“Maritime financial instability and supply chain management effects”

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MARITIME FINANCIAL INSTABILITY AND SUPPLY CHAIN MANAGEMENT EFFECTS

Abstract

The paper investigates the offshore crisis 2015–2017 and its impact on central international offshore oil and gas related maritime cluster, the Blue Maritime Cluster, located at the North-Western coast of Norway.

This complete maritime cluster, heavily involved in offshore petroleum operations, it experienced an almost devastating blow, as it lost almost one-third of its employees as its value added contracted by 39 percent.

When the crises is basically seen as a result of falling of oil prices and lower activity and squeezed profit margins, this paper investigates the crisis in the light of financial instability and reactions down the maritime supply chain.

By collecting data from the Blue Maritime Cluster and the Norwegian central company register one is able both to trace the fall in the activity due to the crisis and measures of financial strength. The study approaches the data by using a structural time series analysis in order to map cycles as deviations from polynomial trends.

The findings ascertain that financial instability was dominant within the Blue Maritime Cluster during its boom before the crisis. Debt ratios and thereby gearing (leverage) were high. Thus, the companies could not meet their obligations when the crisis hit.

The paper also finds that narrow focused supply chain management made the cluster fall deep into the abyss. Companies with a more diversified portfolio were able to meet the hard years better than others.

Keywords maritime, cluster, supply chain management, financial instability, financial crisis

JEL Classification G32, L22, L91, M21, N74

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INTRODUCTION

After the years of significant growth, maritime industries connected to offshore petroleum production experienced a global crisis manifested from early 2015 and lasting throughout 2017, with shock waves even further out in time. One of the complete maritime clusters in Norway, called the Blue Maritime Cluster (BMC), concentrated to the north-western coastline of Norway, experienced an almost devastating blow during this crisis.

The crisis was basically explained by the considerable decrease of oil and gas prices from summer 2014, and thus lower activity in offshore oil fields (Koilo, 2019). This made a significant share of ocean-going vessels engaged in the oil and gas industry redundant. Access supply made prices on services to the oil sector, freight rates, and shipyard activity fall dramatically, resulting in a slump for the offshore oriented industry worldwide.

It is indisputable that the huge fall in oil and gas prices was the main triggering factor for this international maritime crisis. However, little

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has been done in order to investigate a lack of financial stability and supply chain management defaults prior to the crisis. The BMC, concentrated around the city of Ålesund, suffered a deeper crisis than other companies in the market. The article investigates the crisis of this cluster in light of a financial instability hypothesis connected to supply chain management defaults.

The paper holds two explicit research questions:

1. Did financial instability play a substantial role in the depth of the offshore crisis within the Blue Maritime Cluster?

2. Did supply chain management influence the depth of the same crisis?

In order to answer these questions, the paper utilize data on turnover, value added, employment, operational margins, rentability, and asset structure. These are compiled from the Blue Maritime Cluster and the national register for companies[1].

The data are used to conduct a structural time series analysis in order to identify deviations from trends, to check if financial instability was present. Thereafter, the chain reaction downstream and upstream the supply chain in order to throw light on its impact on the crisis is studied.

3. LITERATURE REVIEW

3.1. Financial instability

Financial stability is considered central for sustainability both in financial markets and for firms. It can be defined as a financial system's robustness to survive in bad times. This implies that it should be able to provide sufficient capital for the business to survive in bad times. This should be equities, loans, credits or any other special means of funding (Grytten & Hunnes, 2013, pp. 25-57).

According to Minsky (1992), lack of financial stability is the most common reason for the evolvement of financial crises. Financial stability is commonly lost during booms in the markets. Profit opportunities make investors willing to put money into projects with high risk due to expectations of continuous upheavals. Not investing means loss of market share and thereby loss of potential profit. Hence, companies are willing to borrow large sums of money to benefit from the boom.

Minsky (1992) describes three forms of income-debt relations for economic units in his financial taxonomy:

1. Hedge finance, which basically is reinvestment of profits. This is basically a balanced and sustainable way of growth.

2. Speculative finance, which is funding based on positive expectations. More precisely this funding takes place during upheavals, where one is willing to invest more money than common profits allow due to expectations of the increasing market price on invested capital.

3. Ponzi finance, which means that growth continuous due to the increase in capital base despite diminishing returns on invested capital. The upheaval has gone so far that returns may be shrinking and creditors are reluctant to invest, but business is going due to increasing capital base.

At the last stage, one is close to the turning point of the markets, often called the Minsky Moment. Minsky (1992) puts emphasis on markets at large. Nevertheless, Apreda (2012) shows that the model is applicable to a corporate finance level.

Based on Minsky's financial instability hypothesis, Kindleberger made his theory of crisis anatomy, claiming that financial markets go through

1 https://www.bluemaritimecluster.no/gce/reports--publications/cluster-analysis/cluster-analysis/, https://www.bluemaritimecluster.no/gce/reports--publications/annual-reports/annual-reports/ and https://www.brreg.no

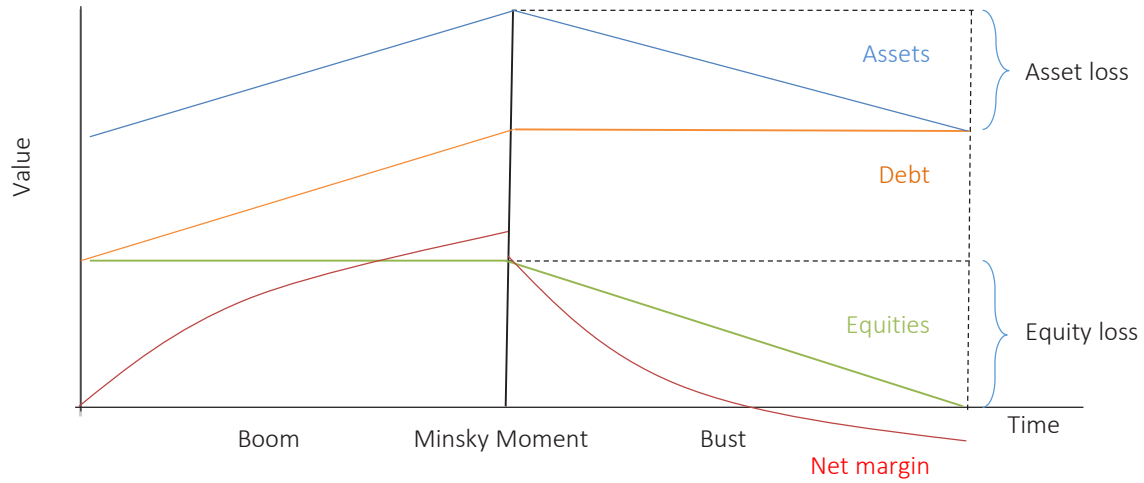

Figure 1. Development of assets linked to the financial instability hypothesis

three stages towards financial crises (Aliber & Kindleberger, 2015):

1. Mania, where a positive external shock leads to euphoric expectations of future profits and make actors willing to invest. During this stage, investors basically take profits from an increase in asset prices rather than from returns. This is a stage of financial instability, and it is not sustainable.

