REPORT

Value Added and Ripple Effects from the Node Cluster

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MENON Business Economics

Preface

This project was carried out by Menon Business Economics on behalf of the Node Cluster (Norwegian Offshore and Drilling Engineering). It entails a comparative value added analysis and an extensive international ripple effects analysis. The value added analysis makes use of Menon's activity database for the Norwegian business sector and Menon's offshore and maritime population. The international ripple effect analysis utilizes Menon's advanced international ripple effect model, the International Total Effect Model (ITEM).

Rasmus Bøgh Holmen is the main developer of ITEM and has been the project leader. Sveinung Fjose has worked as a project member and has in addition been responsible for quality assurance. Anne Grete Ellingsen was the project principal from Node. Note that although the report is in English, it also contains a summary in Norwegian.

Menon takes full responsibility for the academic content and all potential errors in the report.

Rasmus Bøgh Holmen
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Content

1. Main Findings: Node is a Global Cluster that Lifts the Business Sector of Agder

The Node Cluster[1] consists of 63 member companies with 119 branch offices within the maritime and offshore supply industry, located in Agder in Southern Norway. In 2012, the cluster employed 6 778 people and accounted for a value added contribution of NOK 9.32 billion. From 2004 to 2012, the cluster's value added grew by an average 23.5 percent annually. Node had a value added of NOK 1.38 million per person engaged, which is higher than in other parts of maritime and offshore supply. Node is a substantial contributor to value added along Agder's coastline and raises the labor productivity in the region by 8.1 percent. High labor productivity reflects high total factor productivity, in addition to high capital intensiveness.

More than 9 percent of Agder's GDP is related to Node through the value chain. The Node Cluster buys commodities and services in Norway for about NOK 7.6 billion annually. About NOK 4 billion of these purchases are made in Agder, while the neighboring counties – Rogaland and Telemark – are the largest suppliers outside Agder with combined deliveries of NOK 1.5 billion. The revenues of Node's subordinate divisions outside Agder amounted to NOK 10.11 billion. Most of these were earned in Rogaland, followed by Akershus and Møre og Romsdal. Counting both direct and indirect contributions, 15,100 persons are engaged in Node activities. The cluster's activities generate a value added contribution and tax revenues through the Norwegian value chain of NOK 18.7 billion and NOK 10.5 billion respectively. About half of the value added contribution takes place in Agder, corresponding to 9.4 percent of the region's GDP.

Node constitutes a strong global cluster. It buys commodities and services worth more than NOK 10 billion annually. Although many European countries play substantial roles, the most important import countries for Node are USA, China and South Korea. The cluster generates nearly 31,000 jobs abroad, indicating that approximately two out of three persons engaged in Node's activities works outside Norway. Thus, the Node cluster directly or indirectly employs around 46,000 people.

[1] Arbitration for Norwegian Offshore and Drilling Engineering

2. Hovedfunn: Node er en global klynge som løfter næringslivet i Agder

Node-klyngen[2] består av 63 medlemmer med 119 filialer i Agder innen maritim og offshore leverandørnæring. I 2012 sysselsatte klyngen 6 778 personer og sto for en verdiskapingsbidrag på 9 320 millioner kroner. Fra 2004 til 2012 vokste klyngens verdiskapning med 23,5 prosent årlig. Nodes verdiskaping beløp seg til 1,38 millioner kroner per ansatt, noe som er høyere enn i andre deler av maritim og offshore leverandørnæring. Klyngen er en betydelig bidragsyter til verdiskaping langs Agders kystlinje og øker regionens arbeidsproduktivitet med hele 8,1 prosent. Den høye arbeidsproduktiviteten er til dels et uttrykk for høy totalfaktorproduktivitet og til dels et uttrykk for høy kapitalintensitet.

Mer enn ni prosent av Agders BNP er knyttet til Node gjennom verdikjeden. NODE-klyngen kjøper varer og tjenester i Norge for om lag 7,6 milliarder kroner årlig. Om lag fire milliarder av kjøpene er foretatt i Agder, mens nabofylkene - Rogaland og Telemark - er de største leverandører utenfor Sørlandet med en samlet leveranse på 1,5 milliarder kroner. Omsetning knyttet til Node-selskapers avdelinger utenfor Agder beløp seg til 1,1 milliarder kroner. De fleste av disse salgene ble foretatt i Rogaland, fulgt av Akershus og Møre og Romsdal. Samlet er om lag 15 100 personer engasjert i Nodes aktiviteter. Klyngens virksomhet er gjennom verdikjeden knyttet til et verdiskapingsbidrag på 18,7 milliarder kroner og skatteinntekter på 10,5 milliarder kroner. Omtrent halvparten av verdiskapingsbidraget finner sted i Agder, tilsvarende 9,4 prosent av regionens BNP.

Node utgjør en sterk global klynge. Det kjøper varer og tjenester fra flere land for om lag 10 milliarder kroner årlig. Selv om mange europeiske land bidrar betydelig til klyngen, er de viktigste importlandene for Node USA, Kina og Sør-Korea. Samlet generer klyngen nesten 31 000 jobber i utlandet, noe som indikerer at omtrent to av tre personer sysselsatt direkte eller indirekte av Nodes aktiviteter jobber i utlandet. Dermed sysselsetter Node-klyngen til sammen rundt 46 000 mennesker.

[2] Forkortelse for Norwegian Offshore and Drilling Engineering

3. Values Created in the Node Cluster: The Cluster Raises Agder's Labor Productivity by Eight Percent

The Node Cluster consists of 63 members with a total of 119 branch offices within the maritime and offshore supply industry, located in Agder in Southern Norway. In 2012, the cluster employed 6 778 people and accounted for a value added contribution of NOK 9.32 billion. From 2004 to 2012, the cluster's value added grew by an average 23.5 percent annually. Node had a value added of NOK 1.38 million per person engaged, which is higher than in other parts of the maritime and offshore supply industry. Node is a substantial contributor to value added along Agder's coastline and raises the labor productivity in the region by 8.1 percent. The high labor productivity reflects both high total factor productivity and high capital intensiveness.

3.1. The Node Cluster: Representing the Maritime and Offshore Supply Industry in Agder

The Node Cluster consists of 63 members within the maritime and offshore supply industry, located along the coastline in Agder in Southern Norway. Counting units in different municipalities separately and including subsidiaries and other consolidated companies within the maritime and offshore supply industry, the cluster encompasses 119 active branches. These are spread over many activities – from manufactory production of electronics, machines and metal constructions to market-oriented services such as consultancies, direct offshore services, port services, retail trade and shipping.

In 2012, 6 778 people worked in the Node Cluster, of whom 4 292 in Kristiansand, 970 in the rest of Vest-Agder, 943 in Arendal and 573 in the rest of Aust-Agder. This corresponds to 4.8 percent of all employment in Agder. The same year, the cluster achieved revenues of NOK 26.3 billion. The cluster's profit margin (EBITDA) was about 14.8 percent.

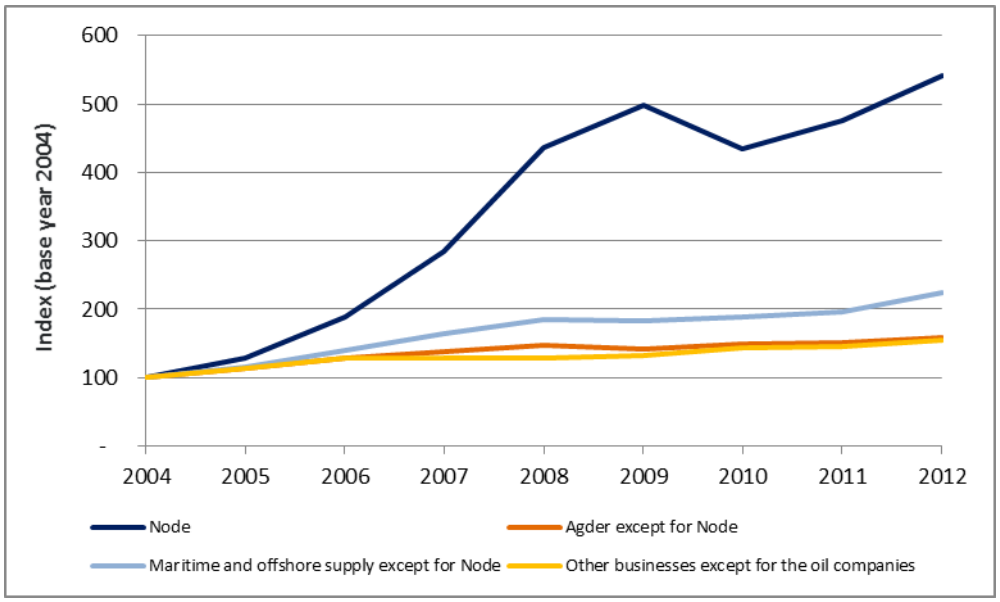
3.2. Value Creation: The Node Cluster Creates Values for More than NOK 9 Billion

In 2012, the Node Cluster created values for more than NOK 9.32 billion. The cluster's value added[3] growth has been substantial – not only compared to the rest of Agder and the rest of Norway, but also compared to other maritime and offshore suppliers in Norway.[4, 5] Although it is easier for a cluster to achieve high growth rates than for a whole industry, the figures appear impressive. From 2004 to 2012, the cluster's value added grew annually by 23.5 percent on average.

In the figure below we show growth in value added in the Node Cluster compared to the maritime offshore industry, the non-oil business sector in Norway and the Agder region.

