truly are. Such transactions have been accused of green washing by some NGOs (ShareAction, 2019; Wiese Bockmann, 2022) but also by one of the shipping asset managers interviewed. Similar to other sectors, green finance in the shipping industry seems to constitute an incremental financial innovation as a response to financiers' landscape pressure to increase their legitimacy by visibly demonstrating an environmental contribution (Monk and Perkins, 2020). Green finance transactions are publicized in the press and companies' public reports so that the lender and the shipowner benefit from positive publicity. Their uptake since 2019 in new debt issued is shown in Fig. 9. Considering that there were practically no green financial instruments for ship finance before 2019, this shows that there is some interest from both lenders and issuers towards this kind of instruments. All interviewed banks had already issued at least one green issuance, which suggests that the uptake covers a large range of banks rather than a few first movers (Figs. 10 and 11).

Only bonds and loans reported in Clarksons SIN whose company sector is classified as shipowner or integrated cargo/shipping group are included. Green issuances cover a large range of bond and loan types which are often not approved by the Climate Bond Initiative (CBI), the International Capital Market Association (ICMA) or the Loan Market Association (LMA), so that the definition of what is "green" varies from issuance to issuance. New shipping loans amount is proxied as the new bank debt issued in 2019 (BRS Group, 2019) and is assumed to be constant in the following years in the absence of better source of information.

4.2. Demand-side transition

4.2.1. Beliefs of the upcoming transition

Overall, financiers did not expect any stranded assets of the fossil carriers they finance in the short-term, as they saw no driver for an immediate and strong decrease in fossil use in land-based sectors and they viewed fossil fuels as necessary to the energy security of countries. Those expectations did not significantly differ by the type of financier: even the alternative financiers who were refusing to finance any coal or oil carriers out of principle grounds did not believe the fall in oil consumption would be dramatic in the short-term. Interviewees believed that coal shipping demand would decrease eventually but that it would not have a large impact on the bulk shipping demand because bulk carriers transport multiple cargoes. They expected the demand for oil shipping to remain strong in the coming decade and maybe decline afterwards, but some acknowledged that there is a risk of stranded assets in the tanker market if its demand declined earlier than this. On the other hand, many financiers expected LNG transportation to remain strong or even increase in the coming decade, driven by its perceived transitional role for decarbonization of the land-based sectors, and geo-political factors such as Russia-Ukraine war, which has led to an increased demand for LNG transportation.

Those beliefs were at odds with the public commitments of most of the major shipping banks to align their finance in land-based sectors to the Paris Agreement, which requires a rapid phase-out of fossil fuels in the coming decade and would likely drive the demand for fossil fuel shipping down. In particular, most of the shipping banks and most of the interviewed banks are signatories of the Net-Zero Banking Alliance, through which they have committed to align their portfolio to a pathway consistent with a maximum 1.5° pathway. This suggests that shipping financiers might not have fully grasped the implications of being aligned with a 1.5° pathway.

This belief of the non-materiality demand-side risks is not communicated publicly, and this issue is largely ignored in the public communications of financiers. A non-public market report sent by one financier to their shareholders, and to which the authors had access, mentioned that oil & gas transportation demand would remain strong. This suggests that opposing views were shared privately and publicly, although it is not possible with the current data to generalize to all financiers.

On the other hand, a few financiers mentioned that the decarbonization of land-based sectors were bringing significant business opportunities. Demand-side opportunities mentioned by the interviewees includes the transport of CO₂, hydrogen, ammonia, bio-energy, and maintenance of offshore wind. Alternative financiers were particularly enthusiastic about such opportunities.

4.2.2. Role in the transition

As a result of the belief that demand-side risk is not material – with some exceptions, most financiers were continuing to invest in fossil fuel carriers, in particular oil and LNG carriers, and were not planning to stop doing so in the short-term: "I have no objection to

² Calculated based on the top 62 shipping banks portfolio reported in Petropoulos (2021).

