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# **Backshoring Manufacturing – A Norwegian Perspective**

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## Preface

This thesis has been written to fulfil the graduation requirements the Entrepreneurship and Innovation program at the Norwegian University of Life Sciences. The writing was conducted between the end of January to May 2017. I'd like to thank everyone who contributed to my thesis, especially.

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## Abstract

Reallocation of manufacturing to Norway has become increasingly common in the past 3 years. This study has attempted to investigate the core motives behind the backshoring decision and which factors that account for a successful reallocation. In addition, study the potential of this phenomenon in Norway, both on a micro and macro level. This is done through case studies on Neuman Aluminium Raufoss, Hunton Fiber AS and Kleven Verft AS.

The study needs further quantified research, but it suggests that smart use of automation, the shortening of lead times and smart configuration of the supply chain are the main motives for backshoring. Furthermore, the research suggest that manufacturing firms do not backshore due to a failure to realize unexpected or hidden transaction costs, but because manufacturing technology is changing, allowing for new opportunities. It allows firms to quickly respond to dynamic markets, the operational flexibility of the firm, through a vertically integrated supply chain.

Furthermore, backshoring manufacturing require competence that may go beyond core competencies, to build and operate an automated manufacturing facility. Backshoring manufacturing companies are acquiring technological innovations to achieve their goal. Some have little experience with building a modern factory of industry 4.0, and are confronted with technical challenges and logistical iterations. However, the know-how is available to companies through open-R&D. This concept is widely used in Norwegian industrial clusters, establishing research institutions that share knowledge and collaborate with firms throughout the country.

The study differentiate itself from other research on backshoring, by focusing on non-strategic resources and automation, specifically the concept of industry 4.0. The ability for Norway to widen its industrial structure will be heavily dependent on infrastructure such as telecommunications, data centres, energy and transportation. In addition to an education system that is focused on digital competence. These factors will have an impact on to what degree Norway can operate as an attractive location for industry and a hub for international trade. This paper suggest that Norway handles these factors well, but the demand for infrastructure will increase with industry 4.0.

## Relevance

Outsourcing has been standard practice for many Norwegian firms in the past two decades, and many firms meet difficult and unforeseen challenges in the process. A Danish study from 2013, researchers found that firms manufacturing in high wage countries generally has the highest benefits in terms of cost (David Hummels, Rasmus Jørgensen et al. 2013). If this stands true for Norway, the chances are high for new opportunities. Backshoring is a heavily under-researched topic, particularly in Norway.

Backshoring is connected to both the geopolitics and economics. The study could be relevant for managers that are considering reshoring to Norway, to get a better understanding of the risks involved and the driving forces that determine a successful reallocation. It can also be relevant for regional or national legislators in determining possible changes that can accommodate Norway as a location for new industry.

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# 1. Introduction

## 1.1 The fourth industrial revolution

Since the late 1980s, most secondary-manufacturing industries in high-wage economies have been sourced to overseas subcontractors. Developed countries have experienced a rise in their competitive advantage in terms of productivity, as many manufacturers have begun to deploy novel automatic and robotic technologies. While manufacturing output has risen in the past decades, as expected, the global employment rate appears to have remained the same. In Norway, it is clear that productivity affects production output, as reshoring manufacturing from low-cost economies has become increasingly common (Stensvold 2016).

Industrialization began in the 1700s with the steam engine, followed by the mass production of steel and the introduction of moving assembly lines in the late 1800s, spurred by Henry Ford. The third industrial revolution is considered in relation to the introduction of the computer in the 1950s, having lasted until the Internet of things—the fourth industrial revolution.

However, Norway is not widely-considered as on the forefront of automation or mass production. According to the International Federation of Robotics, Norway has 47 robots for every 10,000 industry employees (Klingeberg 2017). In these respects, Norway is ranked 41st, while Sweden is ranked 4<sup>th</sup>, just behind Germany. Sverre Gootas of the Kongsberg Group (Klingeberg 2017) suggests that this is to be expected: Norway has a different industrial structure. Norway does not produce millions of identical products, but rather, small volumes of radically differentiated products. While this structure may not change, the technology which supports it will likely evolve. Within the structure of Norway's industries, flexibility and modularization reduce risk in terms of asset-specificity. Flexible robots will likely allow for efficient production of many different outputs, meaning the mass production of "one-of" products. Moreover, such robots are adaptable, allow for, for example, changes to a product to be made in accordance to specific customer requests (Stensvold 2016). This draws the basis of Industry 4.0.

## 1.2 Industry 4.0

The term "Industry 4.0" was first promoted by the German government (BMBF) in 2011 and has quickly become a widely-used to describe high-tech innovation strategies within manufacturing. It concerns achieving a new era of productivity through flexible mass production. New technology allows for increasingly flexible and modular robots through the integration of algorithms, big data, and artificial intelligence. The Internet of things allows for the distribution of information between a range of processes or factories, all monitored and controlled from a single point. This is called a "4.0 Factory" or a "Smart Factory".

While technologies change markets all the time, the gap between what is defined as *labour* and *capital* within intensive manufacturing is shrinking—a process which may reverse the course of globalization. Moreover, robotic technologies are becoming increasingly cost-effective.

A 4.0 Factory can include the following aspects (in short) (Cornelius Baur and Wee 2015, Sharma 2017):

1. Products made in production lines can be, to a higher degree, determined by the customer. It is easier to program machinery to modify products, including custom modifications, as opposed to standard modifications from a library.
2. The product can serve more functions. For example, a container of liquid with sensors that allow for automatic adjustments. Such information can include temperature, expiration, surveillance, chemical compositions, mass, density, coordination optimization, etc.
3. Production equipment and control systems can transfer information to suppliers (or others) to optimize the supply chain, process, products, or maintenance in parallel with production. This is also known as a “Learning Factory” and can involve training machines through neural networks.
4. The factory, or factories, can then share this neural information. The factory can also use stored and/or real-time data shared from other factories, hence the term “big data”.

Automation within manufacturing is a broad subject involving many different technologies and methods across a landscape of sectors. The Partnership for Robotics in Europe (SPARC) (SPARC 2015) has a valuable overview of the available technologies in their Multi-Annual Roadmap, Robotics 2020, released for the for EU’s innovation funding program, Horizon 2020. This document visualizes progress made within the field of robotics.

According to Walter Qvam of the Kongsberg Group, Norway is entering a new phase as an industrial nation (Qvam 2015). He describes it as Industry 6.0—the Norwegian response to Industry 4.0. Qvam suggests industrialization began with the Vikings, and Norway is currently at the vanguard of a sixth industrial revolution.

### 1.3 The problem, relevance and problem definition

This thesis studies the phenomenon of backshoring in Norway, the circumstances that leads firms to reallocate their manufacturing activities back to Norway. This phenomenon is known as reverse globalisation, which is strongly connected to a global progression within automation technology and the increasing pressure for firms to adapt in rapidly changing markets.

Since the 1960 until today, Norway has gone through a considerable change in economic wealth. During that period, new industries has come to exist, while other industries has been lost. And some industries have not existed in Norway at all. Economic wealth has made the cost of manufacturing in Norway higher, subsequently changing the know-how and the industrial composition. The conception is that managers must respond when faced with this change, often resulting in what is known as offshoring. Today however, we see a different, emerging trend, known as reverse globalisation. Some scientists see the core of this phenomenon as a change in productivity, where technology is transferable rather than bounded. This means that the phenomenon does not only extend to domestic backshoring high-wage countries, but also that domestic firms in low-wage countries will reallocate to high-wage countries (Pandya 2013). The core idea behind this thesis, and what I am attempting to do, is speculating in whether Norway has the know-how to transfer this technology. Furthermore, if this technology is applicable to the Norwegian industrial structure.

*Main Issue: What factors affect firms' decision to backshore their product manufacturing to Norway and what factors allows for backshoring to Norway?*

Underlying Issues:

*What is the potential for backshoring to Norway?*

*How can Norway become a better location for manufacturing?*

## 1.4 Concepts

### 1.4.1 Outsourcing and Offshoring

Outsourcing is a collaboration between two firms to meet a common goal. A company may externalize activities to fulfil long-term or short-term objectives. To outsource manufacturing, one systems coordinator takes control of the value chain of a product by distributing production across markets to a specialized subcontractor (Eliasson 2005). This is also known as vertical disintegration (Jerome Barthelemy and Quelin 2001).