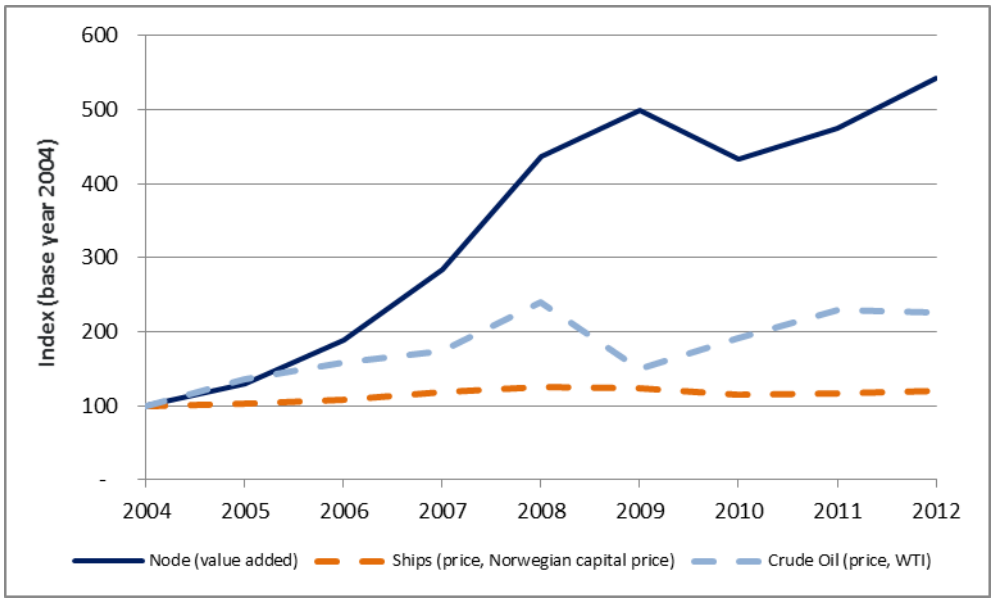
[3] Value added is a measure of internal value creation and encompasses profits and labor costs. Due to imprecise figures on amortization and depreciation, we follow the common custom to measure value added before abrasion of capital is taken into account (i.e. we measure gross value added and not net value added). Note that a firm's ripple effects are not included in its value added.
[4] The oil companies have not been taken into account in this comparison.
[5] Over many years, Menon has built a population for the Norwegian offshore industry. The population is quality checked against similar populations from other institutions, including the International Research Institute of Stavanger (IRIS) and several regional actors.

Figure 3-1: Indexed development in value added for Node and other parts of the Norwegian business sector from 2004 to 2012. Source: Menon (2014)



As seen in the table, the Node Cluster experienced a marked downturn in 2010, the second year of the financial crisis. Yet, the cluster had recovered fully two years later. As Figure 3-2 below shows, the downturn was accompanied by a significant drop in prices of ships and oil, decreasing both investments and profitability of the industry. Due to offshore deliveries and high order reserves among many Node members, the Node Cluster downturn lagged by one year compared to the rest of the economy. Overall, offshore suppliers where hit to a lesser extent than the rest of the maritime industry. This is shown in the figure below.

Figure 3-2: Indexed development in value added for Node and price developments for crude oil and ships from 2004 to 2012. Source: Menon (2014)

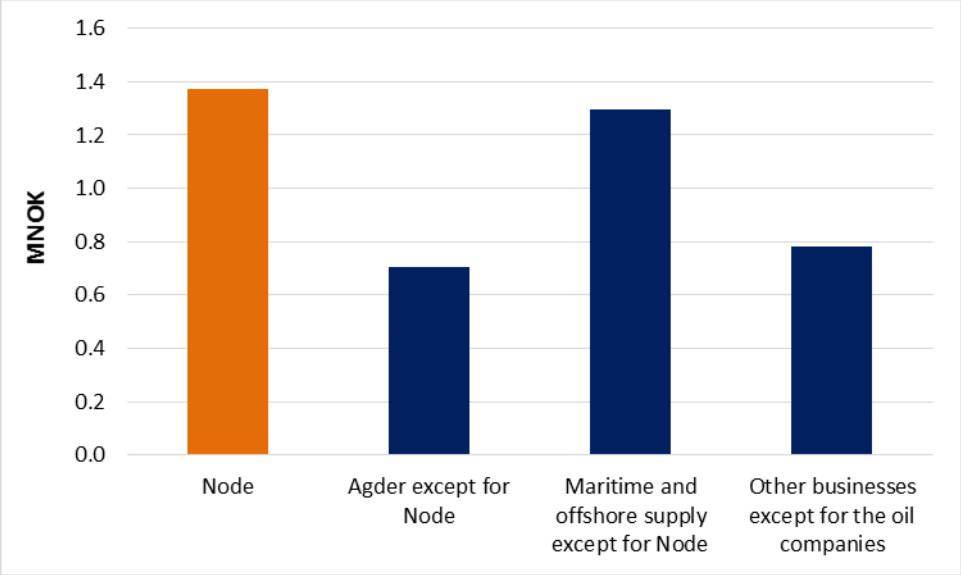


3.3. Value Added per Person Engaged: Labor Productivity in the Node Companies is Rather High

Value added per person engaged[6, 7] is probably the most widely used measure for labor productivity. Value added per person engaged is often referred to as a measure of labor productivity. Labor productivity reflects total factor productivity and capital intensity. If a business has higher productivity and works within markets with higher willingness to pay, it will create values, which will be spread over owners, workers, tax authorities and creditors. In the following, the government could extend its welfare services, save more and/or decrease taxes, whereas a wealthier population could increase demand in other parts of the economy. Some of the gain from the value added wedge would also be redistributed through the tax and welfare system. Thus, more value added will not only result in wealthier stakeholders – it will benefit the rest of society.

As illustrated in Figure 3-3 below, the value added per person engaged in the Node Cluster was about NOK 1.38 million per person engaged in 2012. This is not only considerably higher than in the rest of the business sector in Agder and Norway, but also NOK 80 000 higher per person engaged than in the maritime and offshore supply industry elsewhere in Norway. The Node Cluster's high value added per person engaged implies an important contribution to Agder's economy through efficient use of scarce resources. The value added in Agder per employee rises from NOK 703,000 to NOK 760,000 due to the Node Cluster, which corresponds to 8.1 percent.

Figure 3-3: Value added per person engaged in Node and other parts of the Norwegian business sector in 2012. Source: Menon (2014)

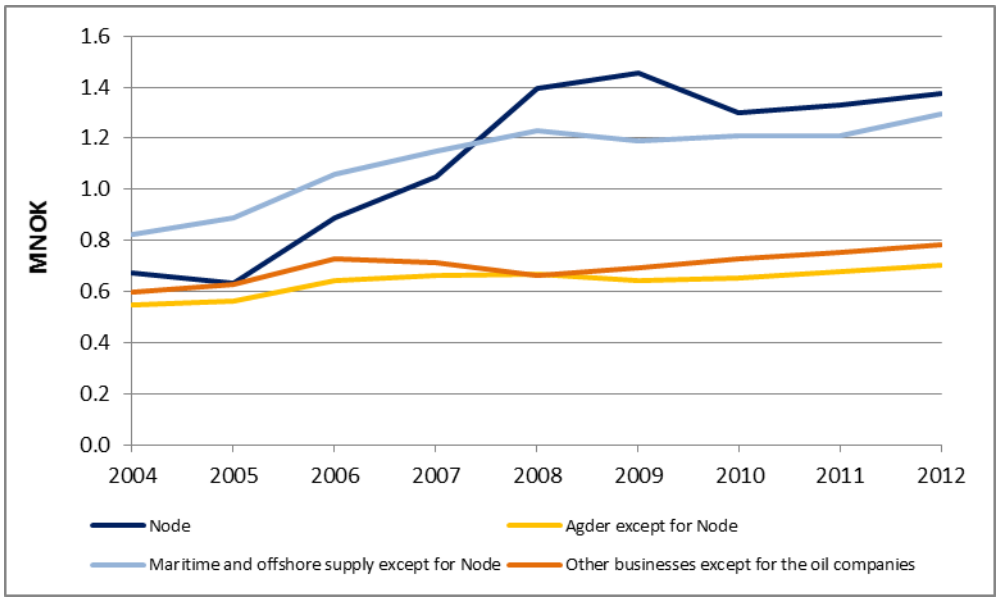


The Node Cluster has experienced a substantial growth in value added per person engaged since 2005. As shown in Figure 3-4 below, the cluster's value added per person engaged was hit harder by the financial crisis than the rest of the economy. Since it has better absorptive capacity for labor than the rest of the business sector in Agder, the value added per person engaged in the Node Cluster must be expected to grow slower as activities grow. Although growth in operations could limit the growth in value added per person engaged, it would imply a higher

[6] Persons engaged include both employees and the self-employed.
[7] In a dynamic context, value added per person engaged should be measured in fixed prices for a given base year in order to only capture the productivity effect. In our analysis, we also seek to capture the price effect and choose therefore to look at value added in current prices. If one only looks at one year, the two measures will be the same.

value added per person engaged in Agder as a whole. In any case, the numbers show that the Node Cluster contributes to higher wealth in Agder.

