

Offshore Industries as Growth Sector: The Norwegian Case

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Offshore Industries as Growth Sector: The Norwegian Case

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Abstract

Writers on Norwegian economic history often claim that marine and maritime industries, i.e., the offshore sector, played a major role for value creation in the Norwegian economy for centuries. However, little has been done to quantify the sector's contribution to the economy. The present paper seeks to quantify the size of the key offshore industries compared to GDP and exports. To do so it has been necessary to draw on new historical national account calculations in addition to compute several new series.

Based on these calculations we find that the offshore sector made up a significant and important part of Norwegian GDP, and a dominant part of exports, 1816-2021. The key offshore industries were first fishing, thereafter ocean transport, and finally petroleum extraction. The sector's overall size of the Norwegian economy has been quite stable in a long-term perspective, but with an increasing GDP share after the takeoff of oil and gas extraction from the continental shelf in the 1970s.

Keywords: marine, maritime, offshore, economic growth, national accounts, economic history

JEL classification: N13, N14, N73, N74, N83, N84

Introduction

Offshore related industries are considered to have been very important for Norwegian growth and development for centuries. These industries historically include marine harvesting and operations, such as fishing, whaling, and from the late 1960s aquaculture on the one hand and maritime operations such as ocean transportation and services on the other hand. Since the discovery of oil and gas on the Norwegian continental shelf during the Summer of 1969, and its exploration from the early 1970s, one also includes oil and gas extraction as part of the offshore sector, since the way to extract the petroleum resources is by conducting marine and maritime operations on the continental shelf.

Writers on economic history seem to agree that the offshore industries have been very important for Norwegian wealth and growth. Their contribution has basically come via high revenues and value creation, foreign exchange income, tax income, significant employment, labor force empowerment, technological progress, and ripple effects to the economy. However, surprisingly little is done to measure this economic impact. This paper takes up this challenge and seeks to quantify the size of the offshore sector, its value-added and export values compared to the rest of the economy. Chiefly, we offer new calculations of the sector's contribution to gross domestic product and exports, along with growth rates and relative shares. These parameters enable us to measure and discuss the sector's importance for the Norwegian economy during the last two hundred years.

It is a considerable challenge to deal with the era of German occupation during World War II, since a huge part of the offshore economy was then under control by the exile government in London. For this period, the paper offers a set of new calculations, which enable us to include this part of the economy into our analysis. Similar calculations have never been presented previously.

Literature review

If one goes to the research literature, scholars seem to agree on the significant importance of the maritime and marine sectors' contribution to Norwegian historical economic growth. In his pathbreaking books on Norwegian economic history Hodne (1975, 1981) argues that fisheries and maritime transportation were key industries for economic growth for most of the 19th century and even until the late 1960s. This is followed up in his joint research-based textbooks (Hodne and Grytten, 1992, 2000, 2002). This view gained significant support in the book on Norwegian growth and development 1820-1980 by Bergh et al (1983) and another book on Norwegian general history by Danielsen et al (1991), Helle et al (2013), and finally by Sandvik (2022). Not surprisingly, we also find these conclusions in the five-volume research on the history of the Norwegian fisheries edited by Kolle (2014) and on Norwegian maritime history by Tenold (2018), Johnsen (2013) and Vigeland (1953).

In 1994, Hodne and Grytten estimated the share of fisheries, whaling and maritime transportation to account for 14.2 and 16.0 percent of GDP in 1835 and 1845 respectively (Hodne and Grytten 1994). Statistics Norway (1965) estimated these industries' share of GDP to 13.2 percent in 1930, 14.8 percent in 1950, and 13.5 percent in 1960. These are all very high figures, and surprisingly stable. It should also be added that the sector has huge ripple effects, seen in fish processing, shipbuilding, financial

activities, and other related industries (Johansen, Myhre, and Richardson 2020). Brautaset (2002) computed the size of Norwegian exports 1830-1865 and concluded that maritime services accounted for a good 30 percent, and fisheries for almost 30 percent of total Norwegian exports, which was very high compared to most other countries. Thus, the marine and maritime industries' direct and indirect contribution to value creation and exports have historically been very high.

Both Solhaug (1976) and Kolle et al (2017) argue that fishing, including whaling, has been one of the largest export industries and a catalysator for technological innovation with huge ripple effects to the rest of the economy. In addition, Hovland (2014), Christensen (2014), Møller and Haaland (2014, 53-86) argue that aquaculture has shown a tremendous growth since its birth in the late 1960s and now contributes now significantly more to value creation than traditional fisheries. They emphasize that aquaculture was born out of a restructuring process of fisheries, making the industry more efficient and directing both capital, technology, and labor into this new and closely related industry.

In a series of papers on maritime history, Nordvik and Fischer (1987, 1988, 1989) put emphasis on the maritime sector's great importance for foreign exchange income, technological shifts and development, and economic growth. The same is done by Tenold (2018) in his work on Norwegian maritime history, while Basberg (2004, 2017, 471-496) has illuminated the contributions of whaling to technological development and ocean transportation. The great importance of maritime and marine industries is also shown in recent works by Koilo (2021, 230-246), who argues that maritime and marine clusters have been networks for technology innovation, diffusion, and human capital building along a substantial domestic supply chain to an extent which has few parallels in other European countries. Since the 1970s, this development has been fueled by closeness to the new offshore oil and gas extraction industry and related industries. These technological skills have made Norway a pioneer within the green maritime shift.

After two decades of decline in the importance of the offshore industries in the 1950s and 1960, the discovery of oil on the Norwegian continental shelf in 1969 paved the way for the revival of the sector's importance for the overall economy. Hanisch and Nerheim (1992) describe the pioneer years as somewhat hesitant and confusing. This attitude was, however, soon overturned by years of extraordinary optimism. Norway took renewed steps into a natural resource dependent economy. Until then fishing and timber had been the two large natural resources of income. Soon oil and, perhaps understated, gas, were the two dominating natural resources in the Norwegian economy. Nerheim (1996), Olsen and Sejersted (1997), and Ryggevik and Smith Solbakken (1997) have focused on the huge technological shift created by the new industry with huge ripple effects to the entire maritime and marine sectors as well as the Norwegian industry in general. Ryggevik (2013) concludes this also paved the way for Norway becoming a high-tech country with a very skilled labor force. Scholars even argue that the pollutive Norwegian petroleum industry has made it both technologically and financially possible to introduce greener marine and maritime industries (Grytten, Lindmark, and Minde 2020, 110-123, Grytten and Hunnes 2021, 76-89, and Koilo 2019, 48-65, Koilo 2020, 289-302).

A special feature of the high-quality research in Norwegian maritime and marine history is that huge parts of the research is quantitative in nature, offering a solid amount of time series on volume and price components. However, the analyses are basically qualitative (Tenold, 2020, Thowsen, 1983) and surprisingly limited effort has been put into quantifying this sector's size of the economy.

Model

To be able to say more about the impact of the offshore sector on the Norwegian economy, the present paper will quantify the size of the sector during the two last centuries. We basically use two different time series, i.e., value added and exports. These can be calculated in current and fixed prices, and as shares of total gross domestic product and exports. The variables are important figures in both national and historical national accounts.

Gross domestic product (GDP) measures the sum of economic activity by value creation in a geographical area. It can be measured by three approaches, i.e., the production approach, the expenditure approach, and the income approach. The present paper uses both the production and the expenditure approach. The production approach describes the supply side of the economy, while the expenditure approach describes the demand side.