While outsourcing has many connotations, it should be distinguished from offshoring (Arnbjørn and Mikkelsen 2014). When manufacturing is moved offshore, the control and ownership can remain in-house and/or be controlled by a supplier. As such, it is solely location-based. Captive offshoring means that control and ownership are kept in-house, while offshore outsourcing implies that an external foreign supplier is used (Kinkel and Maloca 2009).

### 1.4.2 Reshoring

The terms backshoring and backshoring are often vague, along with words like reshoring, onshoring, reversed globalisation, insourcing, and internal reconcentration.

In this thesis, reshoring (i.e. backshoring) is defined as a company reclaiming an activity that was previously exercised abroad (John V. Gray, Keith Skowronski et al. 2013). The term is fundamentally about location and has recently been recognized in relation to automation and internalizing manufacturing. While backsourcing is similar, it is associated with the *supplier* to whom a company previously outsourced activities—this supplier does not have to be located abroad.

According to Gray (John V. Gray, Keith Skowronski et al. 2013), there are four different scenarios for reshoring. First, in *in-house reshoring*, there are no suppliers. The offshore production facility is owned by the firm and the activities of the facility are returned to a domestically owned facility. The second scenario is *reshoring for outsourcing*, wherein the offshore production facility is owned by the firm, before the activities of the facility are outsourced to a domestic supplier. Third, *reshoring for insourcing*, involves offshored manufacturing activities that are outsourced or performed by supplier, and the activities of that supplier is returned to a domestic owned facility. The term “insourcing” has many connotations, but this thesis uses Gray’s definition, wherein insourcing means that a firm owns the manufacturing facility. Insourcing is not location dependent, meaning that a firm can insource the production to a non-domestic location. Finally, *outsourced reshoring* describes when activities are moved from an offshore supplier to a domestic supplier.

Kinkel defines *backshoring* as the reallocation of parts for production to a domestic site. While this is similar to reshoring, it is ultimately different—reshoring only involves location. Backshoring includes location, but also includes that reallocation is from both own foreign locations and not own foreign suppliers (Kinkel and Maloca 2009). Kinkel also defines two forms of backshoring: internal and external. *Internal backshoring* is when a firm’s ownership and control are kept in-house, meaning the firm owns the assets used to manufacture the product, but the asset’s production is sent from abroad. *External backshoring* refers to reshoring activities previously completed by a foreign outsourcing supplier.

Both outsourced reshoring and reshoring for insourcing are described by the terms backsourcing and external backshoring. Holz defines backsourcing as the return of production from an external foreign supplier (Holz 2009). While this implies that backsourcing is only related to the location and supplier, some definitions of backsourcing also involve ownership.

## 2. Theory's and literature

This section examines the reallocation of resources between firms by using transaction cost theory, resource-based view, and Porter's location theory. Moreover, an overview of research on backshoring is provided.

Note: This thesis examines the reshoring of manufacturing and not IT-services.

### 2.1.1 Transaction cost Theory

Transaction cost economics (TCE) (T. Russell Crook 2012), or communication costs, focus on transactions across markets and within firms, focusing on the decision to make or buy. A transaction cost is a cost that is included in the transaction itself, but excludes the cost of the product. These include bargaining costs, search costs (such as finding an outsourcing supplier), and policy costs. Williamson split the level of authority into three levels of authority, market, hybrid and hierarchy. In this thesis, we will focus on hybrid and hierarchical transactions. First is hybrid transactions, where resources are exchanged in the environment between two parties. This is often an outsourcing agreement where each party is responsible for their part, or activity, of/in the supply chain. Second is the hierarchical structure, where the supply chain is vertically integrated. If a firm is fully vertically integrated, they will have control of the entire supply chain from raw materials to the retailer, because the resources is managed within the organisation. The difference between the two structures are the level of incentives and the frequency of the transactions. In general, there will be more transactions costs when the firm is built up by a hybrid structure, i.e. outsourcing. In a hybrid structure, there are a certain amount of incentives depending on the degree of bilateral dependency between the two.

Williamson's theory of TCE suggests that an internal organisational structure, a hierarchy, is favourable to an external market/hybrid structure if three conditions are met: 1) The asset must be specific to the transaction; if an asset is highly specific, it has no value outside the firm, such as customized manufacturing equipment or employees with special training; 2) uncertainty around the transaction must be high— for example technological and volume uncertainty; and 3) the frequency of transactions must be high—such as production output. Williamson (1981) argues that asset specificity is the most crucial factor for favouring a hierarchy, while the effect of frequency and uncertainty has been inconclusive in later research (McIvor 2009).

There are three sources of transaction costs when it comes to TCT in terms of relations. First is relational uncertainty and the bounded rationality of the individual. The individual rationality is limited and cannot make a perfectly informed decision. One is limited when it comes to the amount

of information that one can process in a certain span of time. The environment is also limited to what information is available. The second factor is opportunism, which is connected to the dependency between the partners, the hold-up problem and the third factor of asset specificity (Steven Tadelis and Williamson 2010).

There are considerable risks when a partnership involves specific assets. Physical/tangible and dedicated assets are the two sub-types of asset specificity that are focused on in this thesis. Physical assets are tangible, such as machinery and buildings, while dedicated assets are the necessary investments a supplier must commit to, to meet the needs of the buyer.

Asset specificity in manufacturing depends on the products' changeover cost for the outsourcing partner. Asset specificity is high if the outsourcing partner must construct specialized equipment to manufacture the product. In such cases, depending on the outsourcing location volume, the marginal costs are likely higher than the cost of producing the product in-house. Asset specificity adds complexity to the transaction. Such outsourcing is more beneficial if the asset specificity of the manufacturing equipment is low, such as packaging, wherein the supplier's economies of scale are highly modularized.

It is necessary to clarify that a company can be vertically integrated and perform manufacturing in-house through an offshore activity if a third party does not own the facility or a specific part of the supply chain. In terms of contracts and opportunism, a hierarchical firm likely has better opportunities to monitor processes locally and has more control over internalized manufacturing through vertical integration (Tracy R. Lewis 1991). When vertically integrated, disputes can be solved within the firm, rather than needing to cancel or renegotiate contracts.

### 2.1.2 Real options

It is evident that insourcing often involves asset-specific investments with high capital intensity. This helps to protect core competencies and decrease opportunistic behaviour. In support of outsourcing, real options (RO) theory suggests that it is possible to adapt to the market uncertainty of an outsourcing agreement through interruptible contracts (Grayburn 2012).

One should separate RO flexibility from strategic flexibility. The former refers to contractual flexibility in terms of economics, while strategic operational flexibility is the ability to react to market changes, such as new trends and abnormal demands (Awwad 2007). These dimensions of flexibility could include the ability of manufacturing systems to change over time, to quickly alter products' attributes, or efficiently adapt to changes in demand.

### 2.1.3 Resource-based view

The *resource-based view* (RBV) is a strategic theory that examines why some firms and businesses are more profitable than others. It focuses on finding the source of a firm's sustained competitive advantage through the analysis of external opportunities, threats, internal strengths, and weaknesses. A firm's resources include its capabilities, assets, attributes, knowledge, and information, among other aspects. To achieve an advantage, resources must be valuable, rare, inimitable, and non-substitutable (Barney 1991). The RBV theory defines resources that are shared between one firm to another as internal and external resources. When attempting to achieve a competitive advantage through a partnership with a supplier, the firm must evaluate if they can access the external resources of the partner. To achieve a competitive advantage, the resources shall also be complementary, where the partner can substitute the firm's activities while also augmenting them. These resources include assets, such as manufacturing equipment and facilities, and intangible resources such as expertise or tacit knowledge. There is limited value to be gained if the firm cannot control or exploit the external resources of the supplier.

There may be highly qualified and low cost manufacturers in Asia, but there are challenges such as efficiently communicating and controlling the activities across cultures and borderlines.

### 2.1.4 Core competency and asset specificity

The RBV is suggesting that it is not beneficial to act upon activities without the know-how, stating that it could be an inefficient use of resources. As fields have become increasingly specialized alongside the evolution of technology, firms are often forced to choose between technology intensive development through R&D and employing specialized sub-contractors. In other words, firms that lack the internal capabilities or resources to complete specific activities may find it more profitable to outsource these tasks. However, activities concerning resources that hold a competitive advantage or focus on core competencies should remain in-house (McIvor 2009, Schepker, Oh et al. 2013).