Figure 3-4: Development in value added per person engaged in Node and other parts of the Norwegian business sector from 2004 to 2012. Source: Menon (2014)

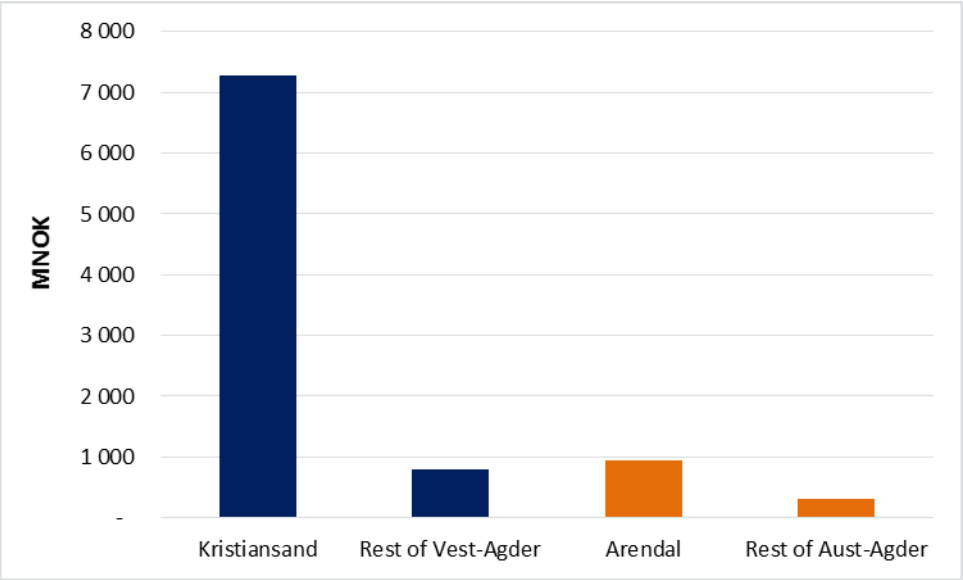


3.4. Geographical Value Added Spread: Kristiansand Is Largest by Far, but the Node Cluster Creates Values All along Agder's Coastline

The Node Cluster's activities are spread along Agder's coastline. The largest value added[8] contribution by far takes place at Kristiansand in Vest-Agder and amounted to NOK 7.274 billion in 2012. This does without doubt represent a large share of Node's value added, but is not that surprising considering Kristiansand's dominant role in the labor market region and its importance as the leading regional port. Thereafter follows Arendal in Aust-Agder with a value added of NOK 939 million. The rest of Vest-Agder and Aust-Agder had value added contributions from Node of NOK 790 million and NOK 315 million respectively. The regional spread of Node's value added is illustrated in Figure 3-5 below. Note that the population is 1.6 times higher in Vest-Agder than in Aust-Agder.

[8] In macroeconomics, value added is the most used term for economic contributions. Strictly speaking, value added is a measure of internal value creation, covering wages to employees, dividends to owners, interest to creditors and net taxes to the public sector. Summing up the value added in a whole country, one will end up with the country's gross domestic product. External value creation involving consumer surplus and externalities is not included.

Figure 3-5: The Node Cluster's value added distributed over main locations. Source: Menon (2014)

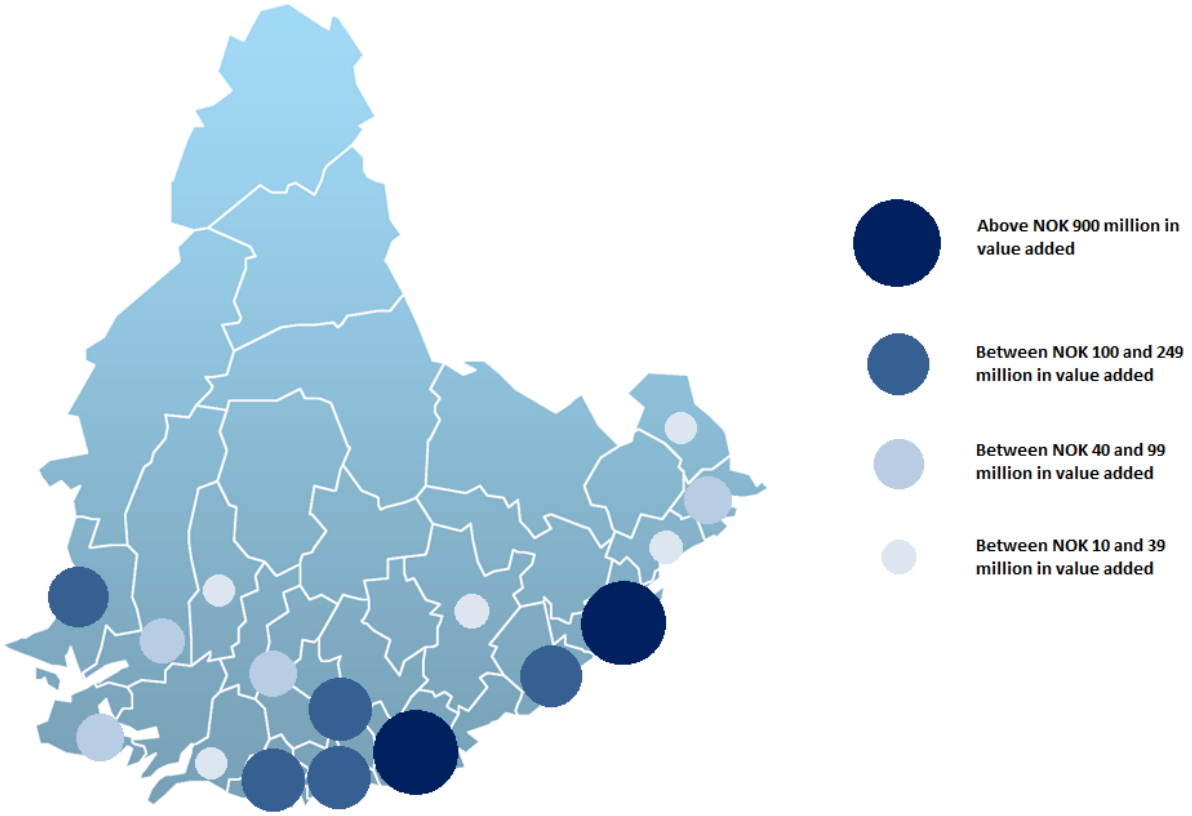


Node's activities are spread across fourteen other municipalities along the Agder coastline. The municipality with the third highest value added is Grimstad in Aust-Agder with just over NOK 200 million in value added. Thereafter follow four municipalities in Vest-Agder: Songdalen with a value added of NOK 170 million, Mandal with NOK 131 million, Søgne with NOK 126 million and Flekkefjord with NOK 109 million.

In addition, three municipalities in Vest-Agder and one municipality in Aust-Agder had a value added of between NOK 40 and 99 million, whereas one municipality in Vest-Agder and three municipalities in Aust-Agder had a value added of between NOK 10 and 39 million.[9] The geographical spread of the Node Cluster's activities is shown in Figure 3-6 underneath.

[9] Here is a list of these municipalities with specification of their county and the value added from Node actors in parentheses; Kvinesdal (Vest-Agder, NOK 83 million), Farsund (Aust-Agder, NOK 71 million), Risør (Aust-Agder, NOK 55 million), Vennesla (Vest-Agder, NOK 49 million), Hægebostad (Vest-Agder, NOK 37 million), Tvedestrand (Aust-Agder, NOK 27 million), Birkenes (Aust-Agder, NOK 17 million), Gjerstad (Aust-Agder, NOK 16 million) and Lindesnes (Vest-Agder, NOK 14 million).

Figure 3-6: Map over the Node Cluster's value added in Agder. Source: Menon (2014)



4. National Ripple Effects: More than Nine Percent of Agder's GDP is related to Node through the Value Chain

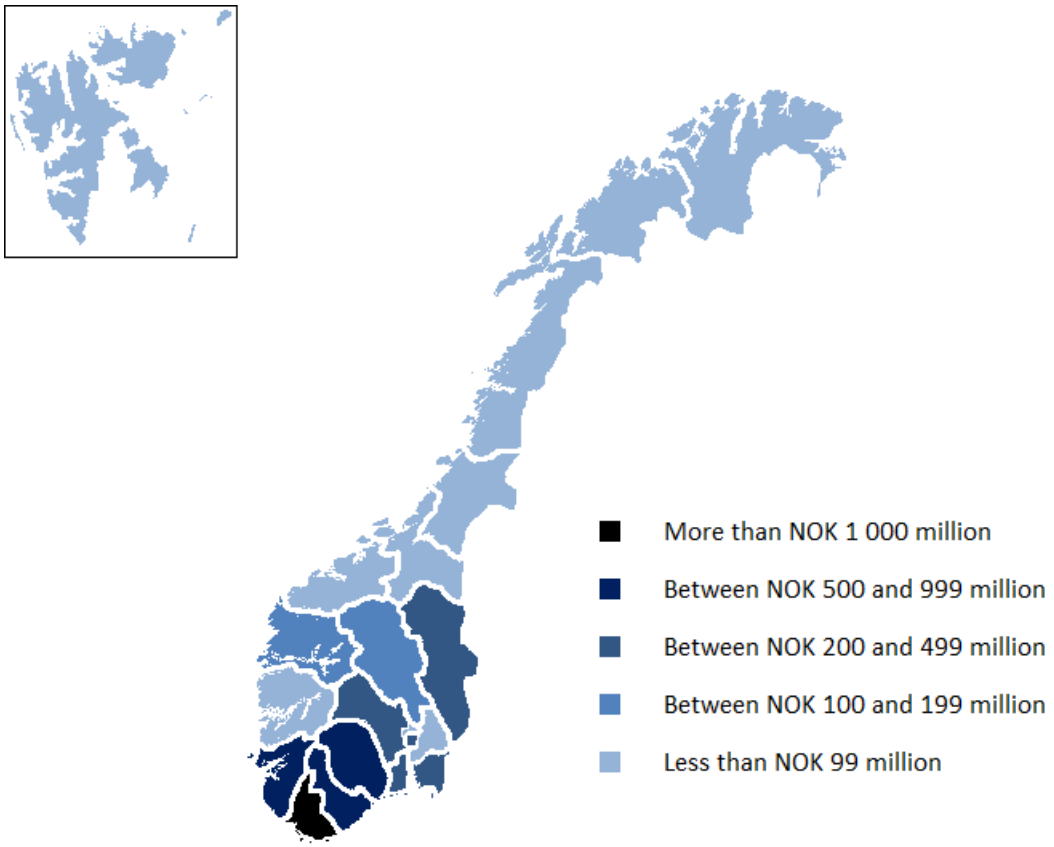
The Node Cluster buys commodities and services in Norway for about NOK 7.6 billion annually. About NOK 4 billion of the purchases are made in Agder, while the neighboring counties – Rogaland and Telemark – are the largest suppliers outside Agder with combined deliveries of NOK 1.5 billion. The revenues of Node's subordinate divisions outside Agder amounted to NOK 10.1 billion. Most of these were generated in Rogaland, followed by Akershus and Møre og Romsdal. Counting both direct and indirect contributions, 15,100 persons are engaged in Node activities. The cluster's activities generate a value added contribution and tax revenues through the Norwegian value chain of NOK 18.7 billion and NOK 10.5 billion respectively. About half of the value added contribution takes place in Agder, corresponding to 9.4 percent of the region's GDP.