2. Panic occurs when investors realize that asset prices are too high and they fare the market will turn from upheaval to depression. They seek ways out in order not to lose money.

3. Crash occurs if panic sets in the market and the willingness to supply new capital is far lower than the eagerness to get out of the market. Prices on assets fall and business runs into liquidity problems.

Hence, both Minsky and Kindleberger conclude that financial crises very often occur due to financial instability mirrored in high gearing, i.e. high debt ratios, which cannot be served during financial stress.

3.2. Leverage cycle

Drawing on both Minsky and Kindleberger along with empirical work by Grytten and Hunnes, one can follow a common pattern of debt and asset development prior to and during financial crises (Grytten & Hunnes, 2014) This development is described in Figure 1.

Acharya and Plantin (2017) argue that in good times, companies would over-invest in order to gain market shares and short-term competitive advantages. In order to invest, they will increase their level of debt and reinvest profits, making equities apart from reinvested profits stable, unless asset emissions are carried out. Increased debt makes the gearing component, i.e. the share of assets financed by debt, increase, meaning that their leverage is getting larger (Acharya & Plantin, 2017). When the turning point hits the market and a crisis is at hand, often denoted the Minsky Moment, the companies have to use their assets as a buffer for losses. If the losses continue over time, all equity will be lost. The companies may go into insolvencies and debt negotiations or bankruptcy takes place. This development is sometimes called the Minsky leverage cycle (Bhattacharya, 2011).

Thus, Figure 1 shows that assets increase with increased debt as a source, when equities are held stable in good times (booms or mania). After the Minsky Moment (Panic), when net margins fall dramatically and even become negative (Crashes), companies will use their assets as a buffer by drawing on their equities. Finally, the equities may be lost and even negative and the firms may go into bankruptcy.

3.3. Applications for maritime industries

The maritime industry is very sensitive to business cycles and is characterized by uncertainty both in the short and the long run. Thanaopoulou and Strandenes (2017, pp. 325-331) have tried to incor-

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porate uncertainty connected to long-term forecasts in shipping. In the short run, supply of vessels is fairly constant, implying a steep supply curve. Thus, even small shifts in demand may cause huge fluctuations in operational rates (Jugovic, 2015). Stopford (2008, p. 97) has mapped four and seven years cycles within shipping on the basis of match and mismatch of supply and demand, when Kavussanos (2010, pp. 709-745) look at the speculative elements of shipping investment, leading to overheating in good years and revulsion thereafter. Chew, Lee, and Tang (2011, pp. 217-218) on their side put emphasis on the importance of maritime supply chains in the industries development.

Tenold (2019, pp. 195-230) has also highlighted the sensitiveness of shipping-related industries in his extensive research into Norwegian maritime history. Together with Ojala, he also concludes that historically shipping is oversensitive to maritime trade and economic activity (Ojala & Tenold, 2017).

3.4. Supply chain management

There are different understandings and definitions of the term supply chain management (SCM). Research literature gives many different views and understandings of the concept. Based on Larson (1998), and Rogers a very simplified definition of supply chain management would be the management of a product chain from the start as raw materials to fully processed and consumed products.

In line with the research by LeMay, Helms, Kimball, and McMahon (2017) another more normative definition could be planning, administering and organizing product and information chains within or between different companies or industries to obtain efficient floats and production at the lowest possible costs given quality standards (LeMay, 2017).

This means that SCM is often seen as part of the logistics and optimization of production organization. It involves a conglomerate of components. Also, it is important with successful SCM in order to sustain a competitive industrial environment.

When one talks about the BMC, one basically focuses on the maritime industry, leaving most marine operations, such as fishing, aquaculture, and petroleum drilling out. However, maritime operations linked to these should be included.

Since the 2015–2017 crisis took place in the offshore chain, i.e. maritime operations connected to the production of oil and gas, the paper will concentrate on these. The offshore fleet belongs to several supply chains. Three of the most evident would be the supply chain for raw materials, for offshore freights, and for financial operations. These can be summed up as in Figure 2, which shows product flows from the origin to the customers when demand flows basically go in the opposite direction. Moving towards the right means higher up in the supply chain (upwards movement), when moving to the left means lower in the supply chain (downward movement).

Here we can see that the maritime sector is interlinked with marine operations connected to the production of oil and gas (row 1). Offshore services (row 2) present more of a hard-core maritime supply chain when the last (row 3) represents the financial system linked to offshore services.

The crisis started in the first supply chain when oil and gas prices fell rapidly from the summer of 2014 and onwards. This had an effect on the supply chain by causing lower drilling activity and lower demand for offshore vessel services, which influenced the other two chains.