From the supply side, we present computations of the total production value in the Norwegian economy and the production values by industries. GDP is built up by summing up value added in all production units, by finding output subtracted by input for each of the units:

$$(1) \quad y_t = q_t - h_t$$

Here y is the gross value added, q is the gross value of output in period t , and h is the value of intermediary consumption used in production (input) in period t . Aggregates for the entire economy are found by adding the sums of all production units (capital letters). Here GDP, Y^B , is expressed in base values, B , i.e., without the value of indirect taxes and subsidies:

$$(2) \quad Y_t^B = Q_t - H_t$$

One obtains GDP in market values, Y^M , by adding net product taxes, calculated as gross product taxes, T^Q , minus product subsidies, S^Q to Y^B :

$$(3) \quad Y_t^M = Q_t - H_t + (T_t^Q - S_t^Q)$$

GDP from the expenditure side describes the demand side, where c denotes consumption of different products, i investments by activity, g , public expenditures by purpose, and x exports and m imports by products in period, all in period t :

$$(4) \quad y_t = c_t + i_t + g_t + (x_t - m_t)$$

In aggregated form we obtain aggregated GDP, in market values, Y^M by adding aggregated private consumption, C , aggregated investments, I , public expenditures, G and aggregated trade surplus (exports less imports), $X-M$, all for the same time-period, t :

$$(5) \quad Y_t^M = C_t + I_t + G_t + (X_t - M_t)$$

The export sector, which is the most interesting parameter in the current analysis, is the sum of all exports of goods and services produced by a Norwegian production unit. This includes both products made in Norway and products made by a body registered in Norway, e.g., ocean transport.

Finally, the income approach, which plays a minor role in this paper, reports the income distribution of GDP in market prices on aggregated compensation of employees, W , aggregated gross operating surplus, S , and aggregated taxes, T , less aggregated subsidies, S , on aggregated production, Q , and aggregated imports, M , in period t .

$$(6) \quad Y_t^M = W_t + S_t + (T_t^Q - S_t^Q) + (T_t^M - S_t^M)$$

To analyze the importance of the offshore sector to the Norwegian historical economy, we will in the following highlight calculations of its size of both GDP and the export sector.

It is a special challenge to quantify the size of the offshore sectors during World War II. During most of the period, Norway was under German occupation. However, a significant part of the economy, about 90 percent of the Norwegian merchant fleet, one of the largest in the world at the time, escaped, and served the Norwegian exile government and its allies throughout the war. It would be meaningless not to include this part of the maritime sector into our calculations. Hence, we come up with a hybrid model of the Norwegian economy, including both occupied Norway and the exile economy, made up by the Norwegian armed forces and public administration abroad and the merchant fleet, sailing for the allied powers.

This implies that the paper offers calculations of an extended composite GDP in base values, Y_t^{CB} , with value added figures in base prices for the domestic economy, Y_t^{DB} , and the abroad economy, Y_t^{AB} :

$$(7) \quad Y_t^{CB} = Y_t^{DB} + Y_t^{AB} = (Q_t^D - H_t^D) + (Q_t^A - H_t^A)$$

Since the existing GDP-series for World War II are less precise and detailed than the rest of the historical national accounts, we will also have to calculate a novel series for marine industries at the time, i.e., fishing, whaling combined, which also has never been published before. The new series are described in the following sections.

Calculations

The early historical estimates of GDP by industry and sector by Statistics Norway (1965) are somewhat problematic. In the first place they are basically done for a limited number of benchmark years, including few industries until 1930. Thereafter, they present annual series by industry. Secondly, they are constructed according to the System of National Accounts from 1958 (SNA1958). This does not include significant

parts of the service sector, which are included in the modern SNAs, e.g., huge parts of domestic services. Hence the GDP figures are lower, and the relative size of the non-service figures are significantly higher than what they would be according to modern definitions.

Thirdly, the first calculations of value creation by primary industries made by Shweigaard (1840) and Tvethe (1848) included significant parts of processing, i.e., agricultural and fish preservation was considered agriculture and fisheries respectively. In latter calculations Grytten (2022) defines all agricultural and fish processing as part of the food processing manufacturing industry, including preservation. This is in line with the SNA2008. Thus, the first historical GDP calculations present overestimations of the offshore sector, in particular fisheries, compared to modern accounts.

Hence, one needs to reconsider the existing figures and construct new historical series of GDP by industry. This was done by Grytten (2022, 2023). New series of gross products from the production side, i.e., sectoral value added was given for 17 different industries 1816-2021, and also from the expenditure side. These series make it possible to map the development of the different sectors of the economy. By diving into the data, one might be able to compute both value added and exports of the offshore sector.

Starting with GDP, it is possible to trace value added from fishing, whaling, aquaculture, ocean transport and petroleum. These are all calculated based on domestic sources.

Fishing, whaling, and hunting

Fishing is basically limited to the value of catches, i.e., the value of the fish caught on to the fishing vessel. That means that all kinds of preservation and processing are considered food processing industries.

Based on the foreign trade statistics it is possible that the volume of catches exported and based on consumption data one might find catches for domestic use. [Brautaset \(2002, 168-189\)](#) has calculated detailed series of fish exports 1830- 1865. Consumption surveys provide information on domestic fish consumption for households. Adding these two together, it is possible to make estimations of total production figures.

From 1865 onwards, public statistics provide detailed figures on volumes and prices on fish exports, along with consumption in several benchmark years [NOS \(1949, 91-104\)](#) From 1866, public statistics report quantities and prices of fish brought on shore, and from 1908 gross and sometimes net values of catches. Input has been computed based on benchmark year calculations for 1835, 1845, 1855, 1865, 1875, 1890, 1900, 1910, 1920 and 1930 found in the historical national accounts by Statistics Norway (1865) and reports from county representatives, recorded in the County Reports (Amtmannsberetningene). We assume constant fixed-price output-input relations between the benchmark years. Before 1830, we extrapolate the gross product series back to 1816 with available trade statistics (Schweigaard 1840, Tvethe 1848), and from 1930 onwards, we use revised annual figures from Statistics Norway.

As for whaling and hunting, the application of data is different. According to applied definitions by national statistical offices the entire process until oil production is considered whaling, when firsthand sales is considered the value of hunting. Our data

are basically taken from [Kiær \(1877\)](#) and Statistics Norway (1960, 1965). To interpolate, we use public foreign trade statistics along with public records on catches and oil production Statistics Norway 1949, 1968). These are coupled with corresponding 1930 values whaling and hunting in the revised historical national accounts by industry, calculated by [Dean \(2018\)](#) and Statistics Norway. In our figures we include management and administration of the fishing vessels as part of the value creation of the sector.

To cover the gaps of the existing historical national accounts for World War II, we use reported fish catches and whaling along with their corresponding prices registered and summarized by Statistics Norway (1949, 96-105). This makes it possible to calculate production values. Due to limited data, we assume a log-linearly fixed relationship between output and input to find the gross product of the sector. This means that we interpolate between the gross products calculated for 1939 and 1946 by starting in 1939 and adjusting the movements of the production values log-linearly to hit the right level in 1946.

Ocean transportation

Estimations of historical gross product in the Norwegian merchant fleet was first made by [Kiær \(1877\)](#) and thereafter 125 years later by [Brautaset \(2002, 257-261\)](#). Both serve as reliable sources on this industry's contribution to GDP from 1830 and towards the turn of the century. The Wedervang Archive gives us detailed information on income and cost structures, freights and wages in the merchant fleet as early as the 18th century, and thus, serve as reliable sources for the new estimates covering the years 1816-1830 ([Brautaset, 2004, 119-142](#)). The data has best coverage for the fleet engaged in foreign ports. However, we also find sufficient coverage for domestic ports. Value added is calculated based on benchmark year calculations given by Statistics Norway (1960, 1965), [Kiær \(1877, 1890\)](#) and records from the Wedervang Archive located at the Norwegian School of Economics, containing ship accounts for the 18th and 19th century, and used in calculations of national accounts ([Grytten 2015](#)).