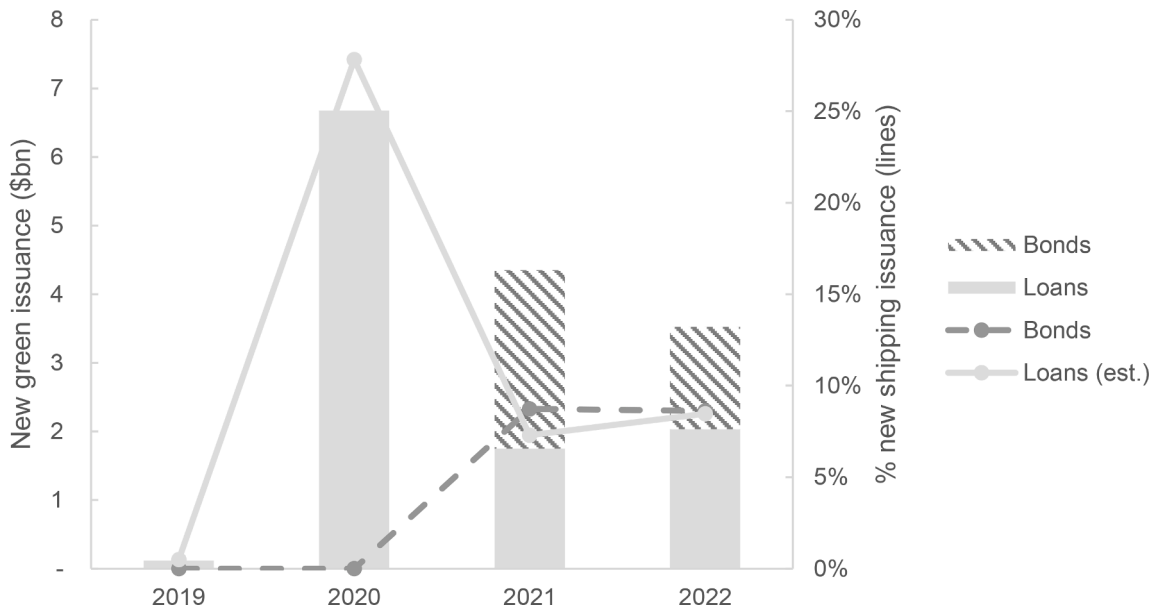


Fig. 9. Issuance of green bonds and loans (Clarksons SIN, BRS Group 2019).