4.1. Node's Impact on Suppliers: Buys Commodities and Services for Nearly NOK 8 Billion Annually

Through its purchases and associated units, the cluster induces activities across the Norwegian business sector. In Norway, there is nearly full employment, implying that most factor inputs have an alternative usage. Consequently, the value contribution related to the gross ripple effects (i.e. the net ripple effects) will be related to higher value creation per factor input than the alternative usage.

In 2012, the Node Cluster bought commodities and services from other Norwegian companies for NOK 7.6 billion. The cluster purchased goods and services in Vest-Agder for more than NOK 3.3 billion, whereas the purchases in Aust Agder amounted to about NOK 700 million. The neighbouring counties, Rogaland and Telemark, delivered goods and services to the Node Cluster for about NOK 880 million and NOK 620 million respectively. Beyond the surrounding areas, Eastern Norway is the most important delivery region for Node. Node's purchases in Norway are illustrated in Figure 4-1 below.

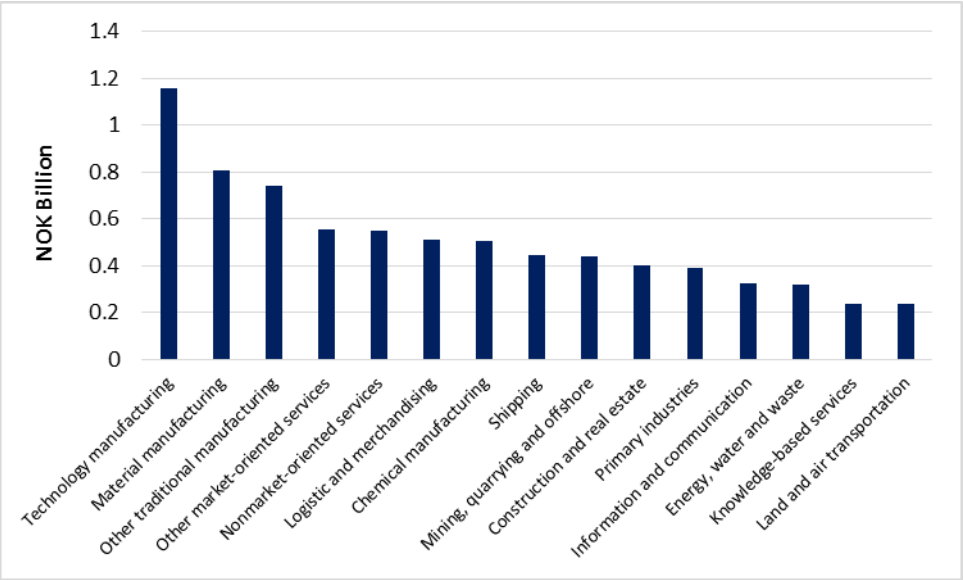
Figure 4-1: Geographic spread of Node's suppliers in Norway. Source: Menon (2014)



The production shares are spread according to empirical evidence on gravity effects, in terms of distances and industry agglomeration. As one follows purchases higher up in the supply chain, the distributional spread will resemble the national production shares. Note that we have adjusted for cluster internal purchases.

Node's most important Norwegian suppliers outside the cluster are technology manufacturers with deliveries of nearly NOK 1.16 billion. Thereafter follows material manufacturing with more than NOK 800 million, and other traditional manufacturing with NOK 740 million. The top ranking of the delivery industries to the Node Cluster does probably not come as a surprise for too many. Perhaps less known is the fact that the cluster contributes to ripple effects across all industries. In Figure 4-2 below, we illustrate how Node's purchases in Norway are distributed across supply industries.

Figure 4-2: Industry distribution of the Node Cluster's external Norwegian suppliers. Source: Menon (2014)



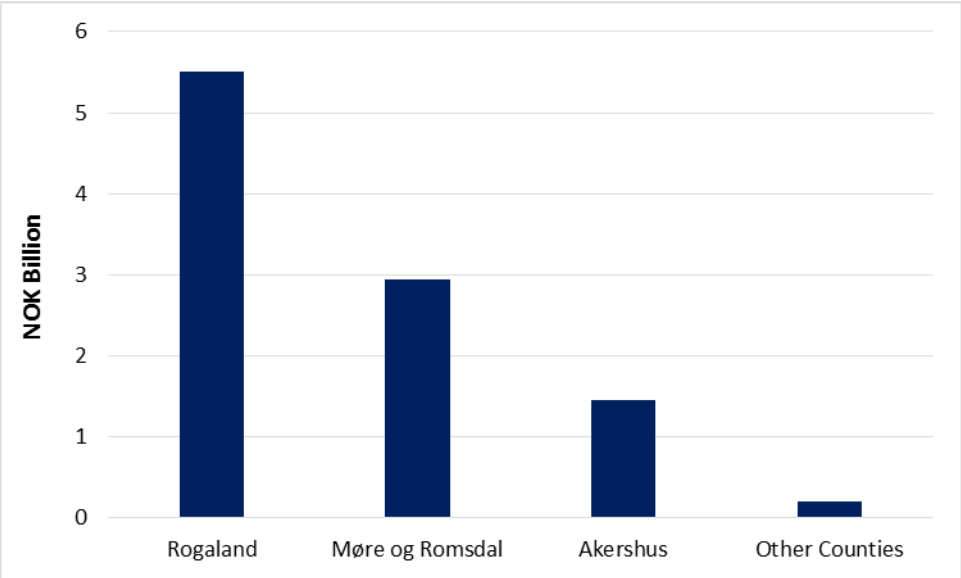
The distribution will be even more even for second and higher order effects, as services typically dominate higher up in the supply chain. External effects, consumption effects and reductions in tax distortions are not included in our calculation. Thus, our calculations could be considered as conservative minimum estimates.

4.2. Node's Affiliated Divisions outside Agder: Sell for More than NOK 10 Billion Annually

In addition to the suppliers, Node prompts activities through operations in other places in the country[10]. Combined, Node's subordinate divisions outside Agder had revenues of NOK 10.11 billion in 2012. With a Node-revenue of NOK 5.51 billion, Rogaland is the largest Node-county outside Agder. Thereafter follow Møre og Romsdal and Akershus with revenues of NOK 2.94 billion and NOK 1.45 billion respectively. The geographic spread of Node's subordinate divisions' revenues is illustrated in Figure 4-3.

[10] Many companies operate both in Agder and other counties in Norway. It is neither straightforward nor clear how affiliated divisions with the same organizational number should be dealt with. We believe that a good way to deal with this is to consider subordinate divisions as suppliers to the companies' headquarters. Consequently, we have included subordinate Node-divisions outside Agder in our ripple effect analysis.

Figure 4-3: Geographic spread of the revenues of Node's subordinate divisions outside Agder. Source: Menon (2014)

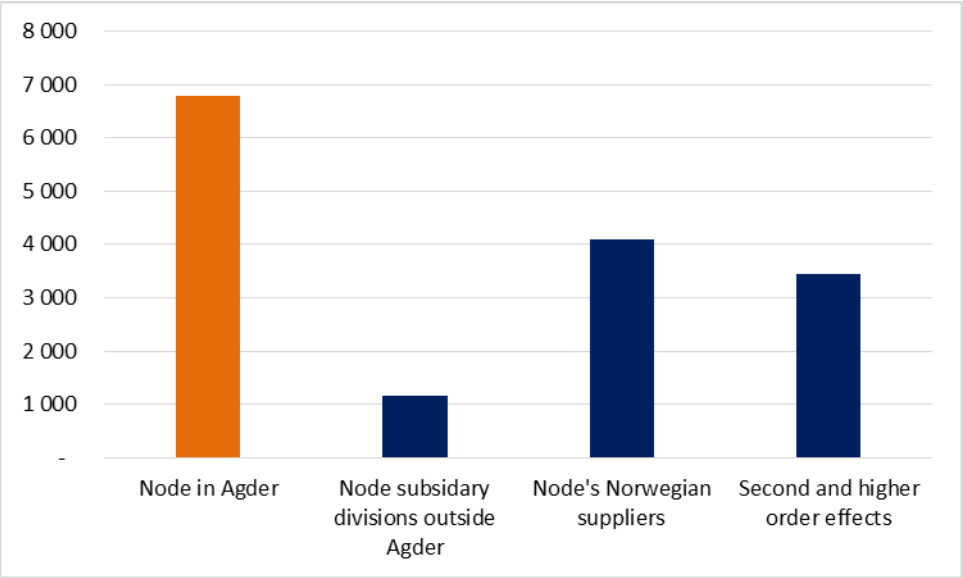


Generally, we do not include other company divisions of Node-companies, when their headquarters lie outside Agder. They will however be included in accordance to their involvement, if they take part in the supply chain. By the same token, we have not considered subsidiaries or other associated companies outside Agder beyond the extent that these deliver goods and services to the Node Cluster. This is because our purpose is to study Node's impact on the value chain from Agder, not to assess the impact of Node ownership.