In addition, [NOS \(1978, 376-408\)](#) reports volumes of the fleet and the ships' engagements making it possible to interpolate with constant fixed price output-input relations between benchmark years. From 1930, we use the revised Statistic Norway accounts for the merchant fleet, revised by [Dean \(2018\)](#) and thereafter running data from Statistics Norway. In our series, we thrive to include services directly connected to ocean transportation, like administration and management of the ship-owning companies. However, port management and onshore cargo handling and services are not included.

As for covering the World War II gap in the gross product figures for maritime transportation, there are different possible sources. One is the so-called London Accounts reporting the incomes and costs of the Norwegian government in exile. This had a huge deficit every year, which was covered by the Norwegian national ship-owning company; Nortraship, controlled by the exile government. When the German armies attacked Norway on April 9, their plan was to hijack as many merchant ships as possible since Norway had the fourth biggest fleet in the world. However, they were unsuccessful and about 90 percent of the fleet were kept in the hands of the Norwegian exile authorities. This fleet, engaging more than a thousand ships became the largest

Norwegian contribution to the allied ware-fare, and it financed the large bulk of the London based exile government's expenses. However, these data do not provide sufficient information on the total gross product contribution provided by the fleet.

Thus, we to seek a better method. We conclude on using the tonnage of the fleet engaged distributed by sailing, steam, and motor vessels (Statistics Norway 1949, 242-243) multiplied with corresponding freight rates taken from Mohammed and Williamson (2004, 172-203) and Jacks and Stuermer (2021) as an indicator for interpolation between the existing benchmark calculations for 1939 and 1946. Again, we interpolate between the gross products calculated for 1939 and 1946 by starting in 1939 and adjusting the movements of the production values log-linearly to hit the level of the existing accounts in 1946. Close reading of alternative sources (Mossige 1989, Thowsen 1992, Basberg 1993) confirm that the approach gives a valid approach to the size of the exile fleet during the war.

Oil and gas extraction

Oil and gas extraction is a new industry in Norway, and it is solely located on the seabed of the continental shelf along the Norwegian coast. The industry is of different kinds of advanced marine and maritime operations and in the core of Norwegian offshore activities.

The national accounts series include both extraction or production activities and services directly linked to the extraction process. The latter includes management, administration and supporting services. Hence, we also include all these sub-industries here (Tjønneland 2018). This paper applies the national accounts figures from Statistics Norway running from 1971, after the first production started up in June the same year, almost two years after the discovery of the first exploitable oil and gas field on the Norwegian continental shelf in August 1969. The national accounts data for oil and gas extraction along with similar data for other sectors and industries are published in the databank of Statistics Norway.¹

World War II

To be able to calculate the offshore sector's contribution to an extended composite GDP during World War II, one needs to add maritime transportation to total GDP plus the gross product of military forces and public administration abroad. The necessary data can be found in the mentioned London Accounts, which were compiled and published in a single publication by the ministry of Finance in 1951 (Finans- og Tolldepartementet 1951). A challenge with these records is that they were originally made by budget years, stretching from July 1st to June 30th the following year. To make them compatible with the rest of our series, we have annualized them, by assuming half of the costs were used from July 1st to December 31st the first year and half from January 1st to June 30th the following year.

The annualized London Accounts are presented in table 1. The table reveals that the Norwegian exile government, unlike most other exile governments, was able to cover all its expenditures, and that Nortraship alone covered between 84.5 and 94.3 percent of these expenditures. In addition, the state-controlled ship owning company sailed in an

¹ <https://www.ssb.no/statbank/table/09170/>

excessive fortune. Not surprisingly, defense made up the largest expenditure share which was between 58.8 and 79.2 percent of all public expenditures of the exile government during the war (Finans- og Tolldepartementet 1951, 2-3).

The accounts enable us to give estimations of the size of the exile government's contribution to GDP. In the existing national accounts, one finds the ratio between value added and expenditures on public administration and defense (Statistics Norway 1965). Assuming the same ratio for each relevant expenditure group in the London Accounts as for the interwar period, it is possible to find annual series for public administration and defense's contribution to GDP during the war years with a methodology which is very similar to the one Statistics Norway applied for the years leading up to and after the war in their historical national accounts.

Table 1. Income and expenditure by the Norwegian exile government 1940-1945.

Year	Expenditures						
	Public administration		Defense		In all		Share Defense
	UK pund	NOK	UK pund	NOK	UK pund	NOK	
1940	612,419	10,778,574	2,332,942	41,059,770	2,945,361	51,838,345	0.792
1941	1,474,108	26,165,417	3,141,945	55,769,515	4,616,053	81,934,932	0.681
1942	2,612,299	46,368,298	5,126,759	90,999,972	7,739,058	137,368,271	0.662
1943	4,049,257	71,874,303	8,374,047	148,639,325	12,423,303	220,513,628	0.674
1944	6,412,715	113,825,682	10,763,000	191,043,241	17,175,714	304,868,924	0.627
1945	4,032,946	71,584,783	5,762,333	102,281,411	9,795,279	173,866,193	0.588

Year	Income						
	Miscellaneous		Nortraship		In all		Share Nortraship
	UK pund	NOK	UK pund	NOK	UK pund	NOK	
1940	167,573	2,949,276	2,777,788	48,889,069	2,945,361	51,838,345	0.943
1941	714,495	12,682,286	3,901,558	69,252,646	4,616,053	81,934,932	0.845
1942	1,084,569	19,251,100	6,654,489	118,117,171	7,739,058	137,368,271	0.860
1943	1,188,971	21,104,235	11,234,332	199,409,393	12,423,303	220,513,628	0.904
1944	2,110,519	37,461,703	15,065,196	267,407,220	17,175,714	304,868,923	0.877
1945	1,428,560	25,356,940	8,366,719	148,509,253	9,795,279	173,866,193	0.854

Source, Finans- og Tolldepartementet (1951), 2-3.

By drawing on this information, one can calculate extended GDP series at base values for 1940-1945 by adding GDP for the exile-government controlled merchant marine and public administration and defense, as reported in table 2.

Table 2. GDP in current prices for the Norwegian exile and extended economy

Year	Fishing, whaling, and aquaculture	Maritime transportation	Public administration and defense	GDP in base prices	Offshore share of GDP	Extended GDP in base prices	Offshore share of extended GDP
1940	160,456	1,140,124	24,844	6,891,608	0.189	8,031,731	0.162
1941	278,497	1,270,676	39,269	8,494,001	0.182	9,764,677	0.159
1942	293,334	1,251,547	65,836	8,589,743	0.180	9,841,290	0.157
1943	258,288	1,198,880	105,684	8,555,687	0.170	9,754,567	0.149
1944	266,459	1,118,440	146,113	8,207,392	0.169	9,325,831	0.149
1945	295,499	898,501	83,328	9,306,758	0.128	10,205,259	0.117

Source, Finans- og Tiollddepartementet (1951).

Constant price calculations

To obtain GDP results in constant prices we need to deflate the nominal series with relevant deflators. The Norwegian historical national accounts to a large degree use a double deflation technique, i.e., both output and input are deflated to arrive at value added in fixed prices. For the interwar period we do not have sufficient data to construct a double set of deflators. Thus, we deflate value added directly, as is common for historical national accounts for most countries.