In terms of transaction cost theory (TCT), firms tend to be more protective of opportunism when asset specificity is high as it tends to require long-term contracts (Hill 1990). Managers are limited by their bounded rationality when facing uncertainty. Firms resist collaboration because of fear of opportunism, consequently reducing their profits. However, firms tend to outsource specific assets if the density of the contract is sufficient (Jerome Barthelemy and Quelin 2001), allowing for a stronger bilateral dependency between the two partners. However, highly specific dedicated assets create more complications when disputes and changes occur, meaning that the adaptation costs are higher when the supplier owns the asset (Steven Tadelis and Williamson 2010). This is known as a hold-up

problem, which often occurs with low density contracts (Klein 1996). Highly complex governance structures require more comprehensive elaboration and provisions (Jerome Barthelemy and Quelin 2001), further reducing flexibility.

As can be seen above, the two theories cover important, but different, aspects of outsourcing. While TCT focus on opportunism and the complexity of contracts and RBV examines the use of crucial resources. While TCT will favour in-house manufacturing if the uncertainty around opportunism is high, Real Options favour outsourcing if the market uncertainty is high. It suggests that high capital investments are not favourable if the market demand is low.

An example of radical vertical disintegration is Boeing, having outsourced their Dreamliner components to several tiers of subcontractors. Boeing outsourced 70% of components for the new Dreamliner to shorten their production time and lower costs. Boeing did not have the technological competence to manufacture the entire plane internally. However, long-term contracts with a large number of subcontractors are costly to design, and even more costly to adapt and monitor. This was especially true for Boeing with hundreds of suppliers and subcontractors for the suppliers. Multiple alliance portfolios can eliminate much of the complexity involved in product development, but may also add complexity to transactions.

#### 2.1.5 The entrepreneur and sourcing decisions

Jong Chul Won analyses entrepreneurial theory and sourcing decisions by drawing a parallel to RO, RBV, and TCT (Won 2015). In relation to TCT and RO, Won notes that uncertainty is subjectively perceived, so different individuals or entrepreneurs, with unique experiences and cognitive behaviours, have diverse perspectives on future markets. Won suggests that entrepreneurs tend to choose outsourcing if their subjective perception of market uncertainty (real option flexibility) is high and asset specificity is low, in-line with the presented theory. The propositions become more exclusive when Won includes entrepreneurs' accommodation and assimilation of knowledge. Contributing opportunities are derived from divergent knowledge and concrete experiences, while innovative opportunities are derived from divergent knowledge and abstract concepts. Hence, opportunities that originate from direct experiences are more likely to contribute to improving a product. In contrast, Won argues that innovative opportunities are unrelated to a firm's current products, and therefore, entrepreneurs are hesitant to invest the necessary resources for in-house production. However, this is dependent on the characteristics of the resources and relates to RBV.

In relation to the RBV, Won states that the uniqueness and in-imitability of a resource is objective, while the value is subjective. It is about the entrepreneur's ability to configure and combine different resources to create opportunities. This suggests that entrepreneurs can create a sustained

competitive advantage by subjectively combining rare (but respectively invaluable) resources in heterogeneous ways. However, rare resources can be imitable or substitutable, regardless of the subjective combinations of entrepreneurial managers. Therefore, firms should turn to property rights in such situations, using methods other than insourcing.

This has some similarities to both the composition-based view (CBV) and Effectuation (Sarasvathy 2011).

Composition-based view is relatively new, 2015 (Yadong Luo and Child 2015). The theory neglects core competencies and resource advantages, and is more oriented around the entrepreneur. It is about being able to combine ordinary (valuable, yet imitable) resources in creative ways to quickly adapt to the market.

The CBV presents a strategy to obtain the ideal configuration and integration of resources through a compositional process. The organisational part of the theory focus on compositional capabilities and network competence. The theory explicitly mention firms that lacks an in-house R&D resource, but develops flexible and adaptive production through external resources such as industrial clusters.

#### 2.1.6 Porter's diamond theory – Non-strategic resources

Location theory plays an important role in explaining the link between company performance and manufacturing abroad. While TCE, RBV, and RO support outsourcing, they do not sufficiently promote offshoring, wherein companies own factories abroad.

Porter's location theory allows for determining if manufacturing in Norway, can have a competitive advantage over the global competition. The theory does not examine reallocation, but rather focuses on why Norway is suited for industries in which its firms operate.

Porter's diamond theory is based on Adam Smith's classical model which suggests that countries profit from their ability to export goods with an absolute cost advantage, while countries that import these goods have a cost disadvantage (Smit 2010). This theory largely concerns converting national advantages into international advantages with the perception that trade is a positive sum game in which natural resources play a major role.

Michael Porter extended this notion by introducing the diamond theory in the 1990s (Porter 1990). With it, he addresses why companies exist within certain nations, and how nations acquire a competitive advantage in particular industries. National competitive advantage is a country's productivity level as governed by a set of factors.

## Determinants of National Competitive Advantage

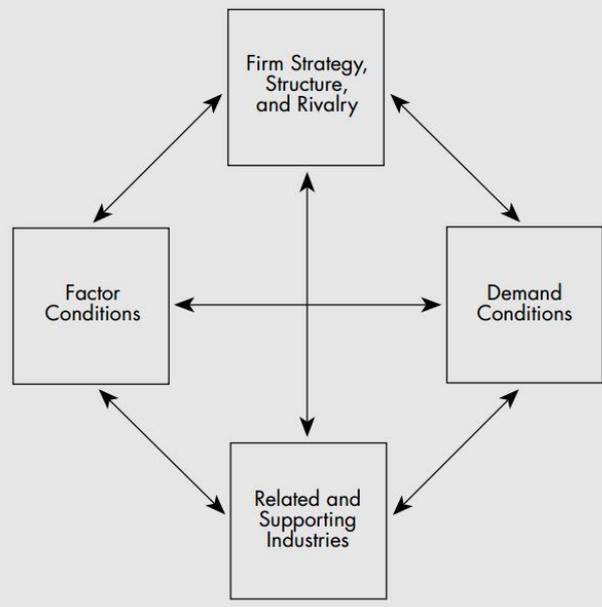


Figure 1: Porter's Diamond Theory (Porter 1990).

**Factor conditions** represent the nation's endowments/resources, such as natural resources, land, and infrastructure. It also concerns a nation's labour skills and technological base. Porter argues that a nation does not inherit, but creates these resources.

**Demand conditions** mean that, for a product, nations gain an advantage when the local demand is higher than in foreign markets. Firms tend to localize where customer segments are large to minimize negative effects on the supply chain. They have an advantage when exporting products from regions in which larger customer bases are located.

The presence of **related and supporting industries** strengthens local competitiveness and generates pressure to innovate. Thus, local firms have a competitive advantage over international firms that wish to enter the local market. Norway ranks 48th in terms of the intensity of local competition per country.

**Firm strategy, structure, and rivalry** concern a nation's business culture. In Norway, the structures of businesses are often flat, whereas in Japan and Singapore, structures are more hierarchical. Porter proposed that these factors are relevant to the industry in which a nation's companies excel. Domestic rivalry forces companies to be more competitive, though this depends on the nation. Porter uses Japan as an example, noting that in 1990, 112 companies competed in the manufacturing of machining tools. Porter argues in his 5 forces model that while companies generally do not prefer intense rivalry, it's presence is overall beneficial, as companies are pushed to

be more efficient and to innovate (Porter 1985). Low domestic rivalry may have a negative effect on quality and may push a nation towards oligarchy.

## 2.2 Quantitative studies on backshoring

The reshoring of manufacturing is an under-researched topic, though the phenomenon has been around for a long time. Moreover, its prevalence has increased in the past years. This quantitative research shows which types of variables that could affect the reshoring decision. However, there is only minor research on Norway even if one could argue that some variables are universal with higher-cost economies in Europe.

### How rare is reshoring?

The European Manufacturing Survey (EMS) collected data from more than 3,500 firms across 13 European countries (Dachs and Zanker (Bernard Dachs and Zanker 2014)). The survey reveals that 4% of all firms backshored their production from 2010 to mid-2012. Reshoring is generally rare in Europe, as the ratio between reshoring and offshoring firms is 1:3, and the number of reshoring firms has decreased by 0.6% since the previous EMS which concerned 2007–2009. While the latest study is from 2012, the increased media coverage of reshoring is more recent.