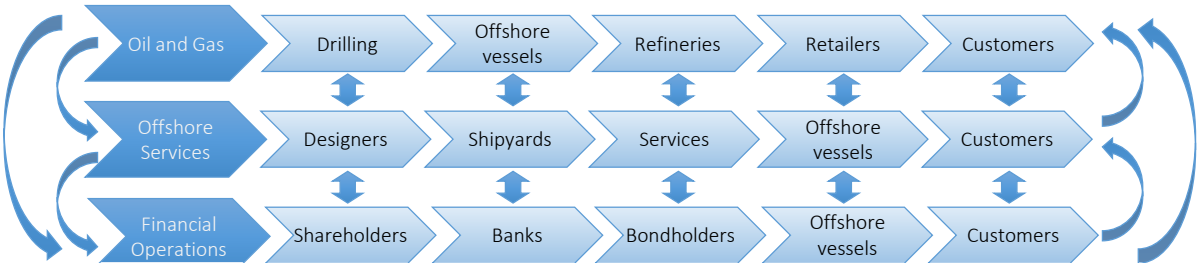

Figure 2. Supply chains related to offshore maritime operations

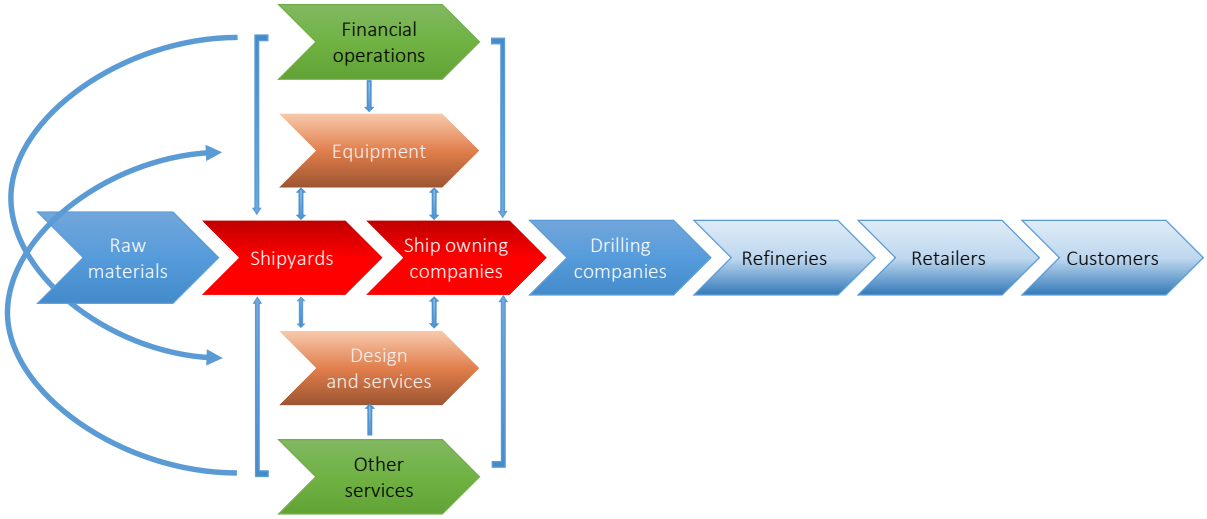

Figure 3. Supply chain related to BMC

Offshore vessels became abundant and demanded less services, shipbuilding and design activity in supply chain 2. Lower activity made it difficult to meet financial obligations, and thus, supply chain 3 was influenced by loss for bondholders, banks and finally shareholders. Via the supply chain, mismatch between supply and demand of oil and gas in the world market caused a financial crisis in offshore-related industries, in particular in the very sensitive maritime-related part. This reveals that the financial system was too fragile to stand against negative stress of this kind, causing troubles for almost the entire supply chain.

This study holds ship owning companies and shipyards as the core or a hub of the maritime cluster and supply chain. This specially applies when investigating the effects of the offshore crisis. Thus, a more tailored supply chain for this investigation is presented in Figure 3, showing the production chain from raw materials for the shipyards, like steel and other metals to refined oil and gas for customers.

Here ship owning companies and shipyards, as the hubs, are colored in dark red, and the other core components, i.e. ship equipment and ship designing and services, are colored in light red. Financial operations and other services as support industries are colored in green, when raw materials and drilling activity are important industries for the supply chain, and colored dark blue when the periphery of the chain is colored in light blue.

4. DATA

4.1. Business activity

In order to carry out this study, one needs to gather key figures on business activity and financial indicators. Some of the most relevant data for business activity would be turnover, value added, net operational margin and employment. These provide some of the best information on success or failure. The relevant data are basically available from annual reports and cluster analysis made for the BMC.

The annual reports are made by BMC itself partly based on the research done by Møreforskning (2009) and Menon (2015). Additionally, there is cluster analysis, done almost annually since 2004. These were first made by Hervik (2008), then by Møreforskning (2009) and lately by Menon (2015).

In order to arrive at a valid set of time series, these data had to be reorganized in a persistent way, by using the latest definitions and standards for the data, basically as done by Menon (2018). The data series are meant to represent the entire cluster, and basically close to full datasets are compiled by around two-thirds of the companies answering questionnaires. These data are supplemented by public registered data from the central national data register. Thus, one arrives at valid and reliable data for our purpose.

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4.2. Key financial indicators

Also, financial indicators are important for this analysis. Here we use total rentability, equity rentability, liquidity, equity and debt ratios, and again net operational margins. These are taken for the hub for this study, i.e. ship owning companies and shipyards. We include all companies in the BMC involved in these industries by compiling data from their financial accounts, operational, and balance sheets.

These data are again taken from the national data register, the so-called Brønnøysundregistrene, and they contain open information on financial dispositions[2]. In some cases, firms went to restructuring processes during the crises due to lack of equity, and one has to adjust for some of these structural shifts in the data by letting out obvious out layers more reflecting bookkeeping principles than reality. One also has to close the books for companies, which de facto exited from the regional cluster.

One is also able to cross-check these data with data reported on a more random basis in the cluster analyses and annual reports of the BMC[3]. Having done this, one arrives at valid and reliable data for financial indicators within the cluster.

5. THE BLUE MARITIME CLUSTER

Before we start our analysis of the BMC, it is also necessary to give a definition of the term cluster. According to Porter (2000, p. 16) it denotes "a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities."

Cooke (2001, p. 24) describes the following typical attributes to a cluster:

1. It displays shared identity and vision of the future.

2. It is "turbulent" with spin-offs, spinouts, and start-ups.

3. It is an arena of close and variable vertical input-output relations, supply chains and horizontal networks of firms.

4. It probably has third-party governance associations lobbying and producing common services.

5. Clusters may motivate governments to assist, in particular in situations with market failure.

6. It includes features of emergence, market dominance and, finally, decline over time.

It is quite evident that the BMC applies to most of these criteria. Its location is geographically limited to the county of Møre and Romsdal, were the Ålesund area hosts the bulk of the companies and activities. Furthermore, it consists of interrelated companies and industries all linked to the maritime sector. In 2014, the same year as the formally organized cluster was given the status of a global centre of expertise, it reached its peak activity level as summed up in Table 1 (BMC, 2015).

Table 1. Descriptive statistics BMC as of 2014

Source: BMC (2014 and 2015).

Company / indicator	Number
Number of companies	
Ship owning	20
Shipyards	14
Ship designing and services	13
Ship equipment	169
Production volumes	
Turnover (billion euros)	8.42
Value added (billion euros)	3.12
Net operational margin (%)	8.3
Employment	18,800

The BMC has traditionally been known as tightly vertically structured. It sits on global excellence in designing, equipment production, and service providence. During the last decades, petroleum-related businesses have increased their presence. Companies representing the cluster have for years been world-leading in most sections of the supply chain.

2 https://www.brreg.no

3 https://www.bluemaritimecluster.no/gce/reports--publications/cluster-analysis/cluster-analysis/, https://www.bluemaritimecluster.no/gce/reports--publications/annual-reports/annual-reports/

Figure 4. BMC and its framework

In the annual report of the cluster, several world-leading companies in their fields are mentioned (BMC, 2018), such as Havyard Design, Marine Teknikk, Skipsteknisk, and Ulstein Design. These are designers of some of the most advanced offshore vessels in the world, operating in most challenging oceanic environments.

Shipping companies, such as Bourbon, Island, Havila, and Olympic, with their modern, advanced, and world-leading equipment, serve offshore fields across the globe. The majority of the ships are designed and produced by local shipyards belonging to the maritime cluster, like Havyard, Kleven, Ulstein, and Vard. The yards use equipment, e.g. motors, propulsion, winches, and dynamic positioning, produced locally by companies like Brunvoll, IP Huse, and Rolls-Royce Marine, also belonging to the cluster.

In addition to core participants of the cluster, some sectors are important in its framework, such as financial institutions, providing necessary liquidity, research, and education, helping to strengthen the innovation speed and level of the cluster and educating the skilled labor force for it.