For fisheries, whaling and aquaculture, we find an implicit deflator by dividing the value of catches by the volume of the catches as reported by Statistics Norway (Statistics Norway 1978, 176-181). However, to interpolate between 1939 and 1946 in fixed prices, the series should be adjusted to hit the right volumes. This is done by extrapolating forward from 1939 and backwards from 1946. The two series are then summed up by changing weighted averages, where the year's closeness to a benchmark year decides its weight. E.g., for 1940 the forward extrapolated series from 1939 counts 65 percent and the backward extrapolated series from 1946 counts 35 percent. For 1941, the weights are 60 and 40 percent respectively, for 1942, 55 and 45 percent, for 1943, 45 and 55 percent, for 1944, 40 and 60 percent, and finally, for 1945 35 and 65 percent respectively.

For ocean transportation, we apply the same principle by using the implicit deflator for values compared to volumes of tonnage in use (Statistics Norway 1978, 388-391 and 403-404). For public administration and defense, we use the available British consumer price index from Statistics UK. Both indices are adjusted to hit both benchmark years 1939 and 1946 by using the same weights as for the deflator for fisheries, whaling and aquaculture. As for exile public administration and defense, we apply an adjusted form of the corresponding deflator for the similar sector in UK World War II GDP calculations (Thomas and Williamson 2023). By doing this, it is possible to calculate both GDP for the offshore sector and the extended GDP for Norway for the war years 1940-1945. The results are reported in table 3.

Table 3. GDP for Norway in current and constant prices 1940-1945.

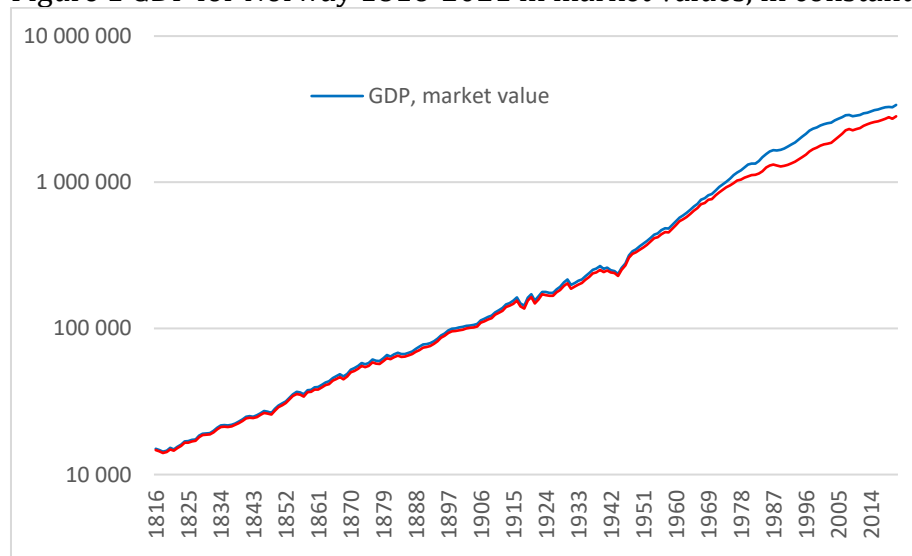
	Fisheries, Whaling, and Aquaculture	Ocean Transport	Exile Public Administration and Defense	Extended GDP in base values	Extended GDP in market values
In current prices					
1940	160,456	1,140,124	24,844	8,031,731	8564,48286
1941	278,497	1,270,676	39,269	9,764,677	10505,7443
1942	293,334	1,251,547	65,836	9,841,290	10607,728
1943	258,288	1,198,880	105,684	9,754,567	10517,4886
1944	266,459	1,118,440	146,113	9,325,831	10057,379
1945	295,499	898,501	83,328	10,205,259	10918,3
In 2015 prices					
1940	2,025,985	10,726,38	1,907,658	245,239,248	257,522,576
1941	1,495,788	9,566,614	2,614,147	249,181,151	262,998,729
1942	1,391,665	7,928,136	3,967,491	238,496,057	252,969,142
1943	1,159,412	6,974,606	6,036,07	235,010,826	249,289,57
1944	1,158,900	6,555,794	7,858,895	224,885,689	238,375,896
1945	1,328,771	6,774,405	4,171,517	247,247,572	261,822,393

Sources, Finans- og Tolldepartementet (1951), 2-3, Statistics Norway (1978), 176-181, 388-391, 403-404, Thomas and Williamson (2023).

Growth of offshore and mainland economy

Summing up all the historical series of gross product for offshore industries and comparing them to the gross domestic product per industry as compiled by Grytten (2022, 2023), we can extract the series of offshore and mainland GDP back to 1816, which is reflected in figure 1. The charts report GDP for both the entire Norwegian economy and for the mainland economy.

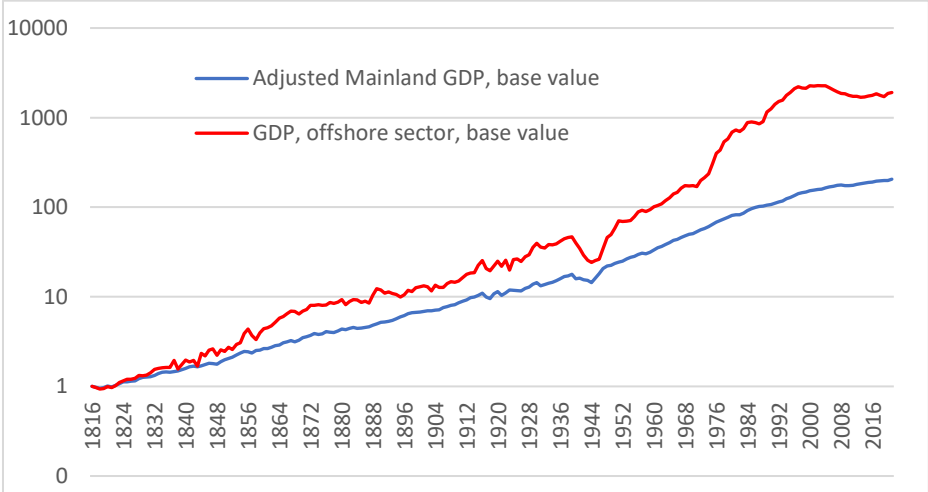
Figure 1 GDP for Norway 1816-2021 in market values, in constant NOK-2015 prices



Source, Grytten (2022), Grytten (2023), Finans- og Tolldepartementet (1951), 2-3, Statistics Norway (1978), 176-181, 388-391, 403-404, Thomas and Williamson (2023).

The calculations also enable one to compare the growth for the offshore to the mainland economy. This should also be done at constant prices, as carried out in Figure 2, which undoubtedly shows significantly higher overall growth in the offshore than in the mainland sector of the economy. Note that the argument is clearly valid even before the takeoff of the extraction of oil and gas in the 1970s.