A similar study was conducted in Denmark by Arlbjørn. Only 17 of the 843 companies in the sample had backshored, while 68 had backsourced. This could be an indication that external backshoring (or backsourcing) is more prevalent than internal backshoring (68:17), as can be seen in Arlbjørns sample of Danish companies (Jan Stentoft Arlbjørn, Teit Luthje et al. 2013).

### Company size

The EMS shows that medium-large sized companies are more likely to reshore. Moreover, Arlbjørn's research on 68 backsourcing companies in Denmark supports this theory (Jan Stentoft Arlbjørn, Teit Luthje et al. 2013). This may be because large companies often have multiple facilities abroad and tend to move towards vertical integration once they reach economies of scale. Furthermore, larger companies are more likely to make efficient use of automation (Angela Jäger, Cornelius Moll et al. 2012).

### Sectors, batch sizes and product complexity

Presumably, reshoring is more prevalent in certain sectors, but there are no clear patterns and it is rare across almost all sectors. The 2012 EMS and Bernard Dach (2014) show that the only sectors with a higher propensity to backshore are manufacturers of rubber products and chemical production. The chemical sector is well-known as a highly automated and capital intensive sector (Bernard Dachs and Zanker 2014). However, according to Fratocchi, there is no substantial evidence

that reshoring is more prevalent in capital-intensive activities than in labour-intensive activities (Fratocchi, Di Mauro et al. 2014) (Luciano Fratocchi, Guido Nassimbeni et al. 2011).

Dach's research, coupled with the EMS, suggest that backshoring is less prevalent in low-technology sectors and more frequent in high-technology industries. Technology intensity (Science 2011) is essentially R&D intensity, or R&D costs in an industry sector. Low-technology sectors include brick, glass, and textile manufacturing—often produced in large batches. Research on 1,663 companies in Germany by Steffen Kinkel supports this (also based on the EMS), finding that offshoring is more prevalent for companies manufacturing large batches of standardized economies of scale products. This implies that firms tend to be more hesitant to offshore customer-specific products (Kinkel and Maloca 2009). Arlbjørn's research arrives at the same conclusion, but also suggests that small companies are more likely to backshore customer specific products. SMEs might outsource until they have the necessary resources and become established enough to invest in specific capital-intensive assets.

Furthermore, a study by the European parliamentary research service (EPRS) suggests that heavy machinery manufacturing is more likely to be reshored (Needham 2014) due to added transportation costs.

In conclusion, offshore outsourcing large batches of standardized or general products is expectedly more prevalent, as these products are available in economies of scale from low-cost regions, while reshoring patterns are more difficult to discover.

### 2.3 Literature on the decision to backshore

This section details additional factors that can affect backshoring decisions. It is necessary to distinguish among different low-cost economies, particularly China, as their characteristics can differ. Dach's assessment of the 2012 EMS (coordinated by Fraunhofer) will be used as the underlying basis in this section. It shows that around 150 of more than 3,500 companies, in 13 countries, backshored their production. The empirical overview includes the primary motivations as to why the companies chose to backshore (Bernard Dachs and Zanker 2014).

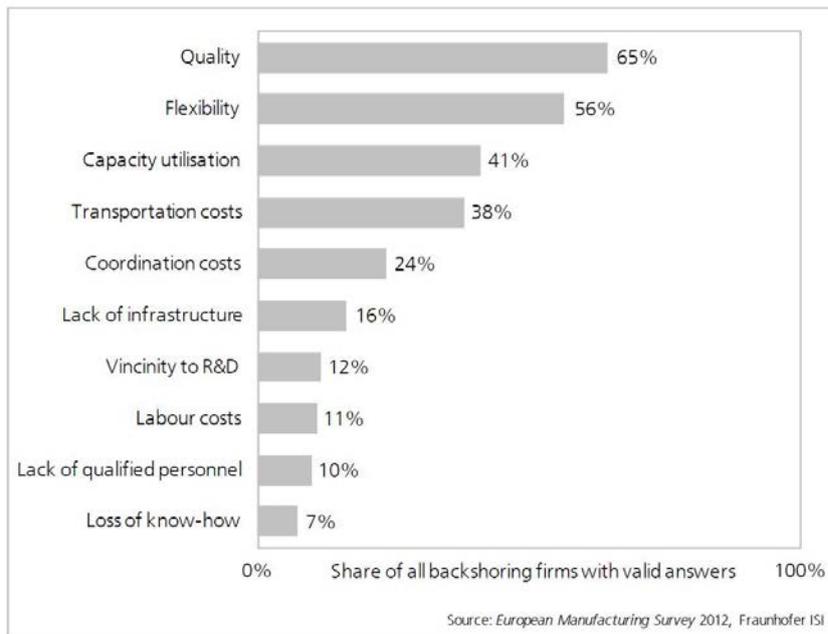


Figure 2: Motivations for backshoring manufacturing (Bernard Dachs and Zanker 2014).

#### Costs

##### Automation

Automating manufacturing is seen as a way to boost productivity by reducing changeover times and labor costs. Even though this is not mentioned in the table above, this is often seen as the primary reason for backshoring judging by the companies studied in Norway. Technological development is starting to affect the efficiency of manual labour, diminishing the influence of wages when it comes to the location decision, allowing lead times, operational flexibility and skilled labour to have a more significant impact.

Jaeger's assessment of the 2012 EMS shows that European manufacturing companies using automation become more efficient and see increases in their productivity compared to non-users (Angela Jäger, Cornelius Moll et al. 2012), suggesting the use of robotics is well-suited to achieving economies of scale. The research also states that a higher degree of vertical integration in automated manufacturing firms allows for a higher degree of total productivity due to technological

progression in the field of robotics. This contradicts the RBV theory concerning outsourcing non-core competencies. Suggesting that companies with higher control over their production will obtain a more efficient use of their resources than those who outsource their non-core activities.

As automation is capital intensive, the entry barrier is high. As such, often only large companies can automate manufacturing (Angela Jäger, Cornelius Moll et al. 2012). However, the entry barrier is more easily overcome as the cost of robotics has decreased by 40-50% since 1990, according to McKinsey (Economist 2013). In 2014, robotic sales increased worldwide by 29% compared to 2013 (Bram Timmermans, Sissel Strickert et al. 2016). The EMS also states that small companies that use robotics achieve higher productivity, flexibility, and production quality. Furthermore, Arlbjørn's research suggests that small companies may backshore as "an opportunity to automate", while larger companies focus on changeover times and logistics.

A study conducted by Agder Research in 2015 examined automation activities and sourcing decisions in Agder business clusters, focusing on Industry 4.0 (Bram Timmermans, Sissel Strickert et al. 2016). They examined 37 companies, of which 7 had backshored and 12 had offshored. However, 3 of the 12 companies that offshored had already backshored their manufacturing to Norway, as of 2016, according to an article by Teknisk Ukeblad (Stensvold 2016). Three of the seven firms that reshored stated that the automation of domestic production was very important. While six of the seven firms stated that total costs were important or very important for the reshoring decision.

The study attempted to compare this with their level of automation, but only 4 of the total 37 companies that responded stated that they used medium to high levels of automation in their processes. Moreover, only 8–10 of the 37 companies stated that they used industrial robots, most of which were large companies. These 37 companies had 125 industrial robots all together, but more than 80% belonged to the same firm. While the data generally varied as to why companies invested in automation, an overwhelming majority (27 of 36) did it to reduce marginal costs.

### Wages and productivity

When it comes to popular offshoring destinations, China has become different in terms of wages, productivity, and competency compared to other low-cost economies. Manufacturing wages in China have risen rapidly, at an average of 12% annually since 2001 (Tate, Ellram et al. 2014, Economist 2015). Moreover, the country's manufacturing is also becoming more efficient. China is also experiencing a shortage of skilled labor (Tate, Ellram et al. 2014), an aspect negatively correlated with labor productivity (Angela Jäger, Cornelius Moll et al. 2012). This has likely resulted in further automation. Companies such as Foxconn are moving towards automation (Klingeberg 2017) and planning to downsize to a minimum of workers. The total cost of production in China has

increased three-fold since 2008 according to Knut E. Sunde (Sunde 2017).