Also, government policy both on regional and national level gives important political and bureaucratic frameworks for the cluster, when different kinds of associations connected to the activities of the cluster both give support and limitations to its development. The business environment, in general, is important for a cluster. A well-developed business environment may give synergy effects through technological development, skilled labor force and access to capital.

Hence, we can map the Blue Maritime Cluster and its framework as done in Figure 4.

6. FROM BOOM TO BUST

If a cluster works as an interlinked conglomerate it should give several advantages. From Marginean (2009) we can extract eight advantages:

1. Superior technology access.
2. High innovation activity.
3. High innovation speed.
4. Good access to capital.
5. Improved human resources.
6. Improved productivity.
7. Low costs.
8. Better market access.

These benefits have been attributed to the BMC both by internal and external actors (Hervik, 2012). However, being an inter-linked cluster with distinct supply chains also make one vulnerable. Asbjørnslett (2009, pp. 16-19) has highlighted vulnerability for downturns in the industry or the market via an open supply chain, creating an

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interlinked algorithm of downfalls by contamination from one company to the other and one industry to the other. Thus, Aarset (2010) stresses the necessity of risk and crisis management, in particular, connected with sensitive industries linked to marine and maritime operations.

6.1. Boom

Until 2014, the cluster experienced very good times, basically caused by high petroleum prices and a high degree of innovation. Between June 2009 and October 2014, monthly prices on North Sea oil, Brent Crude, for most months fluctuated between 80 and 120 US dollars per barrel. From July 2005 until October 2008, spot prices moved between 80 and 160 dollars per barrel[4]. Thus, even oil fields with high marginal costs reached break-even. Hence, volumes of production and developments of new fields were both high.

In consequence, the demand for the offshore fleet was high and increasing. The profitability of marginal fields with immense technical challenges was welcomed by the BMC, which had developed one of the most advanced offshore fleets globally. As an implication, there was a huge demand for both upstream and downstream production in the supply chain, as the ship owning companies needed new vessels and equipment, when related industries demanded the cluster's services. Despite Norwegian oil production saw its peak around 2001–2002, there was high activity concerning discovering potentially new fields. Also, the Norwegian offshore fleet gained contracts offshore elsewhere.

The upheaval made ship owners less risk-averse, and they acted uniformly by over investing. One of the largest owners in the cluster, Per Sævik form the family dominated Havila and Havyard group expressed this by stating: "Everybody reasoned the same way, and nobody reasoned very much" (Sunnmørsposten, 2016).

Overinvestment took place not because profits were increasing after 2009, but because the market actors wanted to take part in the huge increase in offshore shipping activity, and fared to lose market shares.

6.2. Bust

However, during the fall of 2014, the OPEC cartel saw huge challenges from the rapid increase in oil and gas production elsewhere. In particular, they feared the growing production of shale oil would destroy the market by surplus supply. Thus, OPEC countries, among them the dominant producer Saudi Arabia, decided to increase exports of petroleum. Given the inelasticity of demand for price reductions and vice versa the huge price elasticity for an increase in supply, prices fell dramatically in the world market. Spot market prices of crude oil fell from 115 US dollars per barrel in June 2014 to less than 30 dollars in February 2016 as shown in Figure 5. Long-term prices were also very low, indicating low future expectations in the market, decisive for exploration and investment levels.

In consequence of low prices, the drilling activity in the fields with the highest break-even prices was reduced, basically by putting aside new planned or unplanned projects. At the same time, oil and gas companies had to reduce costs by being more efficient. The demand for offshore vessels fell at the same time as newly contracted ships were launched. Hence, a significant mismatch between supply and demand materialized and a huge surplus of tonnage emerged.

In consequence, ship owning companies canceled new construction orders. This had further consequences downstream the supply chain, as shipyards ran into problems, and thereof also maritime service and equipment companies due to a negative shift in demand of their products.

As shown in Figure 6, both turnover and value added (economic value creation) in the BMC fell dramatically from around 2015 after years of growth. Net operating margin in the cluster as a whole has been estimated to minus six percent in 2015 and devastatingly minus 25 percent in 2016. Value added fell by 39 percent, turnover by 33 and employment by 29 percent in three years 2014–2017. In consequence of the significant contractions, market relations in the cluster were severely damaged. Innovation impulses from the shipping companies to the rest of the supply chain were almost cut off and weakening the internal linkag-

4 https://www.macrotrends.net/2480/brent-crude-oil-prices-10-year-daily-chart

Source: Macrotrends.no

Figure 5. Brent crude oil prices in US dollars per barrel (August 2009–August 2019)

Source: BMC (2004–2017).

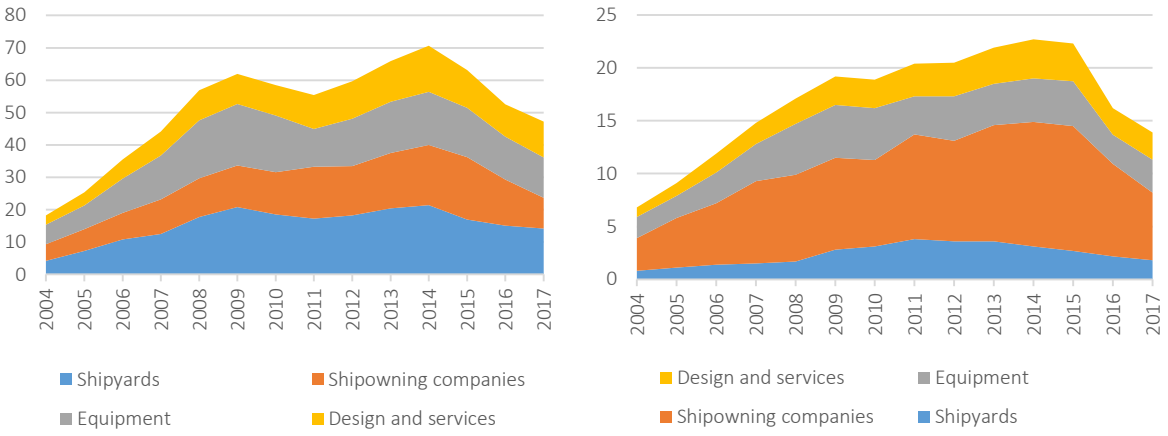

Figure 6. Turnover (left) and value added (right) in the BMC 2004–2017 in billion NOK

es within the cluster. Unemployment increased as employment in the cluster fell.

7. TESTING FOR OVER EXPANSION AND REVULSION

A central question for this study is if the financial instability hypothesis applies to the BMC. In order to study that we will follow central financial components before and during the fall to the abyss. Let us first look at the anatomy of the development itself, i.e. how the crisis evolved.

According to the financial instability hypothesis, busts follow times of overheated markets. This should be mirrored in key variables clearly above sustainable equilibriums, followed by revulsion with key variables clearly under sustainable equilibriums.