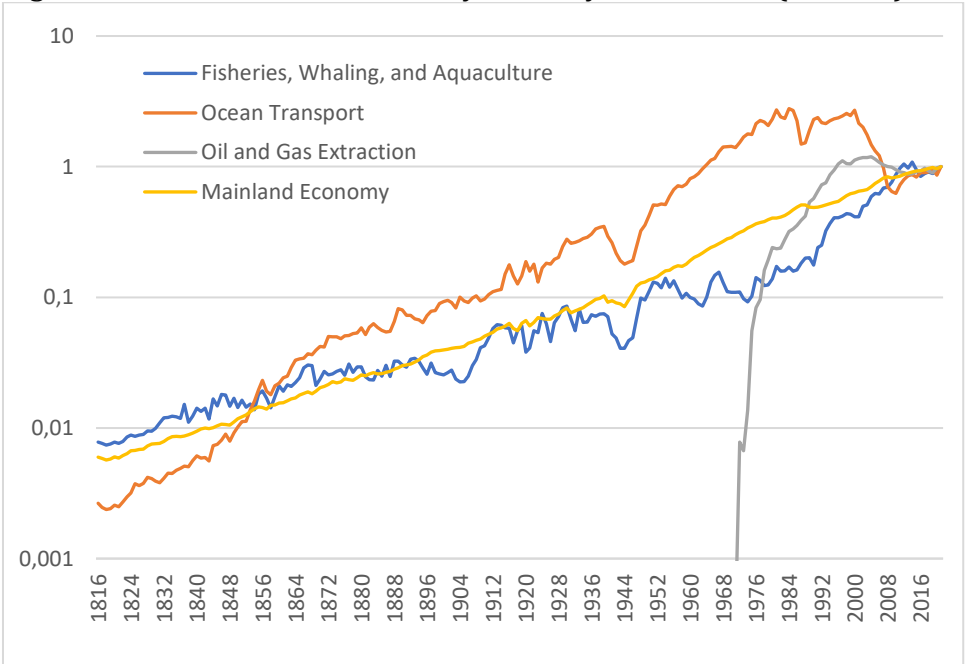
Figure 2. GDP for Norway in volume indices, 1816-2021 (1816=1).



Source, Grytten (2022), Grytten (2023), Finans- og Tolldepartementet (1951), 2-3, Statistics Norway (1978), 176-181, 388-391, 403-404, Thomas and Williamson (2023).

Figure 3 shows the growth of the offshore sector decomposed into the three main industries, i.e., in the first place, fishing, whaling, and aquaculture, secondly, ocean transport, and thirdly, extraction of oil and gas from the continental shelf of Norway. The chart applies the last year, 2021, as reference year (2021=1) instead of the first year, 1816, since petroleum was introduced in the national accounts as late as 1971.

Figure 3. Volume indices of GDP by industry, 1816-2021 (2021=1).



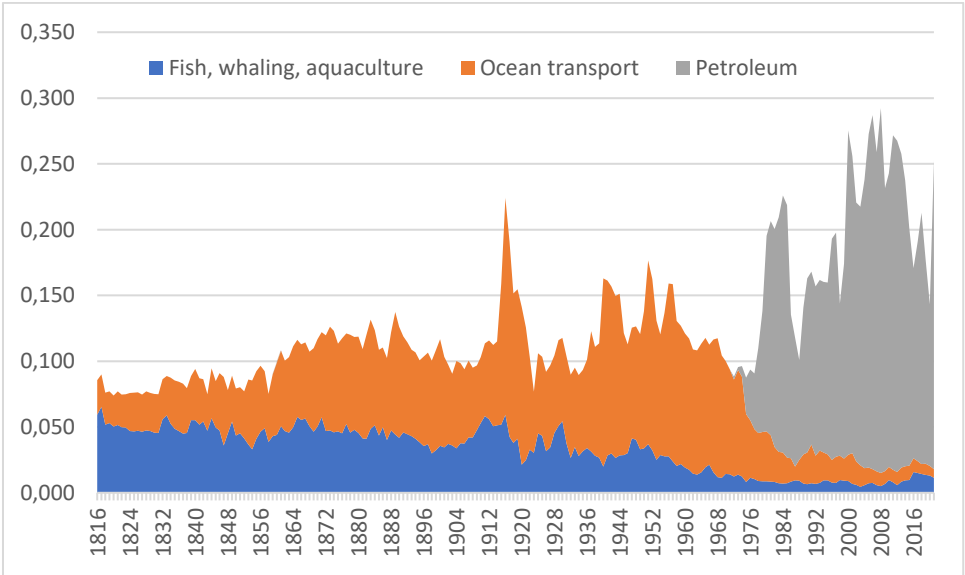
Source, Grytten (2022), Grytten (2023), Finans- og Tolldepartementet (1951), 2-3, Statistics Norway 1978, 176-181, 388-391, 403-404, Thomas and Williamson 2023.

Hence, there is no value for that industry in 1816. The figure clearly shows that ocean transport and petroleum had significantly higher growth than the mainland economy for most of the period, when fishing, whaling and aquaculture performed more in line with the mainland economy, but still slightly weaker during the entire time span.

Relative contribution to GDP

Growth in volume figures gives limited value to the present analysis, since relative shares in national accounting should be compared in current prices, partly because of lack of additivity in constant price or volume series. More importantly, value arguably might be a more important contributor to the economy than volume in the present analysis. Thus, we look at the composition of GDP in current prices. What were the shares of the industries that made up the offshore sector compared to the total economy? The necessary calculations are reported in figure 4.

Figure 4. Industries of the offshore sector’s contribution to the Norwegian GDP in current basic values 1816-2021.



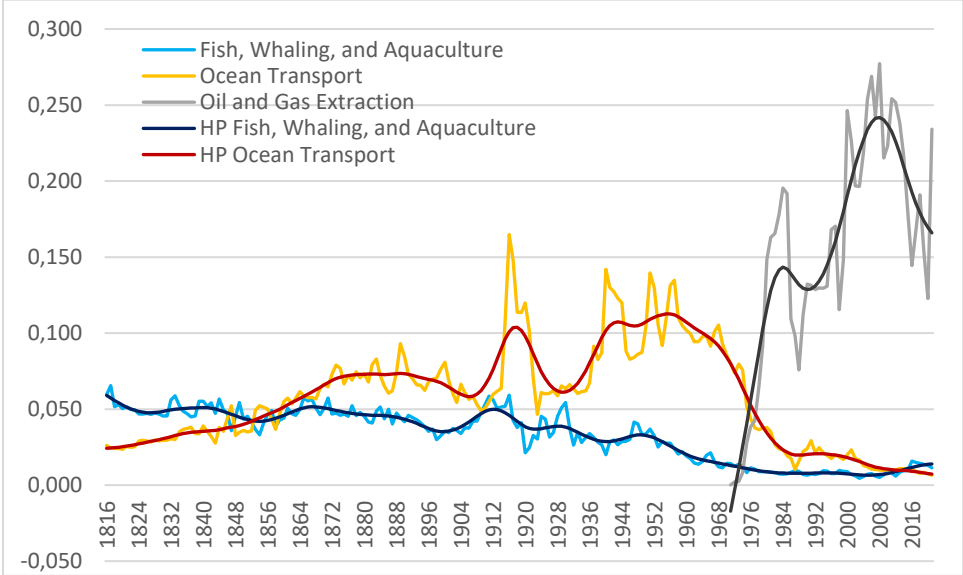
Sources, Grytten (2022), Grytten (2023), Finans- og Tolldepartementet (1951), 2-3, Statistics Norway 1978, 176-181, 388-391, 403-404, Thomas and Williamson 2023.

Chart 4 shows that the joint marine and maritime sector accounted for 8-10 percent of the entire economy 1816-1860, and thereafter between 10-13 percent most years until 1940. A clear exception was during World War I, when due to high freight rates and high fish prices, the joint sector peaked with 22.5 percent in 1916. During World War II, it peaked again with around 15 percent or more of the total extended economy 1940-1944. After World War II, we find new peaks in 1950 with 17.5 percent and in 1955-1956 with approximately 16 percent, before a minimum of between eight and nine percent in the early 1970s. Thereafter, we trace a huge increase with the introduction of oil and gas extraction. The introduction of oil and gas also made the offshore industries to become even more volatile than they had already shown to be, causing peaks to reach higher than 28 percent in 2005 and 2008.