To better understand this phenomenon, it is necessary to examine the relationship between productivity and labour costs. A worker in a low-cost economy may have a wage 10 times lower than a Norwegian worker. However, production in Norway is likely to be more mechanized, so one worker can produce units at a higher rate. In 2014, the *Economist* examined how popular outsourcing destinations are expected to change in terms of productivity and wages, see *figure 3* (Unit 2014).

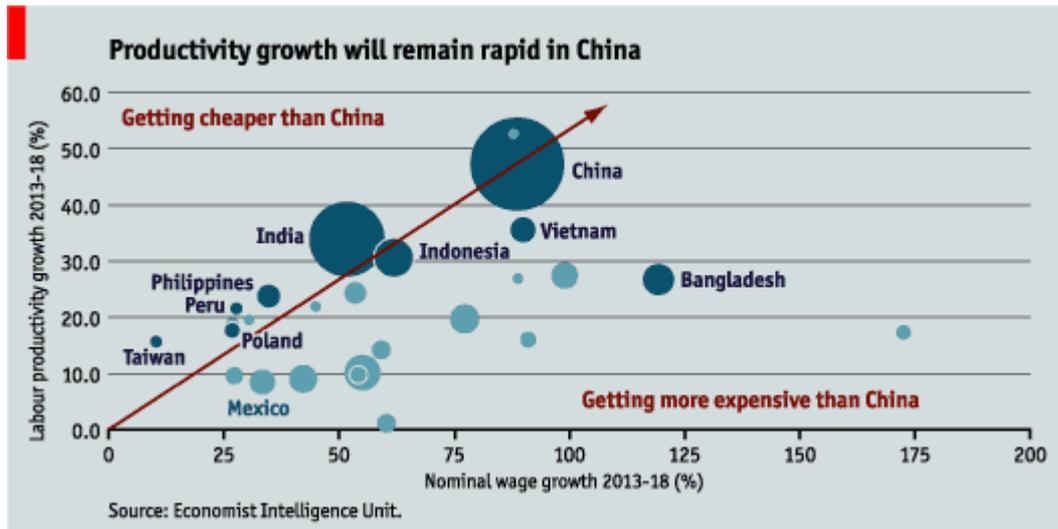


Figure 3: Productivity vs wage, *The Economist* (Unit 2014).

While China appears to be an ideal offshoring destination in relation to productivity and wages, the *Economist* suggests that it is important to include additional factors, such as infrastructure and market risks. Including these factors shows that popular Norwegian offshoring destinations, such as Poland, are also desirable.

As can be seen through Bach's study (*figure 2*), the smaller wage gap between industrialized and low-cost countries is not a major factor for backshoring. Hongyi Sun compared Norwegian quality management practices with Shanghai in 2000. He notes that Chinese manufacturing firms had roughly the same unit cost as Norway when they manufactured products with equal quality standards (Sun 2000).

### Exchange rates

Exchange rates can add considerable uncertainty to costs. For example, the Chinese yuan was worth 0.8 NOK in 2006, rising to 1.21 NOK in 2016 (Norges Bank).

## Protectionism

One factor that argues against backshoring is the current political landscape in North America and Europe, leaning towards anti-globalisation. Free trade agreements such as the Trans Specific Partnership (TPP), Transatlantic Trade and Investment Partnership (TTIP (Regjeringen 2016)) and the North American Free Trade Agreement (NAFTA (NAFTA)) is under heavy debate. This may be for good reason in countries where many has lost their jobs because of outsourcing. However, it is not an advantage for a small country like Norway, with a small local market, being heavily dependent on the global export of goods. If a country adds higher tariffs to imports, it will be more challenging to overcome the domestic competition in that location. This forces firms to produce goods within the state lines of where the market is located.

Norway is a member of the World Trade Organisation and a part of the European Economic Area agreement (EEA) with the EU (Regjeringen 2016). In addition, Norway are in more than 40 bilateral free trade agreements, some through EEA, including Hong Kong, but not China. Norway are currently negotiating new trade agreements with China (not including Hong Kong) and the relationship issues with China are normalized (Kolstadbråten 12.2016).

Norway will also be a part of TTIP between EEA and the US, unless the negotiations are cancelled.

## Capital Ties

Some companies argue that backshoring a wholly owned factory can be a disposal of useful resources, they own assets with high specificity abroad. It is better to put them in good use if there is no resale value, rather than disposing them and building a new domestic factory.

## **Strategic and Relational**

### Core competency and control

When manufacturing takes place abroad, production and jobs are not the only elements that are transferred, but also technology, and possibly know-how. It is difficult to find skilled labor in some industrialized countries as specific manufacturing know-how has been passed on to low-cost economies (Needham 2014).

Competencies, sometimes implicit, must be shared in an outsourcing relationship so both partners can collaborate with a common knowledge base (Karin Širec and Miroslav Rebernik 2012). As discussed in RBV theory, there are risks involved in such a process, including detachment from core competencies and the risk of opportunism.

## Quality control

*Quality* refers to a customer's experience of a product. According to TCT, monitoring opportunism in relation to the quality of products overseas can be costly (McIvor 2009). Moreover, almost all studies done on backshoring suggest that quality is a major factor (Kinkel and Maloca 2009, Jan Stentoft Arlbjørn, Teit Luthje et al. 2013, Bernard Dachs and Zanker 2014, Fratocchi, Di Mauro et al. 2014).

## Lead times and operational flexibility - Dynamic capabilities

A firm's ability to quickly react to external changes, develop, and distribute products are typically affected by distances in the supply chain.

Operational flexibility is the manufacturers ability to quickly react to changes in market demand and to adjust their product mix (changeover times) without sacrificing cost (Raghav Narsalay, Aarohi Sen et al. 2016). Both rationality and control affect this, such as time differences, holidays, local policies, culture, and language barriers effectively add to lead times and coordination costs. Flexibility (operational) is the second most important factor for backshoring, according to the EMS. Arlbjørn's study support this, wherein 79% of companies in Denmark that backshored externally found flexibility to be important for their decision. Arlbjørn's study also found that long lead-times are one of the main reasons for backshoring to Denmark.

Vertical integration and reducing physical distances between activities in the supply chain can have a major impact on response times. According to a study by EPRS, companies that manufacture goods that are subject to dynamic consumer demand are more likely to backshore due to reduced lead-times (Needham 2014). It is important to consider whether demand fluctuates in unpredictable patterns when making a sourcing decision.

The EMS shows that vicinity to R&D is not a deciding factor. To clarify, most companies run R&D locally, while outsourcing manufacturing. One could assume that having R&D and manufacturing vertically integrated in the same location cluster would boost both flexibility and lead times.

## **Non-strategic**

### Infrastructure and transportation costs: Hidden competition

Infrastructure is highly related to the cost of wages, land, skilled labor, and time to market. While inland China and other low-cost areas may have lower wages than coastal cities, like Shanghai or Shenzhen, the lack of infrastructure in less developed regions can become costly (Wendy L. Tate, Lisa M. Ellram et al. 2013). Infrastructure has a major impact on the length of the supply chain. Even though China has a large population and educated labor can be found in inland China, the infrastructure in this region is lacking. Shanghai does not have as much available skilled labor as in

inland China, though they have higher wages. This is likely because working there is unsustainable due to the high cost of living, including housing. Ellram and Tate focus on the importance of non-strategic resources, such as infrastructure, comparing factor market rivalry (FMR) to the RBV (Wendy L. Tate, Lisa M. Ellram et al. 2013). The FMR theory explains how companies compete for the same resources, even if they are not direct competitors. This includes competition for market factors necessary for production, such as skilled labor, land, raw materials, and infrastructure.

#### Environmental

Slow steaming is noteworthy when it comes to shipping (Tate, Ellram et al. 2014). This is a technique shipping companies used to lower shipping costs and emissions, by sailing at a significantly lower speed. Consequently, the shipping of goods become significantly slower. However, this trend is turning around, due to low oil prices reducing the impact on cost (Stensvold 2015).

#### 2.4 Research questions

There is one factor that separate this thesis from other studies – The strong focus on non-strategic resources and the competitive advantages of a nation. This could be a logical decision because the problem and main issue is directed towards Norway and not backshoring in general.

*Figure 2* shows that some of the main reasons for backshoring originates from factors such as quality, flexibility (operational) and transportation costs. However, there is not much research on what drives these issues from a management perspective. Are the backshoring decisions mainly driven by unexpected or hidden problems with quality, costs and flexibility? Or, has changes such as technological progress within automation and location factor changes between country lines presented more domestic opportunities regarding these factors?