4.3. Employment Effects: Node Employs Directly or Indirectly More than 15,000 People in Norway

In total, the Node Cluster directly or indirectly employed about 15,100 persons in Norway in 2012. Of these, nearly 6,800 people work in the Node Cluster, whereas more than 1,100 people work in affiliated divisions outside Agder for companies with headquarters in Agder. Furthermore, Node's operations induced about 4,100 jobs at suppliers and 3,400 jobs higher up in the supply chain. We have illustrated the jobs generated by Node's activities in Figure 4-4 below.

Figure 4-4: Jobs generated directly or indirectly by Node's activities. Source: Menon (2014)

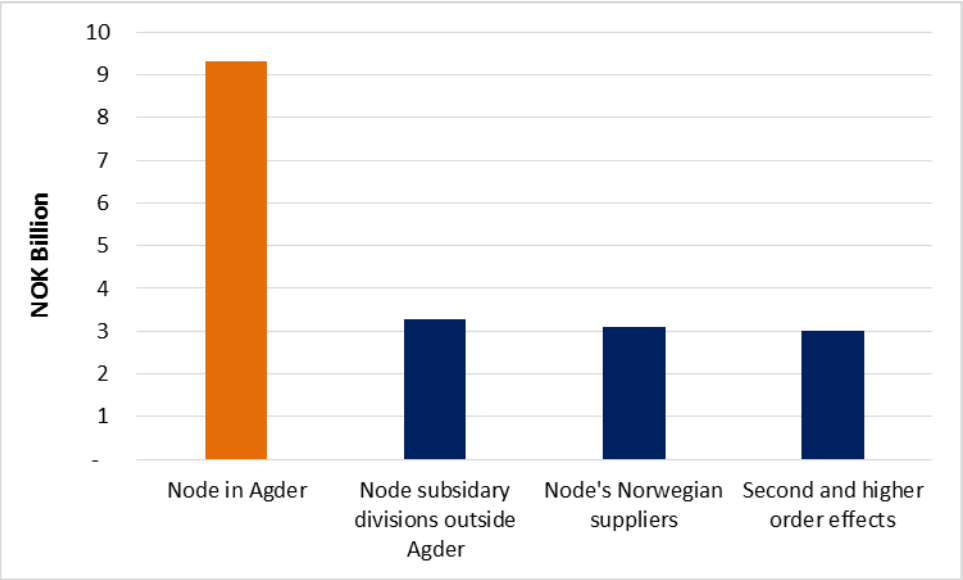


The employment ripple effects are gross. Note that since Norway has almost full employment, most of the workers would have alternative usages. Yet, both the realized allocation of resources and the high value added contributions per factor input from the maritime and offshore industries indicate that the value creation associated with each job is higher, meaning that the realized resource allocation creates more value than the best alternative. Except for some factor market frictions, the most efficient allocation of labor and capital will be realized, since the most efficient firms will have higher willingness to pay for factor input. Value creation is the subject of the preceding subchapter.

4.4. Value Added Effects: Node Generates nearly 19 Billion in Value Added through the Supply Chain

Through the value chain, the Node Cluster generates a value added of NOK 18.7 billion in Norway. About half of the value added, equivalent to NOK 4 billion or 9.4 percent of Agder's gross domestic product, is generated by the Node Cluster itself in Agder. Furthermore, Node's subsidiary divisions outside Agder and the suppliers' Node-related activities accounted for value added contributions of NOK 3.2 billion and NOK 3.1 billion respectively. In addition, Node's second and higher order value added effects amounted to about NOK 3 billion. We have illustrated the value added generated by the Node Cluster in Figure 5-3 below.

Figure 4-5: Value added generated directly or indirectly by Node's activities. Source: Menon (2014)

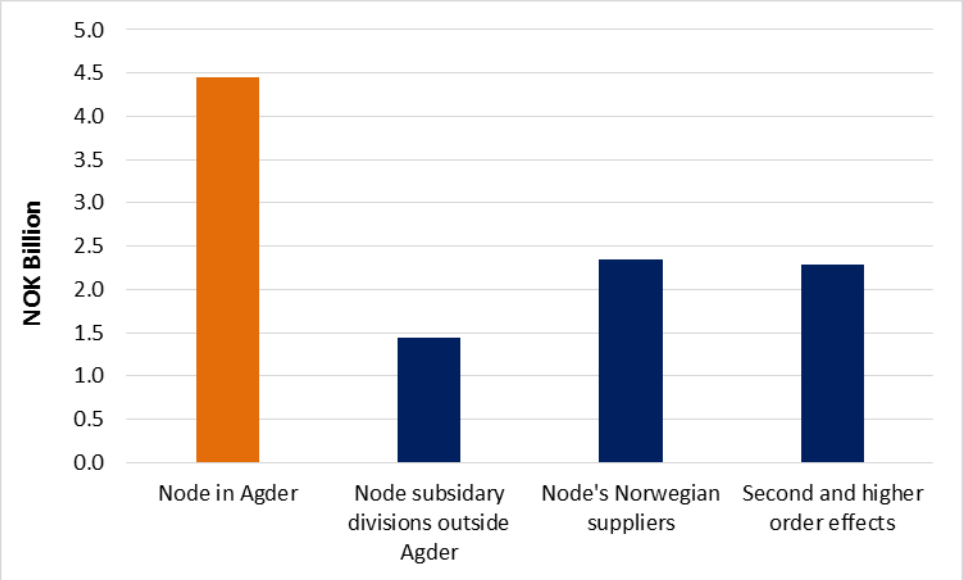


As noted in subchapter 3.2 and subchapter 4.3, most resources engaged in Node's activities throughout the value chain have alternative productive usages. Thus, the net benefit of Node's activities will be related to higher value added per factor input rather than unemployment and an inactive capital stock.

4.5. Tax Generation: The Node Cluster Generates NOK 10.5 Billion in Tax Revenues

Node's activities generate NOK 10.5 billion in tax revenues through the value chain. The Node companies account for NOK 4.5 billion in Agder, whereas affiliated divisions outside Agder account for NOK 1.4 billion. Indirectly, Node's activities generate NOK 2.3 billion in tax revenues both from its suppliers and higher up in the supply chain. The tax generation is shown in Figure 4-6 below.

Figure 4-6: Tax generation induced by the Node Cluster. Source: Menon (2014)



The tax generation includes personal income and payroll taxes, corporate income, value added taxes, net unit production taxes and other net production taxes. Taxes on capital stocks such as real estate and employed assets are not included, since they are unlikely to be related to the Node Cluster's activities. Just as for employment and value added, the alternative usages of the factor input imply that the tax revenues will not be net. The tax generation induced by Node will however be higher than the alternative, since it implies a more efficient use of resources. Note also that maritime and offshore industries have relatively high margins and high productivity compared to the rest of the business sector.

The economic efficiency gain from increased tax collection will not be equal to the rise in tax generation, but just the decrease in the distortion cost related to tax collection. The Norwegian Ministry of Finance (2005)[11] estimates this cost to be about 20 percent of the tax generation. The rest of the tax generation is related to redistribution effects, which also might be attributed weight by decision makers and the public opinion. Increased tax generation could be used to decrease taxes, improve welfare schemes or increase public net savings.