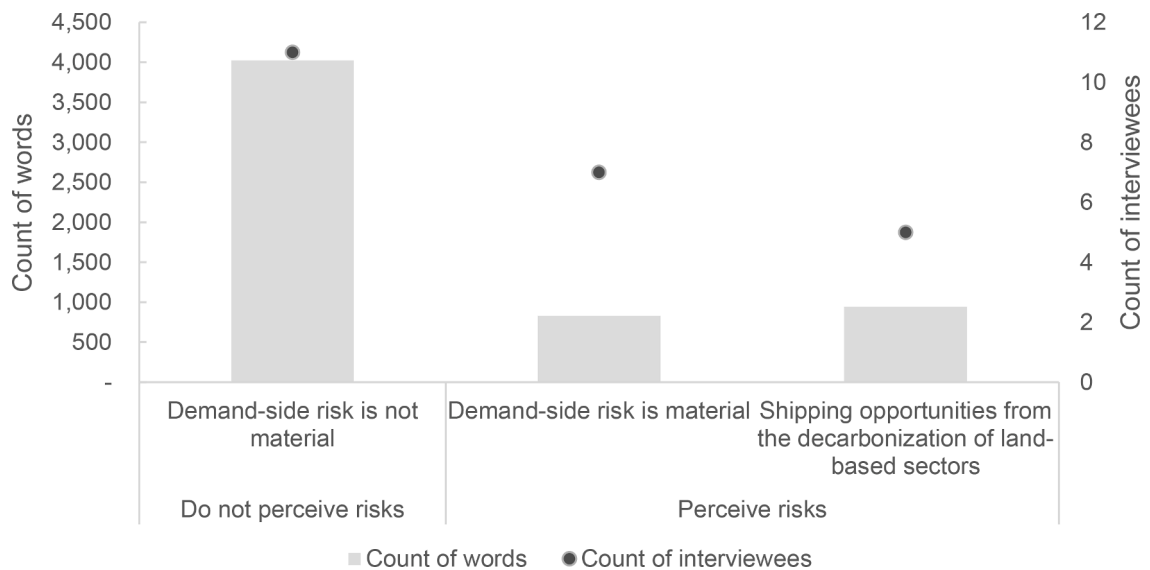


Fig. 10. Words coded in the codes related to beliefs of demand-side risks.

financing a tanker though I would be reluctant to finance a tanker that wasn't dual-fuelled or retrofittable because they're still going to be moving oil." (Interviewee 1). This corresponds to an Inert behaviour. In this context, the only financiers of the sample who have fully refrained from financing oil tankers were the alternative financiers. This finding should however be nuanced by small signs of Winding Down of certain types of oil tankers by a few financiers, which were considered to be particularly at risk. In particular, 3 banks interviewed have mentioned being reluctant or refusing altogether to finance Very Large Crude Carriers (VLCC) while another one mentioned requesting shorter repayment profiles for financing oil tankers. Similarly, as per supply-side risk, some interviewees expressed the belief that their portfolios were not at risk because, as the ships they have invested in are the most efficient on the market, they would be stranded last, so that when oil shipping demand starts declining, they would have the time to divest from oil carriers without incurring losses. Moreover, most financiers are wary of financing bulk carriers dedicated to coal transport - but as most bulk carriers can carry other commodities as well, this rule was not restrictive in practice.

Because some financiers were also particularly optimistic on the future opportunities of LNG shipping, many have adopted an aggressive investment strategy for LNG carriers. This behaviour can be considered as "Loyal Enabler" if the demand for LNG shipping demand materializes, or "Creative Self-Destruction" if it remains steady and declines. It is not possible to conclude between the two

	Heuristics		Behaviours during transition
	Beliefs of the transition	Financial tools and instruments	
Supply-side risks	<ul style="list-style-type: none"> • Most believe transition to low/zero-carbon shipping is happening. • But it will not be fast enough to be aligned with a 1.5-degree pathway. • Given above and tenor, financed ships are thought not to be at risk of being stranded 	<ul style="list-style-type: none"> • Currently measurement lies on corporate ESG score instead of asset/ships. • Measurement and reporting of ships' carbon intensity is based on proxies. • Ambiguous use of green finance (sustainability-linked, Poseidon-Principles-linked, Green Bonds Principles) • Willingness to transfer of risk onto the charterer 	<ul style="list-style-type: none"> • Historically most can be classed as Inert (anticipate stability) • Many have ambition for becoming Loyal Enabler (anticipate and support the transition) • This varies by type of financier: traditional banks, due to the importance of the relationships with their existing clients, are more inclined to be Loyal Enabler. It is not clear yet whether alternative financiers and institutional investors will play a Loyal Enabler or enabling role. • Some face risk of Winding Down (incapable of operating in transition)
Demand-side risks	<ul style="list-style-type: none"> • Demand-side risks are not perceived to be material. • Coal shipping demand will decrease slowly. • Oil tanker demand is perceived to be strong for the coming decade and will decline thereafter. • LNG shipping demand perceived to remain strong or even increase 	<ul style="list-style-type: none"> • Exclusion rules on ship types by a minority of financiers 	<ul style="list-style-type: none"> • Largely Inert for coal and oil transportation • Loyal Enabler for LNG transportation

Fig. 11. Summary of results.

types of behaviour at the time of writing, as there are large uncertainties on the future policies' climate ambitions, for example inclusion of well-to-wake emissions in international regulations, and even if the land-based sectors aligns with a 1.5° pathway, there is no consensus on the consumption of LNG aligned with a 1.5° pathway, so that the future demand for LNG shipping is uncertain (See for example contradicting scenarios outputs from IEA 2021, IPCC 2022, Sharmina et al. 2017, Walsh, 2019).