While the research above focus on Europe, almost none of them factor in Norway specifically, except Agder Research (Bram Timmermans, Sissel Strickert et al. 2016). Another question is to what degree these factors apply to Norway?

### 3. Norway: Porter

This chapter will study Norway's position as an industrial location based on Porter's diamond theory. Although the PESTEL analysis seemed more fitting for including the technological aspect, such as automation and R&D, it seemed more suited analysing a specific market with respect to an organisation rather than a country.

So, what makes Norway attractive as an industrial location? There is an oil industry in Norway because we have oil, but the same may not be easily argued for all manufacturing firms. The underlying question is why a firm that is made, rather than born, would reallocate to Norway.

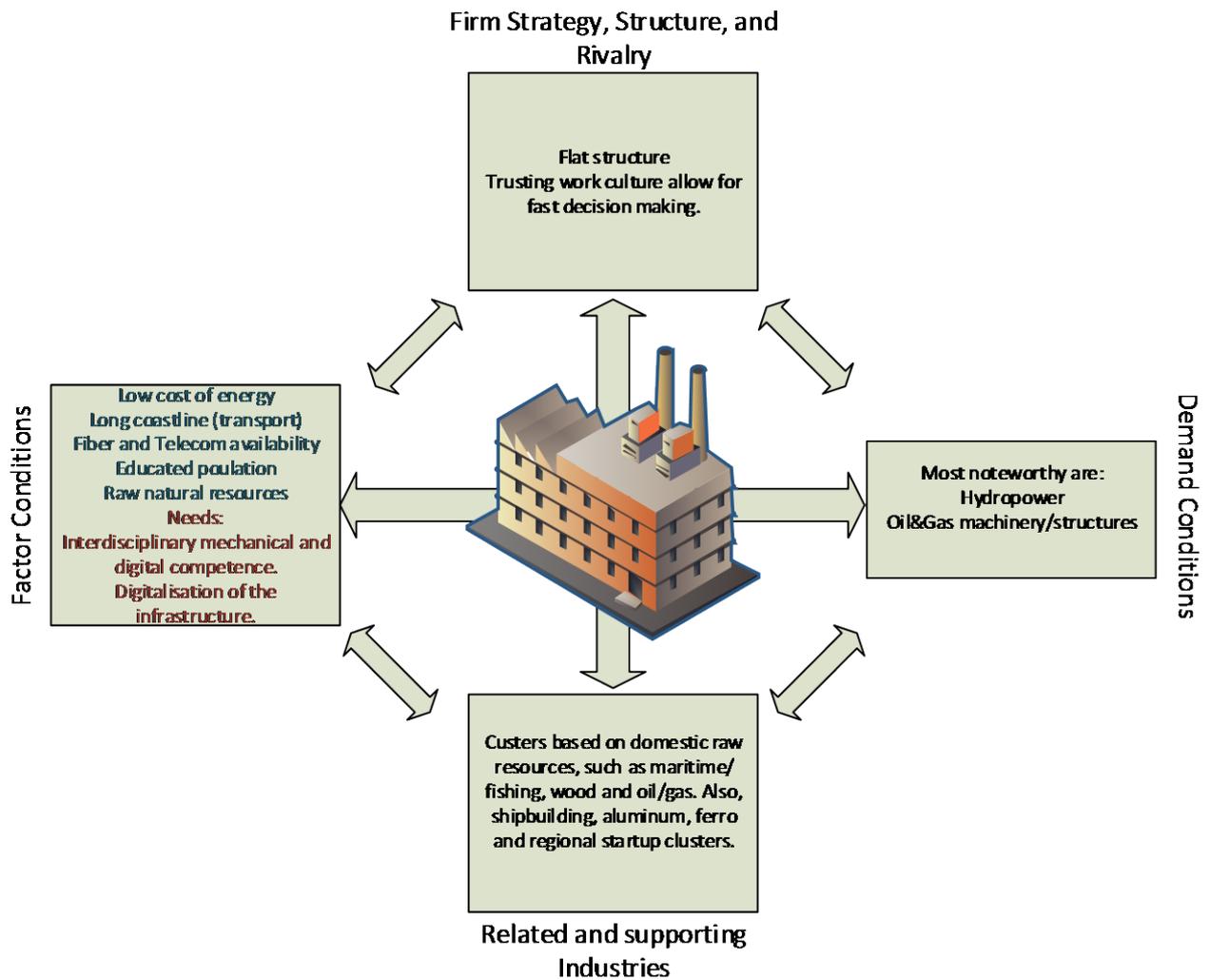


Figure 4: Norway's determinants for a national competitive advantage (Made in Visio).

## Factor Conditions

### 3.1 Energy costs in Norway: The new cost of labour

Norway's unique potential for industrial growth within energy demanding manufacturing or large scale manufacturing (Barbara Breitschopf, Katharina Grave et al. 2016) is well-known. Norway not only has a surplus of low-cost energy, but also in terms of climate change, where 98% of power production in Norway is renewable (Regjeringen 2014). Of Norway's net energy consumption, 29% consists of power-intensive manufacturing (Barbara Breitschopf, Katharina Grave et al. 2016).

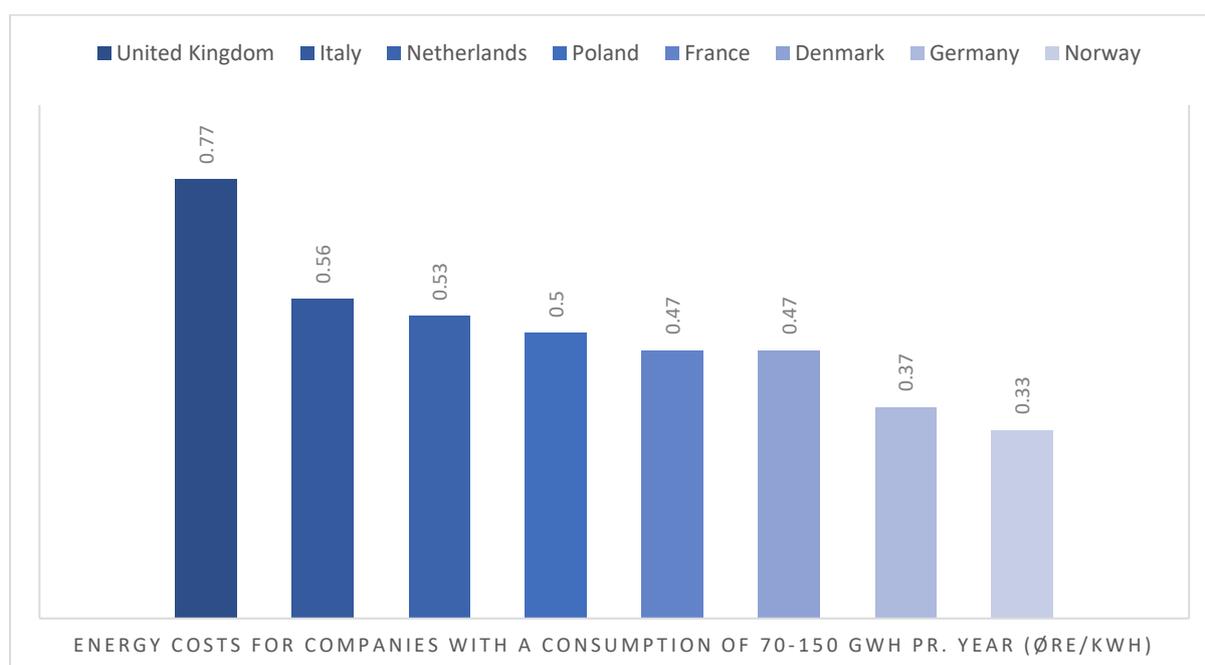


Figure 5: Cost of energy without taxes (Eurostat 2016 (Eurostat)).

Figure X shows the cost of energy without taxes, for energy intensive industry consumers. Energy-intensive industries in Norway tend to secure low energy prices through long-term contracts. They are also exempt from paying electricity fees (Skattedirektoratet 2016). In Norway, there are no taxes and levies for large electricity consumers that follow standards to continuously reduce their consumption.