[11] Source: Finansdepartementet (2005): *Veileder i samfunnsøkonomiske analyser*, veileder utarbeidet av Finansavdelingen i Finans-departementet, september 2005

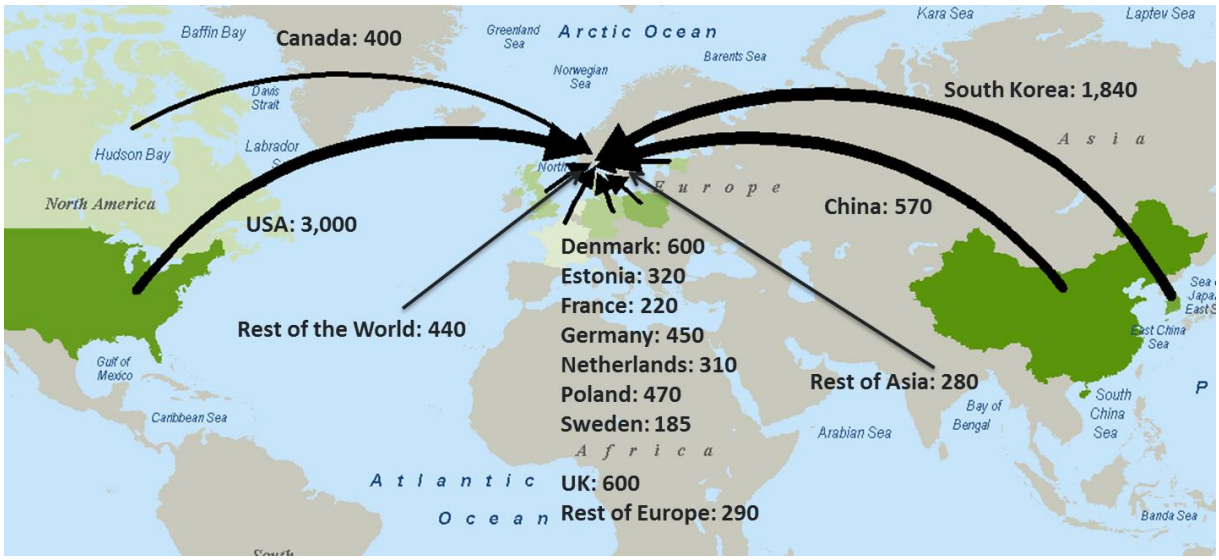
5. International Ripple Effects: Node is a Global Cluster

Node buys commodities and services worth about NOK 10 billion annually. Although many European countries play substantial roles, the most important import countries for Node are USA, China and South Korea. The cluster generates nearly 31,000 Jobs abroad, indicating that approximately two out of three engaged by Node's activities works abroad. Directly or indirectly, the Node Cluster employs around 46,000 people.

5.1. Purchases: Node Imports Commodities and Services for NOK 10 Billion

The Node Cluster's imports of commodities and services in 2012 amounted to approximately NOK 10 billion. In Figure 5-1 underneath, we show Node's total purchases of goods and services in different countries and regions. As the figure illustrates, the cluster is a highly international purchasing goods and services worldwide.

Figure 5-1: Geographic spread of Node's foreign purchases in 2012 measured in NOK million. Source: Menon (2014)

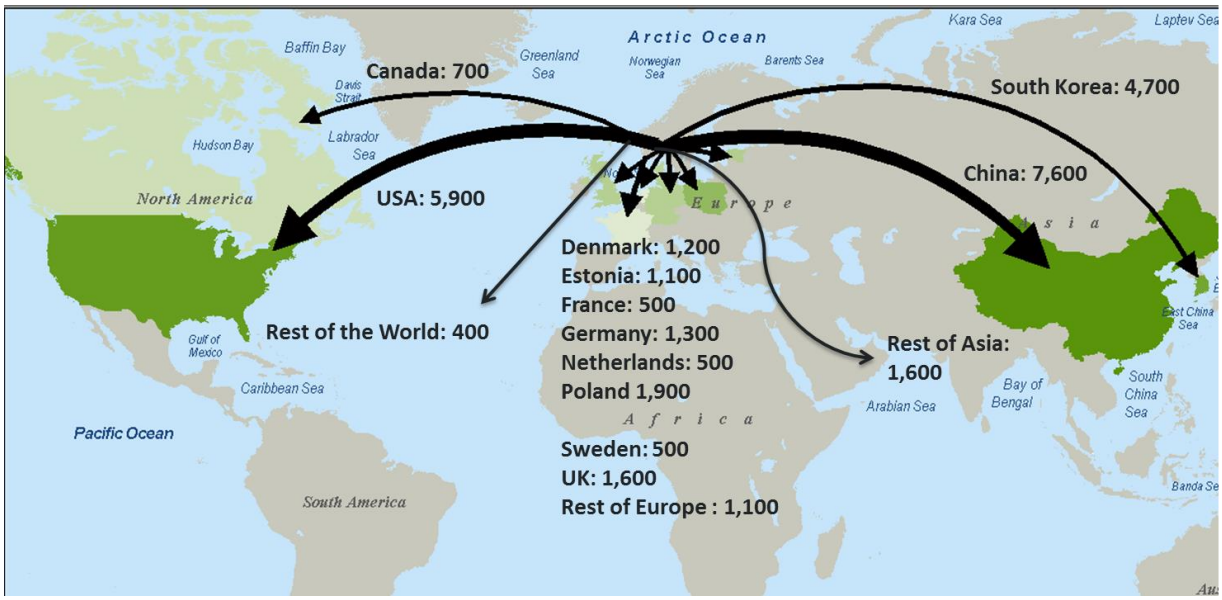


Most purchases were made in USA, amounting to approximately NOK 3 billion. The second largest foreign supplier for the Node Cluster is South Korea with a total export of NOK 1.8 billion. Combined, Europe exported for NOK 3.5 billion to the Node Cluster, compared to NOK 2.7 billion for Asia and NOK 3.4 billion for Canada and USA combined. In addition to these purchases, Node's suppliers induced further ripple effects higher up in the supply chain. We will now turn our attention to how the company generates value in other countries.

5.2. Employment Effects: Node Creates Nearly 31,000 Jobs Abroad

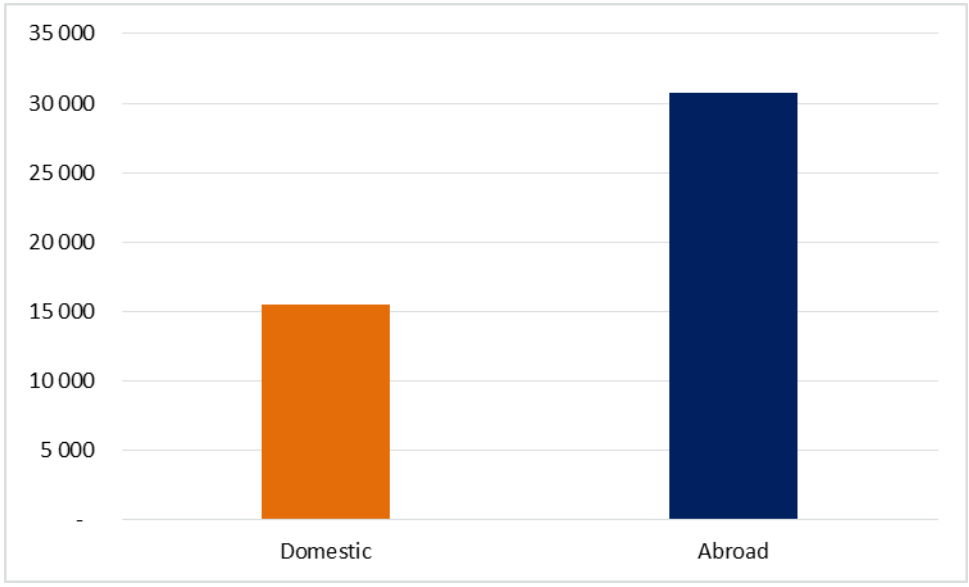
The Node Cluster's activities employ about 56,400 people around the globe, including effects in Norway. In total, the company's activities create nearly 25 180 jobs abroad. Most jobs are created in China, USA and South Korea – 10,700, 9,300 and 8,460 respectively. Approximately 21,300 jobs are created in other countries in Europe. The distribution of jobs is illustrated in Figure 5-2 below.

Figure 5-2: Geographic spread of ripple effects generated by the Node Cluster in terms of employment. Source: Menon (2014)



Although the employment effect in Norway is substantial, it is clear from the figure that the employment effect is far larger abroad – in fact it is almost twice as large. This is both because the cluster is internationalized and because less value added is generally required to employ a person abroad. Figure 5-3 illustrates Node's effect on employment both domestically and abroad.

Figure 5-3: Node's effect on employment, domestically and abroad. Source: Menon (2014)



How large the ripple effects are for a given country depends on the amount and types of goods and services being purchased, as well as country- and industry-specific relations between employment, production and value added. These relations do in turn depend on labor productivity and consolidation. The effects calculated in this report are gross effects, since more activity by Node necessarily displaces labor from other activities. Yet, the alternative usages might be slim for industries in many countries and in some cases even involve unemployment. The estimates does not model re-export and reimport explicitly.

6. Appendix: The International Total Effect Model

Menon's 'International Total Effect Model', abbreviated 'ITEM', is an international ripple effect model meant to illuminate value generation through the value chain. The model illuminates value generation through the value chain, by investigating ripple effects across countries and industries in terms of employment, revenue, value added and tax generation. It consist of two modules – the 'Norwegian Module' (abbreviated 'NM') and the 'World Module' (abbreviated 'WM') – as well as a module bridge. NM utilizes Statics Norway's input-output matrixes, Menon's Accounting and Activity Database and more. VM utilizes information from OECD's input-output table for industries' purchases and various macro data sources to account for economic differences and extend the scoop of the model. The bridge is made with basis in trade flows.

6.1. Norwegian Module

Menon has developed an advanced ripple effect module for the Norwegian economy. *The Norwegian Module* (*NM*) is based on an extended version of Statistic Norway's input-output matrixes for domestic production and imports.[12] These matrixes provides an overview over the purchases in between all industries, as well as key production and consumption figures of all industries and other usages.

When mapping the cluster's value added and calculating the initial shock, we have applied Menon's Accounting and Activity Database to obtain the Node cluster's key figures. Starting out by Node's member list and the database, Menon has for each Node consolidation mapped all ownership relations. We have supplemented Node's member list with all daughter companies and all affiliated companies within the maritime and offshore activities units in Agder. In case of National Oilwell Varco Norway, the effects on suppliers are spread according to the companies' purchases structure. For companies with many branch offices, the key economic figures are spread geographically according to distribution of employment.