4.2.3. Adaptation of financial tools and instruments to demand-side climate risk

Because of the beliefs that demand-side risks are not material, heuristics related to demand-side risks have been very stable. A few financiers have invested some resources in exploring demand-side risks and opportunities, in particular to understand which specific ships are most at risk of being stranded. "I think it's all only if you managed to push the curve down to 1.5–1.4°, if you really manage that, you will not (...) continue building oil tankers. That's our a very brief desktop analysis" (interviewee 9). The resources invested seemed to be limited and the majority of banks did not mention performing this exercise. Furthermore, only one financier has suggested it would look at the potential alternative use of its ship if the demand for its cargo carried were to reduce. A minority of financiers have made the binary choice of excluding oil tankers, and more coal-dedicated bulk carriers from financing.

4.3. Summary of results

Traditional shipping lenders, who are part of the shipping financial *regime*, have been until recently, inert to climate risks and opportunities in the shipping industry. However, our results show that the accumulation of *landscape* pressure (existing and upcoming

shipping and financial regulation, customer and shareholders pressure due to an increased climate change awareness) have led them to change their *heuristics* partially and imperfectly. In particular, they are confident that a supply-side shipping transition is underway, a trend which developed in the last few years. However, they are more conservative about the speed of the transition than what would be required to attain a 1.5° pathway and avoid the dangerous consequences of climate change. They are even more sceptical that the materiality of the risk that demand-side risk materializes, i.e. that the demand for shipping fossil cargo decreases rapidly.

As a consequence, they are not particularly worried about stranded asset risk on the fleet they have financed and continue financing fossil-fuelled ships and fossil carriers. However, they have started to change some of their financial instruments to reflect their growing environmental awareness, firstly by looking at the environmental performance of the borrower and secondly, by starting to take the environmental characteristics of the ship into consideration. This supports the theoretical framework of the AMH that during periods of change and landscape pressure, financiers' *heuristics* do evolve over time but are sticky and slow to adapt.

One heuristic which has been notably stable is the importance of the relationship with and the trust in the judgement of their existing clients, i.e. the incumbent shipowners who are part of the industry *regime*. As a consequence, the financial and the industry *regimes* appear strongly supportive of each other and traditional lenders aspire to support them in transitioning by adopting innovations (LNG or alternative fuelled, LNG carriers), i.e. to play a *Loyal Enabler* role. At the time of the interviews, there were few signs that they would want to support innovations which would require supporting niche shipowners (*Redirecting Enabler*) or that they felt they should retreat from the sector (*Winding Down*). This might give an advantage to regime incumbents to undertake the transition, while making the success of innovations more difficult, and suggests that innovative shipping niche players might need to seek alternative sources of finance.

5. Conclusions

Shipping financiers, like other stakeholders in the shipping industry, are facing a growing pressure to reduce their exposure to high polluting shipping assets due to the ratcheting up of climate policy in the EU and at IMO and from a wider societal pressure to decarbonise the industry. In reaction to this pressure, voluntary private stakeholder initiatives like the Poseidon Principles were created to measure and disclose the climate alignment of their portfolios. This has been a catalyst for the industry to become more aware about climate risks and incorporate new factors into financing decisions and risk management practices.