It is, of course, difficult to know what these equilibriums should be. However, markets will in the

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long run move towards a pattern of steady-state development. Thus, a long-run trend should reflect this development. This trend is by no means linear. Rather both supply-side and demand-side alterations make such trends polynomial, i.e. they are shifting throughout time.

7.1. Model

To be able to decide on the upturns and the downturns of the BMC, the paper maps deviations from trends of key financial indicators. We then use polynomial trends, which reflect smoothed versions of the actual series. In order to do so we use structural time series analysis. This method separates observed time series (x_t) into different trend components (g_t), cycle components (c_t) seasonal components (s_t), and irregular components (i_t):

$$x_t = f(g_t, c_t, s_t, i_t). \tag{1}$$

Using an arithmetic approach to equation (1) gives an arithmetic relationship:

$$x_t = g_t + c_t + s_t + i_t. \tag{2}$$

Here it would be natural considering it a residual:

$$i_t = x_t - (g_t + c_t + s_t). \tag{3}$$

In the present analysis, it is natural to see i_t and s_t as part of c_t. Hence, a reduced form of equation (2) will be as in equation (4):

$$x_t = g_t + c_t. \tag{4}$$

By using a Hoderick-Prescott filter, one might identify these components. The HP filter minimizes variances of c_t subject to responds for second difference variation of g_t. This means that the HP filter defines a trend $g = (g_t, g_{t+1}, ..., g_T)$ of a time series $x = (x_t, x_{t+1}, ..., x_T)$ as the minimizer of equation (5):

$$\min_{g_t} \sum_{t=1}^{T} (x_t - g_t)^2 + \\ + \lambda \sum_{t=2}^{T-1} \left[(g_{t+1} - g_t) - (g_t - g_{t-1}) \right]^2. \tag{5}$$

In equation (5), $(x_t - g_t)$ gives the cycle component of the time series, when $\left[(g_{t+1} - g_t) - (g_t - g_{t-1}) \right]$ gives the difference in trend growth rate from one period t to the other $t+1$. Also, λ, cotrols for the smoothness of growth components of the time series. The unique solution to this minimalization problem (5) is given as follows:

$$g = (I_n - \lambda F)^{-1} x, \tag{6}$$

where I_n is an $n \times n$ identity matrix, when F is the penta-diagonal $n \times n$ matrix, like in (7) (theoretically and with numerical example):

$$F = \begin{pmatrix} f & 0 & 0 & & 0 & 0 & 0 \\ 0 & f & 0 & \cdots & 0 & 0 & 0 \\ 0 & 0 & f & & 0 & 0 & 0 \\ & \vdots & & \ddots & & \vdots & \\ 0 & 0 & 0 & & f & 0 & 0 \\ 0 & 0 & 0 & \cdots & 0 & f & 0 \\ 0 & 0 & 0 & & 0 & 0 & f \end{pmatrix}, \tag{7}$$

$$F = \begin{pmatrix} 1 & -2 & 1 & & 0 & 0 & 0 \\ -2 & 5 & 4 & \cdots & 0 & 0 & 0 \\ 1 & -4 & 6 & & 0 & 0 & 0 \\ & \vdots & & \ddots & & \vdots & \\ 0 & 0 & 0 & & 6 & -4 & 1 \\ 0 & 0 & 0 & \cdots & 4 & 5 & -2 \\ 0 & 0 & 0 & & 1 & -2 & 1 \end{pmatrix}.$$

One may calculate cycle components by subtracting the estimated trend component from the corresponding observed time series:

$$c_t = x_t - g_t. \tag{8}$$

To be able to calculate relative gaps, which are far more relevant than absolute numbers in our analysis, we use logs of the parameters x_t and g_t, which also gives log values of c_t.

$$\log(c_t) = \log(x_t) - \log(g_t). \tag{9}$$

By using the HP filter from equation (5) on equation (6) one arrives at the following relationships:

$$\min_{g_t} \sum_{t=1}^{T} (x_t - g_t)^2 = \\ = x_t - \lambda \sum_{t=2}^{T-1} \left[(g_{t+1} - g_t) - (g_t - g_{t-1}) \right]^2. \tag{10}$$

Here the estimated cycle component would be

$$\min_{g_t} \sum_{t=1}^{T} \left(x_t - g_t\right)^2,$$

which is the residual. Applying this on equation (9) one arrives at relative deviations from the polynomial trend, i.e. relative cycles:

$$\log\left(c_t\right) = \log\left(x_t\right) - \\ -\log\left(\lambda \sum_{t=2}^{T-1} \left[\left(g_{t+1} - g_t\right) - \left(g_t - g_{t-1}\right)\right]^2\right). \quad (11)$$

Applying a high smoothing parameter gives a trend with limited fluctuations, and thus, a significant cycle. A smoothing parameter equal to zero implies that changes in the observed series is decided by the trend only. Thus, high smoothing parameters make cycles decisive components in time series. Smoothing parameters of low values give trends with large fluctuations, and minor cycles. Rules of thumb suggest a smoothing parameter of $\lambda = 100$ for annual figures, $\lambda = 1,600$ for quarterly figures, and $\lambda = 14,400$ for monthly figures.

7.2. Results

Using the data compiled from the BMC and the national register in the stated model, one can map cycles from the trend, or deviations from polynomial trends. We test the following parameters:

1. Value added, showing value creation of the BMC.
2. Turnover, showing the gross value of economic activity in the BMC.
3. Employment, showing numbers of annual man-hours in the BMC.
4. Net operational margin, showing the profitability of the activity in the BMC.

The available data limits one to basically run the analysis on the annual data for 1999–2018. Thus, we use $\lambda = 100$. Since there negative observations for net operational margins one cannot use the HP filter as such for estimation of deviations from trend. Thus, for this parameter the paper reports maximum and minimum values in the cycle. Years of peaks and troughs are reported in brackets. The results are reported in Table 2.

Table 2 reveals major positive deviations from polynomial trends prior to the offshore crisis unfolding from the second half of 2014. Most remarkable are shipyards with a peak of 29.7 percent in value added in 2011, followed by turnover peaks of 19.9 and 19.3, respectively, by ship owning companies and design and service companies in 2015 and 2014. On aggregated level, value added peaked with 13.1 percent over the trend, turnover with 14.9 and employment with 12.3 percent, all in 2014.