Node's activities through their branch offices in Ager are regarded as first order ripple effects. Their suppliers' deliveries and Node's branch offices other places in Norway are treated as second order effects. Effects higher up in the supply chain are collectively referred to as higher order effects. To avoid double counting, we have taken intra-cluster purchases in to account. We have mapped trade within the cluster complete purchases data form National Oilwell Varco Norway,[13] interviews and accounting information from Aker Solutions, Frigstad Engineering Norway, MacGregor Norway and NCE Node.

Our calculations of ripple effects take basis in industry-specific key economic ratios between intermediate purchases and gross production, gross production and employment, gross production and value added, and gross production and tax generation divided into the different tax sources. All ratios are obtained from a combination of Menon's database and data from Statistics Norway. When suppliers in an activity industry belongs to a sub-industry with aberrant characteristics, this will be taken into account. This is for instance the case for maritime and offshore suppliers, which across the activity industries generally have higher value added per gross production unit and lower employment per gross production unit than the industry average.

[12] Compared to the public input-output matrixes, the matrixes entails four additional separation made by Statistics Norway in Menon's request; 1) '*fish and other fishing products*' (NACE 3.1) and '*aquaculture products; support services to fishing*' (NACE 3.2), 2) '*extraction of crude petroleum and natural gas included direct offshore services*' (NACE 6 and 9.1) and '*mining of metal ores and coal with support activities*' (NACE 5, 7, 8 and 9.9), 3) '*passenger rail transport, interurban; freight rail transport; other passenger land transport; other passenger land transport*' (NACE 49.1 to 49.4) and '*transport via pipeline*' (NACE 49.5), and 4) '*international shipping*' (NACE 50.101, 50.201 and 50.204) and '*domestic shipping*' (NACE 50.102, 50.109, 50.202, 50.203, 50.3 and 50.4).

[13] Obtained in relation to the a previous Menon-report; Fjose, S., Holmen, R.B. and Gulbrandsen, M. (2013): *Value Added and Ripple Effects of National Oilwell Varco Norway*, Menon Report 34/2013

In the case of the tax ratios, our tax estimation takes six types of taxes into account; personal income and payroll taxes, corporate income, value added taxes, net unit production taxes and other net production taxes. The calculation of tax generation does not include taxes on capital stocks such as real estate and employed assets, seeing that they are unlikely to be related to the Node Cluster's activities. Our estimates are based on national averages for each industry adjusted for county-specific differences.

The Norwegian second order ripple effects through suppliers are geographically distributed according to Menon's estimation of gravity relations, which spreads economic shocks according to the distances to the shock center and industry agglomeration.[14] These estimations are made with basis in The Institute of Transport Economics' commodity trade matrixes, which builds on Statistic Norway's commodity flow survey (Statistics Norway 2012),[15] as well as Menon's Accounting and Activity Database and Statistic Norway's Regional accounts. We have based our prediction on gravity estimates for the manufacturing industries for all suppliers. The reasons is that the market-oriented service industries that supplies Node are relatively internationalized and therefore should be expected to have gravity relations more similar to manufacturing than private services on aggregate.

In order to integrate ITEM's Norwegian Module and ITEM's World Module, Menon has developed a module bridge based on data on Norwegian import flows. In the case of National Oilwell Varco Norway, we have spread the companies' international ripple effects over countries and industries in line with the company's purchases. For the rest of the Node Cluster, we have spread the international ripple effects over industries according to Statistic Norway's extended import input-output matrix. Applying Statistics Norway's reported import flow for commodities and services, we have then estimated how each industry import-generated ripple effects distributes itself over countries.

6.2. World Module

Menon has established a complex international ripple effect module, which takes country-specific sector composition and purchase characteristics into account. We calculate the foreign ripple effect in terms of employment and value added for all countries and regions. In addition, we illuminate the sizes of the foreign purchases made directly from the Node Cluster. *The World Module* (*WM*) provides country-specific modeling for several countries and regions. In this project, we have applied country-specific modelling for twelve countries outside Norway (Canada, China, Denmark, Estonia, France, Germany, Netherlands, Poland, South Korea, Sweden, United Kingdom and United States) and regional-specific modeling for three residual regions (Rest of Asia, Rest of Europe and Rest of the World).

The import to Norway generated by Node's activities are distributed over countries, regions and industries in compliance with the national results. Next, the model calculates national estimates for employment generated through the value chain. Menon's database for the Norwegian business sector is used to obtain a smooth transfer from the industry division applied in NM (a slightly modified version of the Norwegian industry classification A64 rev. 2, linked to NACE Rev. 2.) to the industry division applied in WM (the European industry classification A38 rev. 1, linked to NACE Rev. 1). USD is used as currency. Data for the development in average annual exchange rates are gathered from Norway's Central Bank. Gaps in these data are filled by applying the Oanda Currency Converter for given years. The exchange rates are used to convert economic figures in local currencies to USD.

[14] Obtained in relation to the a upcoming research report written on behalf of the Norwegian Ministries in cooperation with Vista Analyse by Brunnvoll, A., Grünfeld, L.A., Holmen, R.B., Iversen, A., Skogstrøm, J.F., Wahlqvist, H. and Vennemo, H.

[15] Statistics Norway he (2012): *Varestrømundersøkelse – Dokumentasjon og metode*, Asbjørn Wethal (red.), Notater/Documents 60/2012

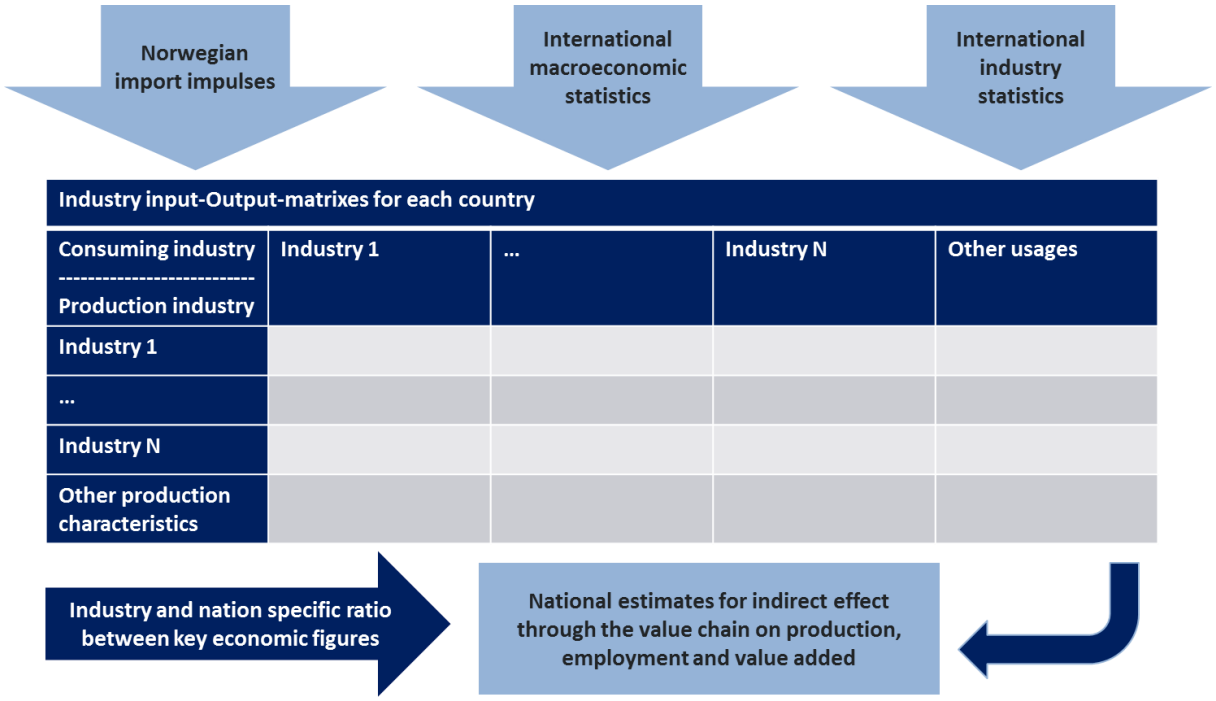
The ripple effect model applies country- and region-specific input-output matrixes (IO-matrixes), which describe the national and regional purchase structure between all industries. More specifically, each IO-matrix involves a complete overview over purchases between all industries for the country in question. By studying the wholesaler-retailer relationships backwards in the value chain, it is possible to estimate the value generation resulting from an initial purchase or activity. In this study, the initial shock in the model corresponds to Node's country- and industry-specific purchases, calculated by NM and in case for National Oilwell Varco Norway obtained from the company itself. We calculate the ripple effects in terms of employment by utilizing country- and industry specific ratios between gross production, value added and employment.

We have gathered country-specific input-output matrixes for purchases between all industries, as well as other usages from OECD's Stan Database. OECD's latest IO-matrixes were updated in 2005 with the European industry classification NACE revision 3 from 2002. The industries' purchase structure changes little over time, implying that their age will not complicate the estimation much. Little evolvement over time is however unlikely to hold for the industry ratios in the IO-matrix, which are estimated separately. The matrixes cover both domestic and foreign purchases, but re-export and reimport are not modeled specifically and will to a large extent offset each other over countries. Domestic industry-ratios between key figures are applied for each country.

Industry- and country-specific figures for employment, revenues in constant prices and value added in constant prices over time are gathered from OECD's Stan Database 3 and benchmarked and adjusted against OECD' Stan Database 4. We base ourselves on the European industry classification from 2002, NACE revision 1, when analyzing according to industries. The time series are applied to estimate the development in labor productivity measures and the ratios between the economic figures for every industry in every country. The data are combined across countries, industries and time to estimate missing figures. Local gross domestic product deflators are obtained from the International Monetary Fund's World Economic Outlook Database. These data are used to deflate the estimates to current prices, as well as for separate productivity and price development.