In this paper, a new and extended theoretical framework was created to understand the role of financiers during sustainability transitions. This builds upon the Multi-level Perspective to describe an energy transition and Adaptive Market Hypothesis to describe how financiers adapt their expectations following a breakdown in heuristics. The framework uses questions to deduce the type of financier, characterising financiers into five archetypes to take into account the wide range of financing behaviours observed in the empirical literature of other sectors and their adaptive nature which is not taken into account in extended MLP frameworks. Second, this paper provides novel empirical insights on the beliefs and ambitions of shipping financiers at the outset of several sustainability transitions in shipping regarding their future role and the risks to their assets using qualitative thematic analysis and semi-structured interviews with ten shipping financiers and two shipowners. The findings from these interviews were used to characterise shipping financiers according to the adapted MLP financier framework.

The results show that the majority of interviewees expressed an ambition to play a *Loyal Enabler* role, i.e. supporting incumbent shipowners in the transition, while a second type of financier – the *Redirecting Enabler* - emerged from interviews with niche shipowners receiving funding from institutional investors. The finding that the majority of financiers interviewed (and all commercial banks) can be categorised as *Loyal Enablers*, i.e. they are supportive of incumbent shipowners which is their customer base, makes it more likely that the energy transition will be largely driven by incumbent shipowners. Most financiers also place the responsibility of the energy transition with the shipowner, which could lead to further technology lock-in (exemplified by some banks' support of their clients' LNG-propelled ship investments) if financiers do not investigate the associated climate risks. This also implies that niche shipowners will not represent a large proportion of the fleet but as first movers, they can put pressure on incumbent shipowners and de-risk technologies that conservative shipowners are unwilling to be exposed to. Financiers' support of fossil fuel cargo e.g. oil tankers, reflects their scepticism of overall demand-side risks materializing, i.e. that the demand for shipping fossil cargo decreases rapidly. This could delay the transition and cause a more difficult transition later on when deeper emissions cuts are necessary due to the cumulative impact of GHG emissions on climate change.

Financiers are adapting to the transition through more stringent requirements, e.g. expecting clients to have a credible transition plan, pay loans off more quickly, own modern vessels, and for low/zero carbon ships to have a contract in place in an attempt to transfer the transition risk onto the owner and charterer. This increased burden implies a trend of consolidation of the market towards owners at the top tier who can invest in transition plans and have a strong cash flow to invest in R&D for greener fuels. There is also a need for more finance from *Redirecting Enablers* to accelerate the transition which is likely to come from alternative funding sources like institutional investors.

Financiers and shipowners should assess the climate risk of their portfolio (fleet) and ensure that the ships in their portfolio (fleet) are climate resilient and financiers' clients have a credible transition plan (e.g. through investing in future fuel ready ships that have the optionality of running on low/zero-carbon fuel and avoiding marginal investments like LNG that have high cost fuel substitutes). However, there are limitations on how much the industry can drive the transition without more stringent climate policy. Among European banks, there is a sense that regulation is needed for banks to properly measure climate risks, such as the EU taxonomy and differentiated capital requirements for green and brown assets. Several European banks highlighted that regulation of financial reporting and capital requirements were needed for banks to fully play their *Loyal Enabler* role, as the market competition between banks was preventing them from fully incentivizing greener technologies. This highlights the potential, but also the limits, of voluntary

initiatives from financiers to promote green investments. Furthermore, pilot projects undertaken by commercial banks were in collaboration with the State, underlining the importance of the role of the State or international finance institutions in sharing financing risk through loan guarantees or financing support.

This study has a few limitations. Although the banks interviewed represent around a quarter of debt financing, it covers largely the views of European and Japanese banks who could be said to be leading on integrating climate considerations into their lending decisions. It does not capture a large and growing area of financing in China. Second, the sample largely represents debt financing from banks rather than alternative financing from institutional investors. The findings from these alternative lenders could be investigated further using a larger sample given their key role in financing the emergence phase of the transition. Future research could therefore attempt to understand the beliefs of financiers diversified across geography and the type of lending (e.g. financiers to smaller ship-owners and alternative lending).

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.