The chart reveals huge fluctuations in the combined maritime and marine sector’s contribution to GDP. To map the trends, we use the Hodrick-Prescot filter with a smoothing parameter (gamma) of 100, which is standard for annual trend estimations.

The results are shown in figure 5. Along with a tremendous growth in the value of fishing from the early 1800s until present times, its share of the economy-wide GDP has been steadily decreasing, despite strong comebacks before and during World War I and in the 1920s, in the heydays of industrial whaling around Antarctica. During the last decades aquaculture has made the industry’s relative contribution to GDP increase again. As for ocean transport, the industry was growing rapidly even compared to nation-wide GDP, with peaks during the 1870s and 1880s, during World War I, and during World War II until the 1960s, before a huge fall, which to a large extent can be explained by transferring the bulk of the fleet to a flag of convenience. Oil and gas extraction showed an explosive trend in the 1970s and until the mid 1980s, thereafter one experienced contraction, before a new impressive growth period until the second decade of the 21st century, when it started to lose its relative importance for the Norwegian economy.

Figure 5. Share of offshore sector industries to GDP for Norway 1816-2021.



Sources, Grytten (2022), Grytten (2023), Finans- og Tolldepartementet (1951), 2-3, Statistics Norway 1978, 176-181, 388-391, 403-404, Thomas and Williamson 2023.

Exports

Another way to quantify the size of the offshore sector is to look at the composition of exports. The historical foreign trade statistics for Norway is quite good, with detailed bookkeeping of goods going out and coming into the country. Norway also has decent historical statistics of export of services, thanks to Brautaset’s (2002) work on foreign trade in historical national accounting.

The overall export series 1816-2021 is taken from the new GDP series (Grytten 2022, 2023). For the period 1830-1865 these figures almost sit entirely on Brautaset’s (2002) work on quantifying Norwegian exports 1830-1865 as part of establishing historical national accounts for Norway. For the rest of the period, the new series used the export data from the historical national accounts for Norway for the period 1865-1970 (SSB 1965, Skoglund 2009). However, checking Statistics Norway’s own historical sources along with updating them to SNA2008 made it necessary to revise the series. From

1970, the export series rests on Statistics Norway's revised export series, as reported in their national accounts.²

For the offshore sector, the exports of fish and fish products, along with whale and aquaculture products are compiled from the trade statistics of Statistics Norway, reported in historical surveys (Statistics Norway 1949, 1959, 1969, 1978 and 1994). These stretch back to 1850. The same statistics also report sales of ships and oil and gas rigs and partly overlapped by the solid figures by Brautaset for 1830-1865. For the period 1816-1830, we use more randomly collected data from the official trade records and from Schweigaard (1845) and Tvethe (1848). When the data for fish, with the exception for mixed products, where fish is an ingredient, are valid to handle, the data for whale products are far more difficult. This is basically because whale fats and oil were used as side products or mixed products in the process industry, and there is no clear definition of exports of these whale-based products. Thus, we dive deeper into the foreign trade and manufacturing statistics. By using Statistics Norway's detailed foreign trade records from the 19th and 20th century, we conclude that whale-based exports are best mirrored in the value of whale oil caught by Norwegian vessels, as the domestic use of whale products seem to equalize the added export values of the reminding value of whale oil for exports (Minister of Domestic affairs 1860-1876, Statistics Norway 1877-1950). This conclusion is in line with that of some of the foremost Norwegian experts on Norwegian whaling history (Basberg, Ringstad, and Wexelsen 1993).

As for ocean transport, we use the trade records 1816-1830, Brautaset's (2002) calculations of aggregated gross freight for the ocean going fleet, and thereafter the same kind of data from Kiær (1871, 1877, 1882, 1888) and Statistics Norway (1949, 1959, 1969, 1978 and 1994), before we use revised exports data from the historical national accounts (SSB 1965, Skoglund 2009). From 1970, we use the present and revised exports series reported in the GDP figures by Statistics Norway.³

Export growth

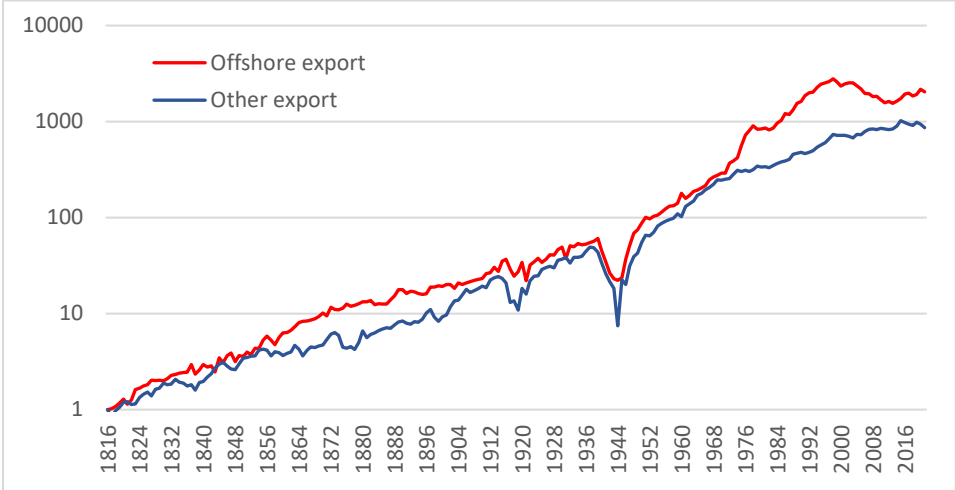
To examine the development and size of the offshore export sector compared to the economy and other kinds of exports, the paper investigates both the growth of exports by the offshore and the mainland sector and the shares of total exports, similarly to what we did for GDP.

By looking at the offshore and the mainland sectors as volume indices based on calculations in constant prices, as done in figure 6, we find that the export volumes increased significantly more for offshore related than mainland related exports, with annual compound growth rates of 3.8 to 3.3 percent respectively 1816-2021. The gap between the two first increased until the 1840s, basically due to fisheries, and thereafter during the golden era of the merchant fleet at the second half of the nineteenth century, and finally from the introduction of oil and gas extraction in the 1970s. This development also confirms that the offshore sector was a driving force behind the export growth during most of the last 200 years.

² <https://www.ssb.no/statbank/table/09189/>

³ <https://www.ssb.no/statbank/table/09170/>, <https://www.ssb.no/statbank/table/09189/>

Figure 6. Export volumes of the offshore and the mainland sector, 1816-2021 (1816=1).

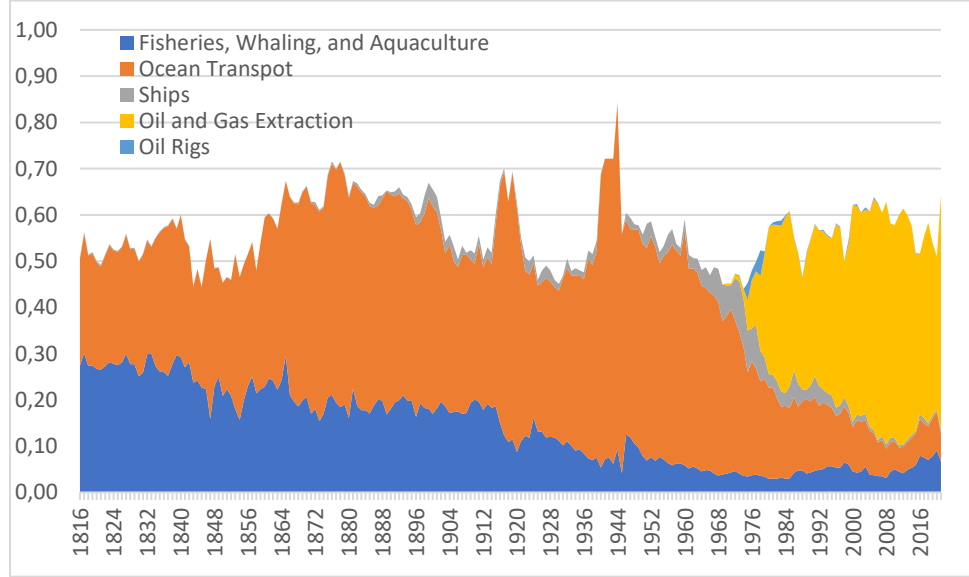


Sources, Grytten (2022), Grytten (2023), Finans- og Tolldepartementet (1951), 2-3, Statistics Norway (1978), 176-181, 388-391, 403-404, Thomas and Williamson (2023), Brautaset (2002), Kiær (1871, 1877, 1882, 1888) and Statistics Norway (1978), 261-275 and 388-408, Statistics Norway (1994), 424-448, SSB (1965), 340-363, Skoglund (2009), 16 and 22.