Table 2. Cycle components by industry for the BMC (1999–2018)

(*N* = 20 x 5 x 4 = 400)	Shipyards	Ship owning companies	Equipment	Design and services	Total
Value added (*N* = 20 x 5 = 100)	0.297	0.174	0.105	0.159	0.131
	(2011)	(2014)	(2015)	(2014)	(2014)
	–0.393	–0.424	–0.291	–0.244	–0.324
	(2017)	(2017)	(2016)	(2016)	(2017)
Turnover (*N* = 20 x 5 = 100)	0.157	0.199	0.077	0.193	0.149
	(2014)	(2015)	(2014)	(2014)	(2014)
	–0.215	–0.494	–0.157	–0.200	–0.242
	(2017)	(2017)	(2017)	(2016)	(2017)
Employment (*N* = 20 x 5 = 100)	0.190	0.190	0.106	0.113	0.123
	(2014)	(2014)	(2013)	(2015)	(2014)
	–0.090	–0.351	–0.122	–0.199	–0.193
	(2017)	(2017)	(2017)	(2017)	(2017)
Net operational margin (*N* = 20 x 5 = 100)	0.112	0.225	0.032	0.099	0.110
	(2011)	(2013)	(2012)	(2011)	(2011)
	–0.020	–0.750	–0.160	0.000	–0.250
	(2017)	(2016)	(2016)	(2015)	(2016)

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Net operational margin peaked with 11.0 percent in 2011, showing that returns were on their way downward before the crisis hit.

The fall during the crisis was even bigger than the peaks. For all four industries value added was 32.4 percent under its trend in 2017, turnover 24.3 and employment 19.3. The net operational margin reached its bottom with –25 percent in 2016, indicating profits were improving after that.

All in all, this test reveals that substantial overheating took place in the offshore markets and thus in the BMC in the years prior to 2014. In fact, our data conclude that this overheating started before the outbreak of the financial crisis and rapid fall of petroleum prices during the autumn of 2008, and it continued after the prices came back to high levels during 2009.

8. FINANCIAL INSTABILITY

8.1. Losing stability

After the Asian crisis towards the end of the 1990s, oil prices, with few exceptions, stayed surprisingly high until the financial crisis evolved during the autumn of 2008. After a significant drop, they regained their high level shortly after. At the same time, the production level of oil was going down in the North Sea. Thus, high prices led to a huge willingness to search for new fields of exploitation in the seabed west of Norway. Thus, there was a large demand for offshore vessels, and thus for construction of these, giving a boom to shipyards, designing and service companies and equipment producers. Between 2004 and 2009, the total turnover in the BMC stepped up by a factor of more than 200 percent when value added increased almost at the same pace (BMC, 2015).

During the financial crises from the autumn of 2008 growth took a break until late 2010, before a new period of growth dominated along with high petroleum prices until the summer of 2014.

The maritime sector and the petroleum sector are both very sensitive to price fluctuations and business cycles. Thus, it should be in the interest of the involved companies to use the upswing as an opportunity to increase equities in order to create more financially solid companies. However, did this happen? Or did the positive demand shock due to high petroleum prices make them go into the financial taxonomy fallacy as described by Minsky (1992).

To answer this question, we have compiled financial accounts data from the hub of the cluster, i.e. ship owning companies and shipyards. The key indicators we look at are:

1. Total rentability of capital, i.e. profits as a share of total assets.
2. Equity rentability, i.e. profits as percentages of invested equities.
3. Equity ratios, i.e. equities as percentages of total assets.
4. Debt ratios, i.e. debt as percentages of total assets.
5. Liquidity ratios, i.e. liquidity as percentages of total assets.
6. Operational returns, i.e. net profit from operations as percentages of turnover.

These figures for ship owning companies and shipyards within the BMC are reported in figure 7.

They reveal that equity ratios did not increase during the upswing. Contrary, debt ratios were increasing until 2007–2008. From almost 50 to 80 percent in ship owning companies and form 80 to 90 percent in shipyards. At the same time, liquidity ratios fell dramatically. In other, words huge profit margins, mirrored in high rentability and operational returns, were not channelled into more solid companies. Rather they increased gearing in order to defend or even gain market shares.

In a consequence of the financial crisis, investments were temporarily cut down and equity ratios increased. However, after a few years, the companies increased their gearing again, and they were not at all ready to cope with any financial downturn when they entered into 2015. In other words, one can trace that the BMC went into a leverage cycle causing a deep downturn.

Source: brreg.no

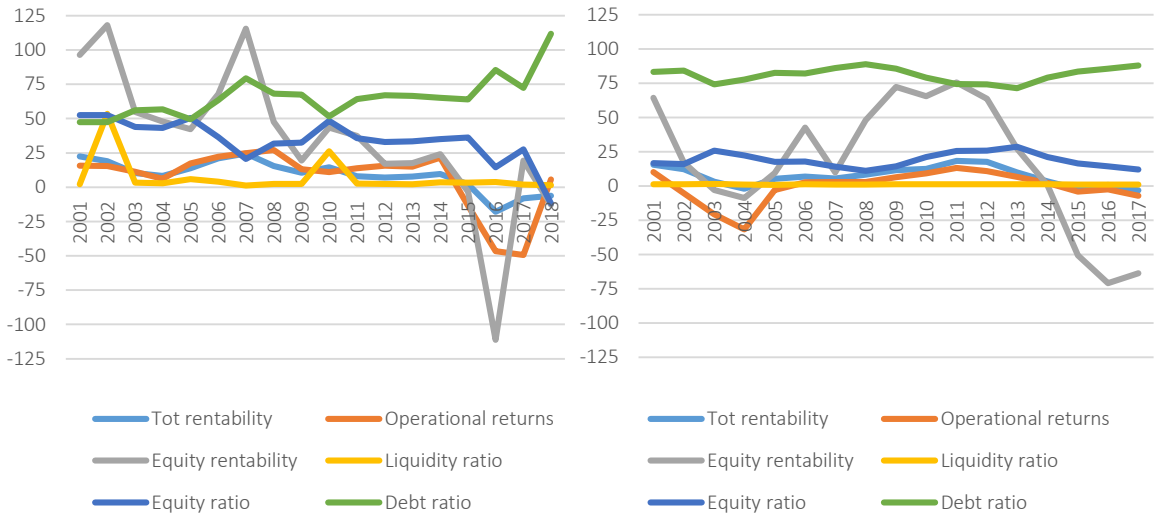

Figure 7. Key financial accounts figures for ship owning companies (left) and shipyards (right) in the BMC (2001–2018)

8.2. Consequences of lost stability

After petroleum prices started their giant fall from summer 2014, most of the ship owning companies still did well for some time due to long term contracts to fixed prices for their fleet. However, after these contracts were terminated and they had to rely more on spot market rates and new long-term contracts with far lower prices thy rapidly went into huge problems. Liquidity fell and huge deficits made equities shrink and liquidity is squeezed.

Bremnes, Sandsmark, and Vekve (2018, pp. 21-33) have given an overview of the crisis and its consequences. They argue that the huge concentration around supply vessels made the cluster vulnerable. The offshore fleets expansion was already seen as risky business by banks, and they had to rely on borrowing capital by selling bonds with high-interest rates. During 2015 and 2016, most of the companies were not able to fulfill their obligations to their creditors. The four largest belonging to the BMC and all family-owned companies, Farstad Shipping, Havila Shipping, Olympic Shipping, and Rem Supply, had to go into debt negotiations.