Data availability

Data will be made available on request.

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Appendix

Interview guide
Investments decisions – descriptive

1. What types of financial products do you provide to shipowners?
2. How long is the tenor and the profile typically?
3. What type of ships and clients do you finance?
4. If you had to give 3 main factors you consider when deciding whether or not you will provide finance for a ship, which ones would they be?
5. If you had to give 3 main factors which influence the interest rate you give, what would they be?
6. Why signing the Poseidon Principles?

Evolution of the industry over the last decade

1. Could you tell me the story of the first ship investment that you made in your carrier?
2. Could you tell me the story of the last ship investment that you made?
3. Have you observed any evolution in the way your company views and mitigates for climate risks since you joined?

Expectations concerning future stranded assets

1. How do you feel the demand for cargo shipping such as oil, coal and natural gas will evolve in the coming [*insert tenor] years?
2. How likely do you feel it is that it will impact the value of the fleet you finance?
3. How do you feel the pressures to limit carbon emissions from shipping will evolve in the coming [*insert tenor] years?
4. How likely do you feel it is that the ships you finance lose their value because of efforts to limit carbon emissions from shipping?
5. How do you mitigate for those risks (if at all)?
6. Under which conditions would you finance alternative-fuelled ships?

Detailed description of themes and codes

Table A1

Description of the themes and code.

Theme/code	Description
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Table A1 (continued)