Contribution to exports

By combining the different sets of data presented here, we obtain export series for different industries, making up the offshore sector of the economy. We add data derived and calculated from the exile government London Accounts and other post-war reported data for the World War II period and calculate the share of the offshore sector relative to total exports, including the extended economy during the war 1939-1945. A significant part of these series represents new calculations which have never been published before. The key industries of the offshore sector’s share of total Norwegian exports 1816-2021 is presented in figure 7.

Figure 7. Offshore sector’s exports as share of total exports in current prices, 1816-2021.



Sources, Grytten (2022), Grytten (2023), Finans- og Tolldepartementet (1951), 2-3, Statistics Norway (1978), 176-181, 388-391, 403-404, Thomas and Williamson (2023), Brautaset (2002), Kiær (1871, 1877, 1882, 1888) and Statistics Norway (1978), 261-275 and 388-408, Statistics Norway (1994), 424-448, SSB (1965), 340-363, Skoglund (2009), 16 and 22.

Figure 7 reveals in the first place that the offshore sector’s share of total exports has been very high, most years over 50 percent. Secondly, it also shows long-term stability despite the short-term fluctuations. Thirdly, it reports that fishing (and whaling) was the largest until around 1850. Thereafter, ocean transport became the dominant offshore export industry until the end of the 1970s, when oil and gas extraction took the lead and gained a clear hegemony. When fishing and whaling declined gradually, ocean transport fell dramatically both in relative and absolute terms in the 1960s and 1970s.

However, petroleum. Perhaps surprisingly, rather defended the export share of the offshore sector, than increased it. This is shown in table 3, which reports the offshore sector’s share of GDP and exports for the period before and during the Norwegian oil and gas era. For GDP, we find a huge difference before and during the introduction of oil and gas, as the average contribution increases from 10.9 to 18.6 percent of the total value added. As for exports, we see a moderate decline from an average of 59.4 percent to 55.8 percent. For the entire period, we find averages of 12.8 of GDP and 58.5 percent of exports, or 7.8 – 17.9 percent and 51.4 – 65.5 percent respectively, as within normal variances, defined as plus/minus one standard deviation.

Table 4. Offshore industries’ shares of GDP and exports 1816-2021.

	Shares of GDP			Shares of exports		
	1816-1821	1816-1970	1971-2021	1816-2021	1816-1970	1971-2021
Average	0.128	0.109	0.186	0.585	0.594	0.558
Median	0.113	0.107	0.193	0.578	0.581	0.571
Stdev	0.050	0.050	0.060	0.071	0.073	0.055
Lower bound	0.078	0.059	0.126	0.514	0.520	0.503
Upper bound	0.179	0.160	0.247	0.655	0.667	0.613

Sources, Grytten (2022), Grytten (2023), Finans- og Tolldepartementet (1951), 2-3, Statistics Norway (1978), 176-181, 388-391, 403-404, Thomas and Williamson (2023), Brautaset (2002), Kiær (1871, 1877, 1882, 1888) and Statistics Norway (1978), 261-275 and 388-408, Statistics Norway (1994), 424-448, Statistics Norway (1965), 340-363, Skoglund (2009), 16 and 22.

This means that the offshore sector’s historical and present contribution to Norwegian exports is nothing less than astonishing. The high share implies that the sector has been and still is a dominant source of currency income. And, when one offshore industry declines its share, another one takes over its role. It could be tempting to say that fishing and the related industries have gradually failed as important contributors to the Norwegian economy. However, its relative decline is not due to contraction of the industry, but lower growth rates than for the economy at large. Nevertheless, also in this field, it has contributed to overall growth. High productivity growth in fisheries with less fishermen catching more fish, has led to transfer gains into other industries and thereby economic growth. Studies of ripple effects in fishing conclude that the effect increases with productivity, i.e., higher ripple effect per crew member as the number of crew members decreases due to increasing productivity levels. Including first and second waves Nordbø (2021, 69-74) calculated the ripple effects of fishing to a multiplier of 5.71 for value added and 7.15 for employment in 2019. At the same time, fishing and aquaculture exports from Norway summed up to 151.4 billion kroner in 2022 or 15 billion US dollars, i.e., still around ten percent of Norwegian exports of goods and 25

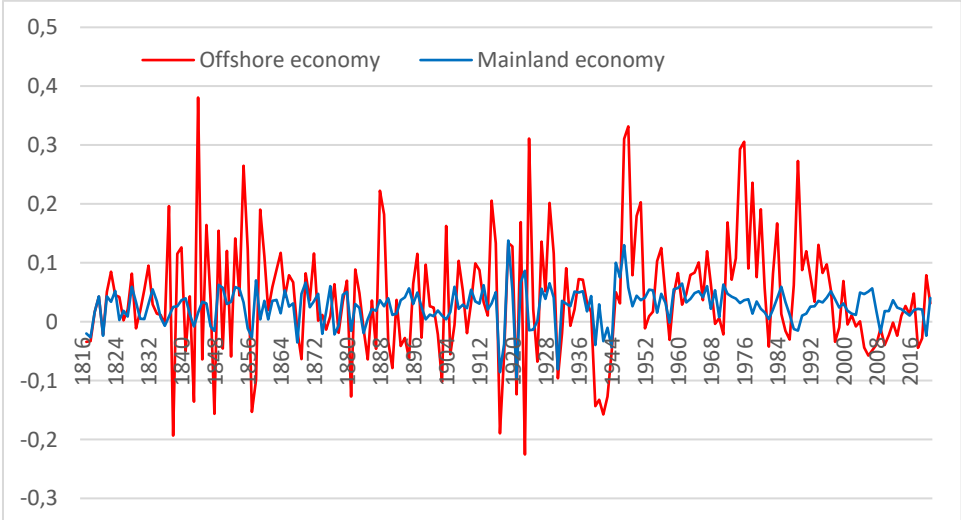
percent of exports of traditional goods (excluding oil and gas) in a normal year. These facts illustrate that the industry is still of significant importance to the Norwegian economy.

As for the rapid decline of ocean transportation, one should note that the Norwegian fleet to a large degree was transferred from ocean going bulk cargo to offshore oil and gas extraction supply, which disturbs the statistical picture in disfavor of the traditional ocean transport. During the last decades, Norway has had the world’s second largest fleet of offshore vessels, after the United States of America, serving the gas and oil industry. All categories included, the Norwegian controlled fleet was recorded as the fifth largest in the world in 2022, measured by value, clearly behind China, Greece, and Japan, and neck and neck with Germany. However, around half of the ocean-going fleet is still registered abroad (Abrahamoglu 2023, 3-19 and NSA 2022).