Many energy demanding factories are centralized in Norway because of the low levelized cost of energy (LCOE), one example is aluminium and ferrosilicon plants. Aluminum comes from bauxite, which is mined in tropical areas, such as Brasil, and ferrosilicium comes from silica, which is extracted from sand mines. The primary materials are not mined in Norway, but sent there for processing, as it requires a high amount of energy to extract the raw materials (Tjøtta 2016). Norway is the fifth largest producer of primary aluminium in the world, with at around seven aluminium plants in Norway (Regjeringen 2000). BerryAlloc and Neuman Aluminium, two factories which

produce aluminium end products that moved their manufacturing to Norway from China in 2016 (Sunde 2017).

As more factories reach an increase in their productivity, the cost of energy will be more important as the cost of labour fades (Berger 2015). This is very dependent on government policies, as energy costs often change. This variation in cost is predominantly due to powerlines being built between Norway and Europe (Lien 2014).

Norway also ranks first in terms of electricity output per capita according to the Global Innovation Index (Index 2016). The amount of power generated pr. capita.

### 3.2 Education

Reshoring for insourcing (John V. Gray, Keith Skowronski et al. 2013) involves retrieving previously offshored competencies and building on them. This can be challenging for firms (Kinkel 2014). From a macro perspective, Norway has a highly-educated and qualified population to tackle the challenges of a digital future (Klingeberg 2017). A cybernetics study at the Norwegian University of Science and Technology (NTNU) is collaborating with Kongsberg (Universitetsavisa.no 2015) and financing a new professorship to meet the growing demand for digital expertise. It will be the first professorship in the world concerning big data cybernetics.

There are also a range of projects from both the public and private sector, such as SFI Manufacturing and Future Robotics Agder, aimed to increase competence within manufacturing technology. These projects are related to the concept of open-R&D, which is something we will come back to in chapter 6.

Norway ranks fourth in employment of knowledge intensive services according to the Global Innovation Index (Index 2016).

### 3.3 Infrastructure

Norway has a mountainous terrain, making the road network large and complex. It also has an extensive coastline with a large network of ports. Norway ranks seventh in the world in terms of logistics performance, according to the Global Innovation Index. However, according to Morten Thorkildsen, there are many challenges ahead and infrastructure is the most important factor for industrial growth in Norway (Thorkildsen 2017). Given that the digitalization of infrastructure will be key to meeting the demands of Industry 4.0, Norway is in the process of digitally upgrading the signal systems for railroads, allowing for more efficient transportation.

## Related and Supporting Industries

### 3.4 Government and business clusters

The Norwegian government released Industrimeldingen in April 2017, representing the Norwegian government's industrial priorities. The 2017 vision is that Norway shall be a leading industry and technology nation (Regjeringen 2017). The main theme this year was climate emissions, exchange of expertise between industries and advanced forms of production. The government strategy is to reduce dependency to the oil&gas sector and convert this know-how to new industries, focusing on innovative production methods. It includes an acknowledgment of the new backshoring trend of backshoring from low-cost countries. It states that digitalization and automation of manufacturing, in addition to more efficient transportation and communication across country lines, will make more businesses return eventually. To boost this trend, the Norwegian Government will develop a global growth investment program established in 2013, it is called Invest in Norway (IIN). The main purpose of this program is to promote and position Norway as an attractive country for businesses abroad, including foreign companies. Norway has strong support from government agencies, funding research and innovation. One of the agencies are Norwegian Innovation Clusters that has started projects to support cooperation based development activities, such as the Norwegian Centres of Expertise (NCE)(Expertise). Funding agencies such as Innovation Norway are also supporting the export and internationalization opportunities, which is important as many offshore businesses has a foreign customer base.

## Firm Strategy, structure and Rivalry

### 3.5 Innovation

Runar Nordby of Tronrud Engineering stated to *Teknisk Ukeblad* that the flat Norwegian model will be an important advantage in implementing the potential of intelligent robotics (Stensvold 2016). A flat and informal organizational structure means that the management levels are relatively compressed (Marco Semini, Håvard Brekken et al. 2016). This often means that a manager can receive feedback from multiple people within an organisation, resulting in both a wider span of control and a shorter chain of command. This means that a flat organization often listens to the average employee, making them feel responsible for the success of the company. It also means that decisions are made more quickly, as they do not need approval from different management levels and in turn increasing innovation.

Siemens and Norsk Industri arranged a competition for “the smartest industry firm in Norway”, determining the winner based on their use of new technology and innovation (Stensvold 2015). The

finalists included the backshoring company Kleven Verft and the gas container manufacturer Hexagon Ragasco in Raufoss. The winner was Hexagon Ragasco given their strategy to involve all employees on every level through feedback. Employees can write messages with suggestions every day before they leave work which are then evaluated by 10 processing engineers every morning. Considering that the company has roughly 70 employees, it is clear that substantial attention is given to feedback.

The labour productivity in Norway is ranked among the top three countries, being third in 2015 and first in 2013 according to the global Conference Board (Board 2016), and first according to Bloomberg (Jamrisko 2016). This is usually calculated through the Gross Domestic Product (GDP) per employee hour worked, although this measurement could be somewhat biased by the location given factor conditions such as the abundance of natural resources. We can assume that high productivity results in a higher value creation, but not that employee's in Norway are more efficient through innovative measures. In most charts, Norway ranks relatively low when it comes to Innovation, including the global innovation index. South Korea is ranked as number one in the Bloomberg Innovation chart, mainly because of their high manufacturing value-added (manufacturing as a percentage of GDP), a measure where the production of raw-materials is taken out of the equation. During the writing of this thesis, I visited the Samsung semiconductor plant in Hwasung, an area outside Seoul. According to an employee in the strategy marketing team, Samsung is highly vertically integrated, outsourcing less than 10% of their total production, domestically manufacturing all R&D-intensive core-products. As previously stated, South Korea has the highest number of robots pr. capita.

### 3.6 The Industrial structure

New trends force companies to make quick, and sometimes radical, adjustments to their products to meet customers' needs. This is an important aspect of Industry 4.0, because it allows even one-off items (items that are produced and sold only once) to be profitable (Gandhi 2015). As discussed, Norway's industrial culture is based on small volumes and items that are highly-specific to the customer. Moreover, according to Teknologirådet, the demand for such products is rising (Teknologirådet 2013). However, such adaptive automation is dependent on Norway's ability to be at the forefront of infrastructure development and education.

### 3.7 Politics

The politics of robotics have also been a controversial topic in Norwegian media recently. The Norwegian government has expressed concern regarding the relation between taxation and automation, as most taxes originate from workers (Sterri 2017). After a proposal by Bill Gates that

robots should be taxed, the Green Party in Norway followed suit. The underlying question is whether it may be valuable to work against implementing efficient technologies.

For the current study, it is important to distinguish between the service sector and the manufacturing sector. In terms of policy in Norway, robots may impact transportation services, as with the possibility of driverless trains. While automation may ultimately contribute to jobs in manufacturing, automation within the service sector may have a more negative impact on employment. The tax commission in Norway is still working on what is defined as a robot.

Looking at manufacturing robotics, a study by IFR looking at Japan, Korea, the USA, and Germany shows that robotics has a negative impact on employment in developed countries (Peter Gorle and Clive 2013). It is possible to consider Norway separately, as the mass production of products has never been a part of the Norwegian industrial culture, with the exception of raw materials. In other words, Norway did not lose factories during the outsourcing era in the same scale as these countries. In some ways, automation can be viewed as an opportunity to bring new industries to Norway. However, this opportunity likely depends on regulations, such as a robotics tax.

## 4. Methodology

This is a qualitative study of companies that backshored their manufacturing to Norway. Semi-structured interviews will be conducted.

### 4.1 Research plan

This thesis uses a qualitative method to determine *what* causes a firm to backshore to Norway, and *how* and *why* they do so (Asbjørn Johannessen, Line Christoffersen et al. 2011). The study consists of three case studies on companies that have both back-sourced and backshored. These are cross-sectional, in-depth, exploratory case studies of a phenomenon that, while not new, but could soon potentially become more frequent.

The study will examine strategic and economic factors that influence the back-shoring decision. While strategic resources may explore why a particular company chose to backshore, they may not provide as deep insight into why companies backshore to Norway. Subsequently, this study sheds light on non-strategic macro-resources such as education and infrastructure.

### 4.2 Design

The research will be conducted through multi-case studies (Asbjørn Johannessen, Line Christoffersen et al. 2011), using data from interviews and literature. This data will be interpreted based on both classical economical and strategic theories and direct quantitative research on the phenomenon of backshoring.