Theme/code	Description
1. Heuristics	Evidence of sticky or evolving heuristics. Heuristics include, as per the theoretical framework, beliefs and financial tools & instruments.
1.1. beliefs	A per the theoretical framework, those cover financiers' beliefs of the drivers of the transitions, such as the availability and risk of the incumbent and new technology and the strength of landscape pressures (policy, customer demand for example) behind the transition.
1.1.1. beliefs on landscape pressures	Financiers' perceptions of the existing and upcoming exogenous pressures to shipping.
Cyclicality of shipping markets	Even without considering climate risks, the cyclicality of the shipping revenues means that financiers are exposed to the risks that shipowners go bankrupt of non-performing loans and devaluation of underlying ship assets.
Financiers' awareness of climate risks has increased	There has been a general increase in financiers' awareness of climate risks over the last few years.
Target to reduce shipping emissions	The financier has published a target for reducing emissions of its shipping portfolio. Note that the targets are not homogenous and not all aligned with a 1.5° pathway.
Further regulation and public support necessary for the transition	The private sector cannot self-regulate climate risks and need some kind of regulatory or financial support from the public institutions.
IMO failure to act fast enough	The IMO has been slow to regulate shipping emissions and more efforts are required.
Role of public finance	Instances where public finance has been an Redirecting Enabler of the transition.
Increasing regulatory pressure on emissions	The financier perceives increasing regulatory pressures on shipping emissions.
Society & customer demand for climate mitigation	Growing demand from society and stakeholders for climate mitigation of shipping emissions and/or land-based sectors decarbonization.
Customer and charterer demand for low or zero-carbon shipping	Customer and charterers increased demand for low/zero-carbon shipping is a driven of profitability of low/zero-carbon ships.
ESG as legitimacy demand from society to financiers	Financiers perceive that there is social demand towards financiers for ESG/responsible investment.
Shareholder demand for ESG	Equity investors have started to require ESG/climate consideration from financiers and shipowners.
Technology risk	Financiers are worried that ships might become obsolescent earlier than they have historically.
My company is not at risk of stranded assets because we only finance modern ships	The interviewee's company only finances the most modern, fuel-efficiency or carbon-efficiency ships so they do not believe they will be at risk of being stranded.
Demand-side risk is not material	Because there is no expected large decrease of fossil fuel shipping demand, fossil fuel carriers are not at risk of being stranded.
Demand-side risk is material	The financier believes that fossil fuel carriers are at risk of being stranded.
Financiers' ambition to reduce the emissions of their land-based sectors portfolio	The financier has committed or expressed the ambition to align their land-based sectors portfolio (e.g. energy, manufacturing, etc) to a decarbonization trajectory.
Shipping opportunities from the decarbonization of land-based sectors	The financier ambitions to support shipping demand linked to renewables, e.g. offshore wind.
1.1.2. beliefs on shipowners	This theme regroups all statements characterising the behaviour of shipowners.
Niche entrant shipowners = first movers	Financiers perceive that emerging niche actors are taking up the opportunities arising from the transition to low/zero-carbon shipping and the decarbonization of land-based sectors.
Regime shipowners = Creative Self-Destruction	Financier perceive that shipowners anticipate a growth in shipping and no significant decarbonization, hence increasing investments into the existing technologies.
Regime shipowners = first movers	Financiers perceive that incumbent shipowners are taking up the opportunities arising from the transition to low/zero-carbon shipping and the decarbonization of land-based sectors.
Low or zero-carbon shipping will lead to a consolidation of the market	The shipowners believe that the transition to low/zero-carbon shipping will favour the largest historical shipowners, leading to difficulties from the smaller shipowners and a consolidation of the market.
Regime shipowners = Inert	Financiers perceive that some or all shipowners are unaware of the risks and opportunities arising from the transition to low/zero-carbon shipping and of the decarbonization of land-based sectors.
Regime shipowners are Winding Down exposure	Financiers perceive that shipowners are reluctant to invest in new ships today because of the uncertainty of the transition.
1.2. Adaptative of financial tools instruments	As per the theoretical framework, those include the tools and rules of thumbs used by financiers to make decisions. Those include for example the credit risk methodology adapted by each financier; the rule of thumbs used to judge the quality of a transaction; and the financial tools and instruments available to financiers.
1.2.1. Sticky heuristics - backward-looking risk management	Backward-looking heuristics and tools which have been traditionally used by shipping financiers to assess the quality and the risk of a transaction continue being used in the transition.
Quantitative backward-looking risk assessment	Standardized quantitative credit risk assessment, based on historical backward-looking data.
Standardised financing instrument	The type of financial product is standardized within and across financiers
1.2.2. Type of business = corporate financing	This set of codes look at how financiers view shipping finance as corporate finance, i.e. finance to a shipowner, rather than asset finance. Concretely, when assessing whether or not the finance will finance a ship, it will look at the characteristics of the shipowners before looking at the characteristics of the ship asset.
Analysis of the asset is secondary	The financier either does not look at the asset, or looks at it after having looked at the corporate.
Large range of financial products to few shipowners	Financiers not only provide ship secured debts but a large range of products to a few clients.
Prevalence of corporate non climate-related metrics	Financiers primarily use financial (non-climate-related) corporate metrics which do not include climate risks on the shipowner to judge of the quality of a deal.
Shipowners' reputation is an important criterion of decision	Qualitative criteria related to the shipowners' reputation are used in financiers' assessment process.
Shipping finance is relationship-driven	The financier has long-term relationship with its clients; it will primarily lend to them, will trust their opinion and maintains a dialogue with them.
Targeting the top-tier shipowners	Financiers are targeting a few incumbent and top-tier shipowners.
1.2.3. Financial innovations	Financiers have started to adjust their heuristics, beliefs and tools used to make decisions to adapt to the transition of shipping and its cargo.