Since they could not meet their obligations, banks and bondholders demanded to transform credits to equity at a higher rate than the owners would accept. Rem was the first to give up as a basically family-owned company in order to be sold to Solstad Offshore at the end of July 2016. After several rounds with creditors, the same happened with the biggest of them all, Farstad, which was a dominant companiy in the market hosted more than 70 ships and 2,200 employees in its worldwide operations. On March 24th, 2017, the general assembly finally decided the company had to merge with Solstad Offshore (Sunnmørsposten, 2017)[5].

After several rounds with their creditors, Havila Shipping, and Olympic Shipping survived as local family-owned companies. Their losses were huge, and they were not at all financially sound and solid in order to meet the crisis. So why did they survive? Partly, because Solstad found more interest in Farstad and Rem. But we also find that their owners had a more diversified portfolio, giving them several pillars to rest on and by that also creditors more willing to arrive at favorable agreements.

The Sævik family behind the Havila group had invested heavily in shipyards, hotels, fisheries, ferry companies both in Norway and abroad. In particular, their acquisition of the ferry company Fjord1 proved to be very profitable and

5 https://www.smp.no/naeringsliv/2017/06/21/Solstad-Farstad-fusjonen-fullført-14905819.ece

http://dx.doi.org/10.21511/ppm.17(4).2019.06

gave alternative income (Sunnmørsposten, 2016)[6]. These investments made the family-controlled group even bigger than Farstad, but offshore vessels were only part of their portfolio. They later also gained a license to coastal voyages for tourists and local passengers and cargo along the coast from Bergen to Kirkenes.

9. SUPPLY CHAIN EFFECTS

As discussed, vertically integrated clusters may have problems with crisis contaminating up and down in the supply chains: in order to build a defense against these chain reactions, one needs financial stability with solid firms and possible diversification of portfolios to avoid a high degree of risk concentration. So what happened in the supply chain of the BMC?

9.1. Supply chain reactions

A study of the chronology of the offshore crisis shows it closely followed the supply chain of the cluster. The shipyards were the next to be challenged by a rapid fall in demand on their products, and thereof designers, service and equipment companies followed. A huge challenge was their dependence on the offshore fleet. Most of them had specialized in the construction of or deliveries to offshore vessels.

Thus, it should be expected that one would see mass bankruptcies in these industries. It is not at all difficult to find they were struggling with negative bottom lines, debt escalation and liquidity problems. However, we find that all these related industries did better than offshore shipping companies. Despite the fact that shipyards ran into huge problems, one only finds moderate negative profits for this industry as a whole in the BMC, with aggregated net operating margins of two percent in 2015 and 2017.

During the evolvement of the crisis, yards rapidly looked for alternative engagements. According to Helseth, Baustad, and Jakobsen (2019, pp. 6-13) they showed a significant degree of market adaptability. One obvious alternative was in the rapidly growing cruise market or emission reduced vessels as the government demanded these.

These new engagements partly compensated for the downturn in the offshore market. However, a problem was an insufficient experience. Cost calculations were made too low due to lack of the same efficient competence as in the offshore sector. Some new projects proved to be non-profitable. In addition, the shipyards struggled with finding new buyers to cancelled ships.

When the crisis started the aggregated debt ratio of the yards, and by that the financial leverage or gearing was even higher than among ship owning companies. Thus, they could easily be victims of the crisis. A study of the dominant shipyards reveals that the family-owned Kleven Verft ran into the worst problems by losing their equity in several rounds of losses. In 2017, their equity became negative and in consequence, they were close to bankruptcy.

However, they were building two ships for the coastal voyage, freighting passengers by the coast along with the bulk of the Norwegian coastline from Bergen to Kirkenes. In June 2018, the same company rescued the yard with a new capital of 600 million Norwegian krone to secure the completion of these ships. Through this package, 750 employees kept their jobs for another year when the crisis struck again due to a lack of profitable orders and the new owners' eagerness to pull out (Sunnmørsposten, 2019)[7].

The other significant shipyards, like the Havyard group, the Ulstein group, and the Vard group also struggled. The number of employees in the shipyards belonging to the BMC was reduced by a third between 2014 and 2015.

9.2. Chain reactions from the hub

The problems in the shipyards went further along the maritime supply chain and design and service companies, along with equipment companies, were the next to face financial problems. However,

6 https://www.smp.no/nyheter/2016/11/28/--Var-helt-åpent-hvordan-det-skulle-gå-13855929.ece

7 https://www.smp.no/naeringsliv/2019/07/25/Vi-skal-jobbe-knallhardt-og-det-skal-byggjast-nye-båtar-ved-Kleven-Verft-19567504.ece

Source: BMC (2004–2017).

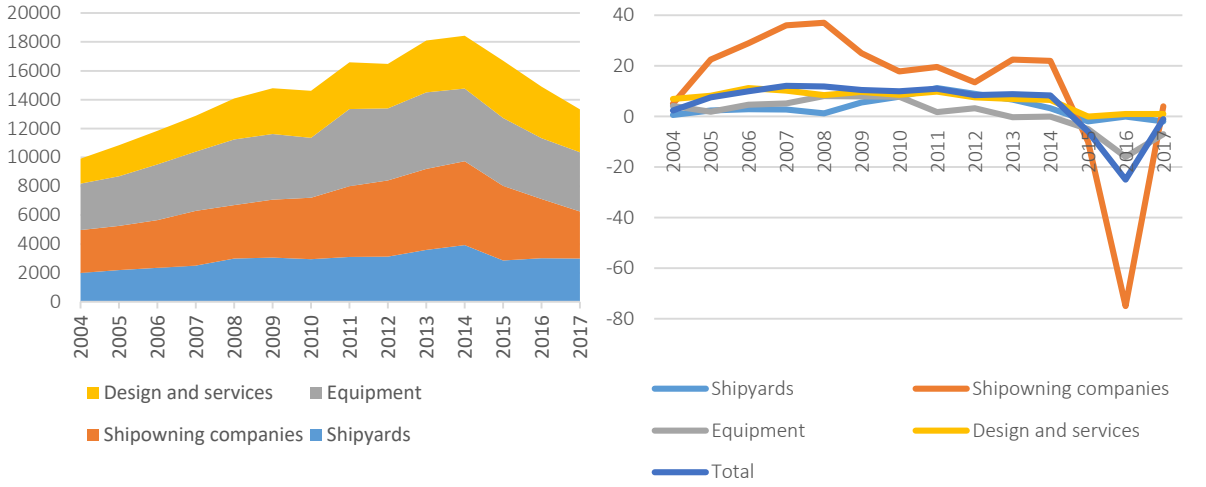

Figure 8. Employment (left) and net operating margins in percent of turnover (right) in the BMC (2004–2017)

these were often smaller companies and more financially solid. Despite this fact, the equipment industry saw a heavy contraction in turnover, value added and net operating margin. The largest equipment company, Rolls Royce Commercial Marine, lost engagements and capital in Norway. However, as part of a huge international group, they kept financially solid, given the depth of the crisis.

The net operating profit margin for the equipment branch of the cluster reached minus five percent in 2015 and minus 15 percent in 2016 (Figure 8).