Comparing GDP and export series

As already seen, the combined offshore sector’s impact on the economy can be examined through growth rates of the industries compared to GDP and exports compared to the mainland economy. The annual growth rates of the aggregated volume series are reported in figures 8 and 9. It is no surprise that the annual fluctuations in offshore GDP are considerably higher than in the mainland GDP, when in exports they are more of the same magnitude. The average first order difference in absolute values of offshore GDP volumes is surprisingly high, i.e., 7.98 percent, when for mainland GDP it is 3.41 percent. Similarly, it is 9.25 percent for offshore exports volumes and 9.99 percent for mainland exports.

Figure 8. Relative first order differences for mainland and offshore GDP, 1816-2021.

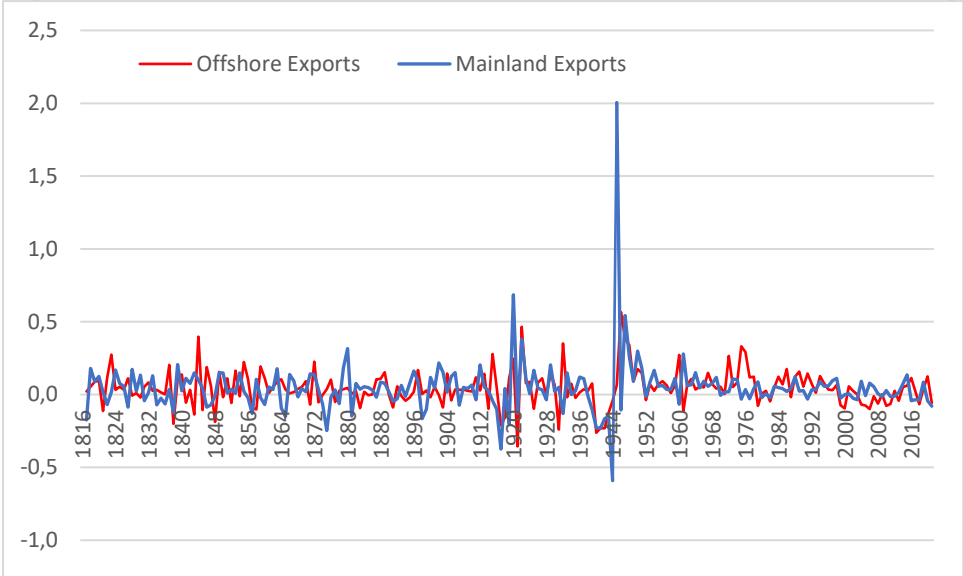


Sources, Grytten (2022), Grytten (2023), Finans- og Tolldepartementet (1951), 2-3, Statistics Norway (1978), 176-181, 388-391, 403-404, Thomas and Williamson (2023).

For GDP, this implies that the offshore economy has been important both in the short and long run. In other words, the offshore sector has contributed significantly both to economic growth as well as the ups and downturns in business cycles. As for Exports, the findings imply that offshore related products normally made up the bulk of total exports. Its growth rate in constant prices is higher than that of land-based exports,

however the annual fluctuations in exports from the offshore and the mainland sector are of the same size.

Figure 9. Relative first order differences for mainland and offshore exports, 1816-2021.



Sources, Grytten (2022), Grytten (2023), Finans- og Tolldepartementet (1951), 2-3, Statistics Norway (1978), 176-181, 388-391, 403-404, Thomas and Williamson (2023), Brautaset (2002), Kiær (1871, 1877, 1882, 1888) and Statistics Norway (1978, 261-275 and 388-408), Statistics Norway (1994), 424-448, Statistics Norway (1965), 340-363, Skoglund (2009), 16 and 22.

The impact of the offshore sector to the economy can also be studied by comparing the compound growth rates of GDP and exports for key periods. Those would be the relative peak era of fishing 1816-1858, the relative peak era of ocean transport 1858-1914, the turbulent years 1914-1945, the post-World War II period, until oil was commercially extracted from the Norwegian continental shelf from 1971, and finally during the petroleum era from 1971 until now. The calculations are presented in table 5.

Table 5. Annual compound growth rates and correlation coefficients of GDP and exports in the offshore and mainland economy, 1816-2021.

	GDP			Exports		
	Correlation Coefficients	Offshore	Mainland	Correlation coefficients	Offshore	Mainland
1816-2021	0.316	0.037	0.026	0.186	0.038	0.033
1816-1858	0.234	0.028	0.022	0.039	0.037	0.033
1858-1914	0.074	0.031	0.018	-0.064	0.031	0.032
1914-1945	0.501	0.010	0.015	0.296	-0.005	-0.002
1945-1971	0.383	0.073	0.045	-0.021	0.098	0.093
1971-2021	-0.083	0.049	0.027	0.055	0.039	0.025

Sources, Grytten (2022), Grytten (2023), Finans- og Tolldepartementet (1951), 2-3, Statistics Norway (1978), 176-181, 388-391, 403-404, Thomas and Williamson (2023), Brautaset (2002), Kiær (1871, 1877, 1882, 1888) and Statistics Norway (1978, 261-275 and 388-408), Statistics Norway (1994), 424-448, Statistics Norway (1965), 340-363, Skoglund (2009) 16 and 22.

The table reveals significantly higher annual compound growth rates for offshore GDP than mainland GDP for all periods, except for 1914.-1945. For the foreign trade sector, we see the same trend, but with a lower difference between the offshore and the mainland industries. For the period 1858-1945, the growth rates of exports are almost identical for the two sectors. For GDP, we find positive correlation coefficients between growth rates of offshore and mainland GDP for all periods, except the petroleum era from 1971. For exports, the correlation between the offshore and the mainland sectors is limited, and sometimes negative.

All in all, our calculations confirm that the offshore sector played a significant role in the Norwegian economy during the last good-200 years, accounting for a large share of the economy throughout the entire period. The argument seems to have the most quantitative support for the long-term rather than the short-term development, since it is easier to track long-term or cross-period correlations than correlation for each sub-period.

Conclusions

The present paper investigates the size of the offshore sector, represented by maritime and marine industries, compared to GDP and exports. The quantitative approach of the paper is quite original in Norwegian maritime and marine economic history writing. The present research is based on presenting new calculations of the offshore sector's contribution to GDP and exports in current and constant prices. We compute both growth rates and shares in comparison with the mainland sector. For the World War II period, it was necessary to include the exile economy, which had to be recalculated and expanded to include contributions to GDP and exports by industry and sector.

We find that the annual compound growth rates of offshore GDP were significantly higher than that of mainland GDP throughout the period 1816-2021. The same applies for exports. However not to the same impressive degree.

When looking at the offshore economies share of the entire economy, we find that the offshore sector's contribution to GDP normally fluctuates around 10-15 percent, but admittedly higher after the takeoff of oil and gas extraction in the 1970s. One should note that in the GDP calculations, fish processing is considered a manufacturing industry and not fisheries, i.e., the contribution of fisheries was arguably higher than reported in the GDP figures. As for exports, the offshore sector normally contributes 50-60 percent. We find that fisheries made the largest contribution until the mid 1850s, thereafter ocean transport until the mid-1970s, and thereafter oil and gas extraction. We also find that the long-term trends have been surprisingly stable, despite significant short-term movements and a clear increasing trend of offshore industries' contribution to GDP after the takeoff of oil and gas extraction into the Norwegian economy in the 1970s.

Based on quantitative measures, it is obvious that the historical contribution of the offshore sector to the Norwegian economy has been of a significant magnitude, and we do not find any lasting downward trend in the sector's relative importance.

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