(continued on next page)

Table A1 (continued)

Theme/code	Description
Focus on corporate climate strategy and ESG metrics	Climate characteristics of the shipowners (climate strategy, whether it is credible or not; ESG metrics are developed, and data is collected) are measured and taken into account in the financiers' decisions.
Impact of the Poseidon Principles (PPs) on investment decisions	The signing of PPs has impacted the lending behaviour of the financier.
Knowledge build-up of demand-side risk	The financier has used resources to build an understanding of the risks and opportunities for shipping arising from the decarbonization of land-based sectors.
Other financial innovations	There have been attempts for financial innovations (e.g. carbon credits to finance ships; retrofit financing).
Risk-sharing by a larger range of actors	Traditionally, financiers would only need to share financial risk with shipowners. Financing low/zero-carbon ships requires this risk to be shared by a larger range of actors (charterers, public authorities e.g. export credit agencies, fuel providers). Financial instruments need to adapt to this new way of sharing risk.
Ship asset greenness becomes a criterion of decision	Ships' characteristics such as carbon/energy intensity, ability to retrofit and dedication to fossil-fuel shipping are taken into account in financiers' investment decisions.
Climate risks are incorporated into the financial risk analysis	
Uptake of green shipping finance	The financier has provided or is planning to provide green form of finance to shipping. This includes sustainability-linked loans, SBTi-aligned, climate-aligned loans/bonds; or inclusion of carbon intensity metrics on the ships' emissions in the covenants.
2. Typical behaviours	This category collects the text which supports the classification of the shipping financiers' behaviour in one of the ideal-typical behaviours proposed in the theoretical framework.
2.1. Creative Self-Destruction	Financiers push shipowners to invest in the incumbent technology which exacerbates the risks of stranded assets.
2.2. Inert	Financiers are unaware of climate risks and opportunities arising from the transitions and keep their activities as business as usual.
Full divestment is not an option	The financier rejects the option of divesting from the sector despite perceived risks.
Inertia towards LNG as a marine fuel	There is an Inertia to move away from LNG as a marine by putting faith in its drop-in fuels such as bio-methane or e-LNG.
It is risky to be a first mover	There are barriers and uncertainties to low/zero-carbon ships which make them more risky than conventional. It is safer to be a follower than a first mover.
Mispricing of climate risks	Loans pricing is determined by the market competition between financiers, not by climate considerations.
Others are not aware of supply-side risks	Other financiers are not aware, or not as aware to supply-side risks.
Will continue financing fossil carriers	The financier intends to continue financing fossil fuel carriers.
2.3. Loyal Enabler	Financiers is/willing to support in some way the transition to low/zero-carbon shipping.
Influence of financiers on shipowners	Financiers are necessary to shipowners and as a consequence, they have a large power of influence over the transition to low/zero-carbon shipping.
Knowledge build-up of low/zero-carbon shipping	Knowledge build-up of low or zero-carbon shipping.
Mitigating emissions is the right thing to do	The financier justifies its action by a moral driver of the financiers to support the transition to low/zero-carbon shipping.
Pushing the transition favours the interests of the financier	The financier feels that it will benefit from the transition to low/zero-carbon shipping; and is therefore trying to influence the process to accelerate it.
Support for LNG as a transition fuel	A financier has supported or is supporting LNG as a transition fuel.
The financier will help incumbents into doing the transition	Financiers will help existing incumbents/existing clients to invest in the ship assets necessary for the transition.
2.4. Redirecting Enabler	Financiers support niche actors to lead the transition to low/zero-carbon shipping.
2.5. Winding Down	Financiers are adopting a cautious approach to the shipping sector altogether, either by retrieving or by requiring harder lending conditions.
Replacement of traditional financiers by other financiers	Uptake of alternative types of finance than commercial banks focusing on the incumbent shipowners to fill the financing gap for low/zero-carbon technologies.
Fit & conform	Evidence of attempts by industry players (both niche and incumbent) and financiers to adjust the fitness of the shipping industry and ship assets to the expectations and needs of potential new investors.
Traditional banks are retrieving from shipping finance	European banks have retrieved from shipping finance after 2010.
Winding Down from demand-side risk	Financiers are reducing their exposure/financial flows to shipping segments carrying fossil fuels because of the decarbonization of land-based sectors.
Winding Down from supply-side risks	Financiers are reducing their exposure/financial flows to shipping as a whole because of uncertainties linked to the transition to low/zero-carbon shipping.

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