During July 2018, Rolls Royce negotiated an agreement with the Kongsberg group about taking over the firm for a price of 5.3 billion Norwegian krone, where the Norwegian government would contribute with 2.5 billion in order to secure that high-tech jobs were kept domestically (Maritime Executive, 2019)[8].

As for design and services, they experienced lower contraction in both turnover and net operating margin than the other industries belonging to the cluster, as they as a group never reported any significant losses during the crisis period. However, their margins were reduced as value added and employment fell drastically. Profits went down to zero in 2015 and stayed marginally above in the two following years when employment was reduced by 29 percent between 2015 and 2017 (BMC, 2018).

Designing companies were engaged in designing smarter and more cost-efficient solutions along with designing new types of vessels for maritime and marine operations.

9.3. Diversification as a survival strategy

Vertical integration between the different companies, in fact, to some degree, secured some demand from the ship owning companies to the yards. This happened when then Havila group, controlled by the Sævik family, secured demand for the Havyard grouped controlled by the same family when the Vard group reduced its local engagement significantly. Important for the Sævik group was that they were engaged in other maritime sectors than offshore. Thus, substantial demand for the shipyards could still be secured.

The Ulstein group had over a longer period paid focus to limited diversification by vertical integration through buying or establishing several firms as part of the supply chain. When the crisis illuminated the problems of the industry, the group had 13 different production companies on the first line under the mother company, engaged in different parts of the

8 https://www.maritime-executive.com/article/kongsberg-completes-acquisition-of-rolls-royce-commercial-marine

http://dx.doi.org/10.21511/ppm.17(4).2019.06

Source: Menon (2018).

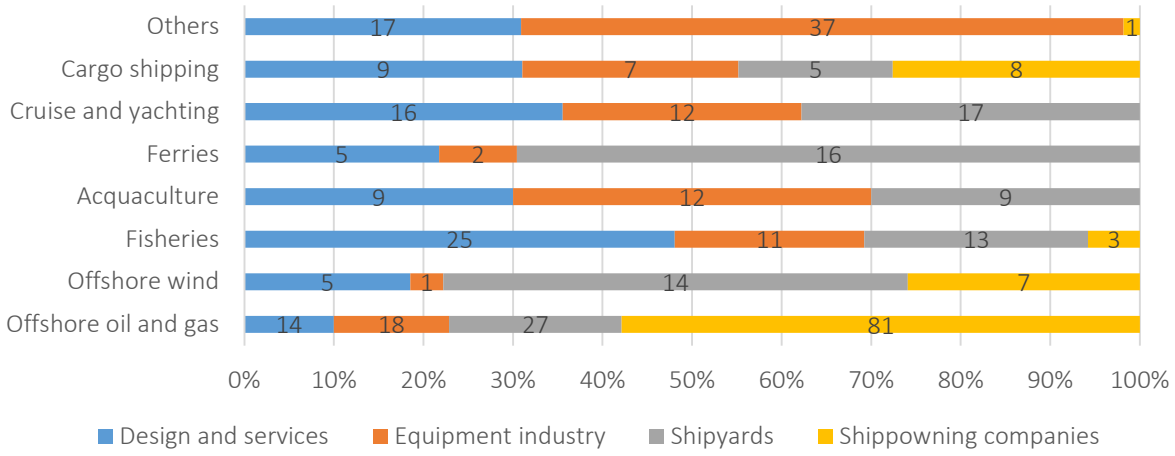

Figure 9. Turnover by markets 2017 as percentages for BMC

supply chain. This had, of course, a high degree of market risk, but the financial risk was spread into different levels of the chain. To some degree, this made the group stand on many different legs financially. Also, as a vertically integrated group involved in different parts of the supply chain, they could benefit from internal orders. At the same time, they were among the first to step into the hybrid market of ships, reducing emissions to the environment, giving them an environmental competition advantage (Sysla, 2019)[9].

Also, the shipyards were able to negotiate lower costs from the equipment industry. This is mirrored in the fact that the contraction in output from the shipyards during the crisis was significantly higher than the contraction within the equipment branch despite deficits were significantly larger among equipment producers to the offshore fleet than among the shipyards.

Could a reason for smaller contraction among equipment industry and services and design than for the hub be higher degrees of portfolio diversification up- and downstream the supply chain? To study this, the turnover reported by the companies can be split into market segments. This is done based on the questionnaires sent to members of the cluster by Menon (Menon, 2018). The results are reported in Figure 9.

The results are convincingly clear. The less the segments of the BMC were involved in the offshore oil and gas market, the better they were able to survive during the crisis, and the broader and more diversified portfolio the better day performed. With a share of 81 percent involved in the offshore oil- and gas industry, the ship owning companies were doomed to end up in trouble, when the broad portfolio of service and design companies made them perform far better during the oil-based crisis. The equipment industry also had a diversified portfolio and experienced a milder contraction than shipyards and Shipowning companies.

CONCLUSION

The present research seeks to explore the role of financial instability and supply chain effects on the evolvement and spread of the maritime offshore crisis of 2015–2017 to the Blue Maritime Cluster (BMC) located at the North Western coast of Norway. The crisis was quite deep and the effects of the crisis were still evident some years after the fall of the markets. To conduct the study, the paper offers time-series of the activity level and key financial indicators of returns on turnover and capital along with equity and debt ratios to assets.

9 https://sysla.no/maritim/verdens-storste-hybridskip-levert-fra-ulstein-til-color-line/

In order to map if the markets went into a Minsky-Kindleberger cycle of over-expansion and contraction, the paper uses structural time series analysis to map cycle deviations from polynomial trends and concluded that this pattern definitely took place. Looking at financial indicators, the paper concludes that this was reflected in increased leverage during the upswing and a financial crisis with lost equities thereafter, which is according to the Minsky leverage cycle.

In other words, we find out that during the booming years prior to the offshore crisis of 2015–2017, the companies belonging to the BMC to a large degree fell into financial instability. During these good years, they were funded by borrowed money in order to sustain or even gain market shares. Thus, instead of increasing their equity base, it became smaller, with debt ratios of more than 90 percent in several companies within the hub of the cluster, i.e. ship owning companies and shipyards. In addition, loans were not granted easily, and they had to pay high-risk premiums via high interest rated in bond markets.

When the negative shock came with a significant fall in prices of oil and gas from the summer of 2014, leading to rapidly shrinking demands for their products, they did not have sufficient solidity to withstand the crisis.

Because of the clusters' dependence on offshore shipping and shipyards, the crisis spread rapidly along the supply chain. Lack of financial stability to set up a proper defence made significant actors to be sold to companies outside the cluster, accounting for more than one-third of the fall in the volumes.

One also finds that narrowly focused supply chain management, related to the cluster alone had a negative effect. There is a tendency that groups with a higher diversification in investments and activity portfolios did better than those narrowly limited to their own hub as the crisis spread down through the supply chain of the cluster.

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