We have illustrated our model in Figure 6-1 below. The model adjusts the ratios in the IO-matrix for each country or region in accordance with time and geography. The adjustment relies on three sets of country- and region-specific sources; industry-specific data, macroeconomic data and price data. Firstly, the industry-specific data covers employment, gross production and value added. Secondly, the macroeconomic data includes value added in constant and local prices, labor force participation and unemployment rates. Thirdly, the price data encompasses both inflation in terms of GDP deflators and exchange rates. In combination with the data for industry-specific and macroeconomic key relations, the price data can be applied to identify productivity development. Accordingly, the country- and industry-specific key ratios applied in the IO-matrixes are adjusted for development in both price and in productivity.

Figure 6-1 – Illustration of the World Module in Menon's International Total Effect Model. Source: Menon (2014)



Country-specific macroeconomic key figures for value added per capita in constant local prices and current USD prices, labor force participation and unemployment rates are obtained from the International Monetary Fund's World Economic Outlook Database and the World Bank's Open Database. These data are harmonized with the industry-specific and macroeconomic key figures from OECD's Stan Databases. More specifically, the macroeconomic data are used to estimate missing country- and industry-specific figures, and for prediction purposes. The macroeconomic data is applied to estimate macroeconomic productivity and key ratios, as well as ensuring compliance between macroeconomic and industry relations.

The ripple effects will not discriminate between domestic purchases and reimport higher up in the supply chain. Thus, the estimates for each country or region involve the ripple effects that are generated through suppliers in the respective region or country, but does not necessarily reflect the ripple effects generated in the country as a whole. This is unlikely to be a substantial error source, seeing that reimport higher up in the supply chain is likely to be limited, and that trade goes back and forth between countries. If there is any bias, the employment effect is most likely to be underestimated, since developing countries are likely to be more present higher up in the supply chain. This underpins that our estimates could be considered as minimum projections.

The ripple effects calculated will be gross, since we do neither calculate nor model how increased factor input in one industry draws on employees and self-employers from other industries. This implies that we do not estimate to what extent occupy factor inputs and measure the alternative activities. Today, there is less pressure on resources abroad than in Norway, implying that the gross effect will be closer to the net effects outside of Norway.

An overview over country- and region-specific data sources is provided in Table 6-1 and Table 6-2 below. In addition, we have listed which countries are used as data sources for different kinds of parameters. It is important to stress that all data sources are combined to estimate different key relations for each country.

Table 6-1: Overview over data sources applied for different countries and regions (1/2). Source: Menon (2014)

Country/Region		Purchase Data	Industry Key Relations	Macroeconomic Key Relations	Deflator Data	Exchange Rate Data	Input-Output Matrixes
Canada	Representative country	Canada	Canada and United States of America	Canada	Canada	Canada	Canada
	Sources	NOV Norway AS (2014) and the NM Module (2014)	OECD Stan Rev. 3 (2005)	IMF WEO Database (2014) and World Bank Open Database (2014)	IMF WEO Database (2014)	Norway's Central Bank (2014)	OECD Stan Rev. 3 (2005)
China	Representative country	China	Japan and South Korea	China, Japan and South Korea	China	China, Japan and South Korea	China
	Sources	NOV Norway AS (2014) and the NM Module (2014)	OECD Stan Rev. 3 (2005)	IMF WEO Database (2014) and World Bank Open Database (2014)	IMF WEO Database (2014)	Norway's Central Bank (2014)	OECD Stan Rev. 3 (2005)
Denmark	Representative country	Denmark	Denmark	Denmark	Denmark	Denmark	Denmark
	Sources	NOV Norway AS (2014) and the NM Module (2014)	OECD Stan Rev. 3 (2005)	IMF WEO Database (2014) and World Bank Open Database (2014)	IMF WEO Database (2014)	Norway's Central Bank (2014)	OECD Stan Rev. 3 (2005)
Estonia	Representative country	Estonia	Estonia	Estonia	Estonia	Estonia	Estonia
	Sources	NOV Norway AS (2014) and the NM Module (2014)	OECD Stan Rev. 3 (2005)	IMF WEO Database (2014) and World Bank Open Database (2014)	IMF WEO Database (2014)	Norway's Central Bank (2014)	OECD Stan Rev. 3 (2005)
France	Representative country	France	Belgium, France and Germany	France	France	European Union (EURO)	France
	Sources	NOV Norway AS (2014) and the NM Module (2014)	OECD Stan Rev. 3 (2005)	IMF WEO Database (2014) and World Bank Open Database (2014)	IMF WEO Database (2014)	Norway's Central Bank (2014)	OECD Stan Rev. 3 (2005)
Germany	Representative country	Germany	Belgium, France and Germany	Germany	Germany	European Union (EURO)	Germany
	Sources	NOV Norway AS (2014) and the NM Module (2014)	OECD Stan Rev. 3 (2005)	IMF WEO Database (2014) and World Bank Open Database (2014)	IMF WEO Database (2014)	Norway's Central Bank (2014)	OECD Stan Rev. 3 (2005)
Netherlands	Representative country	Netherlands	Belgium and Netherlands	Netherlands	Netherlands	European Union (EURO)	Netherlands
	Sources	NOV Norway AS (2014) and the NM Module (2014)	OECD Stan Rev. 3 (2005)	IMF WEO Database (2014) and World Bank Open Database (2014)	IMF WEO Database (2014)	Norway's Central Bank (2014)	OECD Stan Rev. 3 (2005)
Poland	Representative country	Poland	Poland	Poland	Poland	Poland	Poland
	Sources	NOV Norway AS (2014) and the NM Module (2014)	OECD Stan Rev. 3 (2005)	IMF WEO Database (2014) and World Bank Open Database (2014)	IMF WEO Database (2014)	Norway's Central Bank (2014)	OECD Stan Rev. 3 (2005)
South Korea	Representative country	South Korea	South Korea	South Korea	South Korea	South Korea	South Korea
	Sources	NOV Norway AS (2014) and the NM Module (2014)	OECD Stan Rev. 3 (2005)	IMF WEO Database (2014) and World Bank Open Database (2014)	IMF WEO Database (2014)	Norway's Central Bank (2014)	OECD Stan Rev. 3 (2005)

Table 6-2: Overview over data sources applied for different countries and regions (2/2). Source: Menon (2014)

Country/Region		Purchase Data	Industry Key Relations	Macroeconomic Key Relations	Deflator Data	Exchange Rate Data	Input-Output Matrixes
Sweden		Sweden	Denmark	Denmark	Denmark	Denmark	Denmark
		NOV Norway AS (2014) and the NM Module (2014)	OECD Stan Rev. 3 (2005)	IMF WEO Database (2014) and World Bank Open Database (2014)	IMF WEO Database (2014)	Norway's Central Bank (2014)	OECD Stan Rev. 3 (2005)
United Kingdom	Representative country	United Kingdom	Belgium, France, United Kingdom and United States	United Kingdom	United Kingdom	United Kingdom	United Kingdom
	Sources	NOV Norway AS (2014) and the NM Module (2014)	OECD Stan Rev. 3 (2005)	IMF WEO Database (2014) and World Bank Open Database (2014)	IMF WEO Database (2014)	Norway's Central Bank (2014)	OECD Stan Rev. 3 (2005)
United States of America	Representative country	United States of America	United States of America	United States of America	United States of America	United States of America	United States of America
	Sources	NOV Norway AS (2014) and the NM Module (2014)	OECD Stan Rev. 3 (2005)	IMF WEO Database (2014) and World Bank Open Database (2014)	IMF WEO Database (2014)	Norway's Central Bank (2014)	OECD Stan Rev. 3 (2005)
Rest of Europe	Representative country	Rest of Europe	Austria, Belgium, Czech Republic, Finland, Greece, Italy, Slovenia, Sweden and Switzerland	Austria, Belgium, Czech Republic, Finland, Greece, Italy, Slovenia, Sweden and Switzerland	Austria, Belgium, Czech Republic, Finland, Greece, Ireland, Italy, Portugal, Spain, Sweden and Switzerland	European Union (EURO)	European Union (EU27)
	Sources	NOV Norway AS (2014) and the NM Module (2014)	OECD Stan Rev. 3 (2005)	IMF WEO Database (2014) and World Bank Open Database (2014)	IMF WEO Database (2014)	Norway's Central Bank (2014) and Oanda Currency Converter (2014)	OECD Stan Rev. 3 (2005)
Rest of Asia Countries	Representative country	Rest of Asia	Japan and South Korea	Japan, Malaysia and South Korea	Malaysia	Japan, Malaysia and South Korea	Taiwan
	Sources	NOV Norway AS (2014) and the NM Module (2014)	OECD Stan Rev. 3 (2005)	IMF WEO Database (2014) and World Bank Open Database (2014)	IMF WEO Database (2014)	Norway's Central Bank (2014)	OECD Stan Rev. 3 (2005)
Rest of the World	Representative country	Rest of the World	Brazil, Greece and Italy	Brazil and Mexico	Brazil and Mexico	Brazil and Mexico	Mexico
	Sources	NOV Norway AS (2014) and the NM Module (2014)	OECD Stan Rev. 3 (2005)	IMF WEO Database (2014) and World Bank Open Database (2014)	IMF WEO Database (2014)	Norway's Central Bank (2014)	OECD Stan Rev. 3 (2005)