A case study is *descriptive*, analysing a phenomenon to reveal occurrences, without necessarily explaining why they occur (Asbjørn Johannessen, Line Christoffersen et al. 2011). As shown, is a high number of variables affecting the motives behind a backshoring decision, hence this study will attempt to *describe*, in detail, the quantified research presented in this chapter.

In addition, it will attempt to *explore* new factors or phenomenon's that could be the basis for the backshoring decision. The study is *exploratory* by investigating backshoring in relation to non-strategic and abstract factors such as infrastructure and culture. This study is *explorative* based on Porter's location theory specifically, because the amount of quantitative research on backshoring in *Norway*, is minimal to non-existent. Especially in comparison to other countries in Europe. As such, examining location-based resources can hopefully reveal variables that could potentially create a foundation for more *extensive* studies.

The selection is of the *intensive* design because the main analysis consists of only a few companies. A comprehensive analysis of three companies that investigates a broad range of both micro and macro factors influencing the phenomenon.

Furthermore, all three cases are cross-sectional studies, meaning that the observations are done at a single point in time. Some companies have completed the backshoring, while others are in the process of backshoring. It will also be in retrospective, where the data is the reminiscence and the current interpretations of whom is interviewed.

### 4.3 The framework

The concept of analysis will be the *decision* of why these companies chose to backshore. The *decision* is split into four categories; Relational and economic, strategic, and non-strategic. The questions will mostly be analysing the company's micro level, but there will also be some macro questions considering Norway as a location. The selected companies will be both mass producing and one-of manufacturers, within different sectors.

Category	Reshoring for insourcing	In-house reshoring	Outsourcing	Offshoring (wholly owned)
<b>Relational</b>	-Hold-up problems if switching sub-supplier base	-Hold-up problems if switching sub-supplier base	-Contractual hazards	-Culture barriers -Time zones
<b>Costs</b>	-Impact of capital investment	-Impact of capital investment	-Unexpected transaction costs -Market uncertainty -Transportation costs	-Transportation costs -Local policies -Wages
<b>Strategic</b>	-Supply chain optimization -Availability of Internal competence -Operational flexibility -Integration of R&D	-Supply chain optimization -Operational flexibility -Integration of R&D	-Control -Changover times	-Changover times
<b>Non-strategic</b>	-External Competence availability -Infrastructure	-External Competence availability -Infrastructure	-Offshore competence availability (Macro) -Offshore Infrastructure	-Offshore competence availability (Macro) -Offshore Infrastructure

Table 1: Overview of core factors for backshoring in relation to sourcing-scenario.

Note that the categories overlap each other in some areas. As explained in the theory section RBV, RO and TCT has many similarities, and ultimately, costs and strategic resources are about the same concept, the economy of the firm.

It should be mentioned that I considered adding an environmental category, although I do talk about it in relation to Hunton Fiber in chapter 5.2.3. In my field of mechanical engineering, the sustainability of the supply chain is usually analysed through Life Cycle Assessment (LCA), and are dependent on volume, transportation methods, geographical distances and raw materials, in different stages on product life. It may be based on Raymon Vernon's Product Life Cycle theory (PLC) (Cao and Folan 2012). I considered adding a Life Cycle Assessment (LCA) and using data from

Neuman Aluminium Raufoss and the software Solidworks, but I am not sure how relevant this would be to the current major, entrepreneurship. I still believe that the environmental impact of backshoring is highly important, and a great opportunity due to good environmental regulations in Norway. Although, this is dependent on the characteristics of the supply chain, origin of raw materials, customer location, production location and so on.

#### 4.3.1 Relational category

For the manager, it is difficult to predict if an outsourcing agreement will turn out to be successful. I will look further into if contractual disputes were a source of the backshoring decision, or if disputes occurred because of the decision. This could also be the case for wholly owned backshorers as they could be changing sub-suppliers, either to other regions in Europe or to Norway, outsourced reshoring.

This category is predominantly focused on TCT and RO. The goal is to investigate if the companies experienced any problems during their outsourcing that led them to the backshoring. All companies interviewed did change or cancel at least one sourcing partner because of the backshoring.

#### 4.3.2 Costs

Backshoring to a high-wage economy often involve a high degree of automation, which requires high capital investments. Here, we will benchmark the differences in productivity, but also look at transaction costs. Backshoring is generally likely to result in less transaction costs (such as transportation costs). However, this depends on the supply chain. This may not be the case if the raw materials come from, as an example, Asia, or if the end-customer is in Asia.

#### 4.3.3 Strategic category

This category will study the RBV in terms of backshoring by analysing how core competencies and how the level of control impact the decision. In addition, look at the advantages of a closer distance to customer base and domestic integration of activities such as product development and production. The goal in this category is to benchmark the difference in the availability of resources.

The outsourcing trend predominantly affected labor intensive industries. Subsequently, much of competence has been lost and sent overseas during the last decades, which has been the case in Norway when it comes to the textile and shipyard sector. Industry 4.0 suggest that manufacturing require more specialized competence rather than labor. This is likely relevant to the Knowledge-based view, but I decided not to include that in the theory chapter.

There will be a lot of analysis on operational flexibility, lead times and other logistics. After much hesitation, I decided to include logistics in this category, on the basis of the RBV and CBV.

Backshoring is known to gain advantages through Internal resources, such as lead times and

operational flexibility and we will also look at external resources through clusters. However, both lead times and operational flexibility is known to be connected to the integration of the supply chain, reducing transaction costs.

#### 4.3.4 Non-strategic category

The Norwegian industrial structure has distinctive location and cultural attributes. This study will take an extra look at reshoring factors that can be related to those attributes, based on the porter model. Focusing on what makes Norway different from a location point of view can make it easier to distinguish the Norwegian reshoring trend from the general European trend.

The non-strategic analysis will look at the advantages and disadvantages Norway offer as a location. It mainly attempts to answer the research question of the potential for backshoring to Norway. It will be based on Porters Diamond Theory and look at factors such as Infrastructure, education and business clusters. We know that the Norwegian industrial structure is often focused on customer specific products, meaning flexible manufacturing in low volume. How does the Norwegian Industrial structure reflect the possibilities for backshoring?

#### 4.4 Selection

The companies that are selected in this study has backshored parts of their manufacturing to Norway, both internally and externally.

There are four scenarios of backshoring mentioned in chapter 1.4, reshoring for insourcing, reshoring for outsourcing, in-house reshoring and outsourced reshoring. Outsourced reshoring is most common of products with economies of scale (packaging) and is not a core focus in this thesis, while *reshoring for outsourcing* is non-existent in Norway to my knowledge. These strata's will be under-represented, but the selection should be somewhat proportional.

The selection is based on *typical occurrences* (Asbjørn Johannessen, Line Christoffersen et al. 2011). The interviews conducted in this study include individuals representing two out of four firm profiles, *reshoring for insourcing* and *in-house reshoring*. So, two scenarios are covered in the strata of the backshoring spectrum through interviews, but *outsourced reshoring* and *reshoring for outsourcing* is left out. However, a small literature review will be conducted on Foraform AS (furniture manufacturer) who are now outsourcing their production to a manufacturer located in Norway, which is a case of *outsourced reshoring*.

In addition, there is an interview conducted with Sintef Manufacturing Raufoss about the Norwegian Centre of Expertise Raufoss cluster and the firm's collaboration within R&D. This is to learn more about the connection between productivity and backshoring in Norway.

## 4.5 Data collection

Data will be collected in two ways. First, there will be interviews with representatives from three companies that backshored to Norway or are in the process of backshoring. In addition, there is an interview with Sintef Raufoss Manufacturing who are working with many backshoring manufacturing firms. Some factors should be noted about the data collection process:

- Some interviews were longer than others.
- Some data were collected post- interview, through e-mail requests.
- None of the sources were triangulated unless I have specifically given a secondary reference. The data is largely based on the perception of the interview subjects.

Second is a smaller sub-chapter, with a literature review of other manufacturing firms that backshored to Norway. This data is mostly from Tore Stensvold, a journalist in Teknisk Ukeblad, snowballing his readers if they knew of any companies that has returned their manufacturing to Norway. This is the closest I could get to any quantified overview on which companies that backshored to Norway.

The data interpreted through several theories, using theory triangulation to get a better understanding of the phenomenon. To the extent it was possible, each question for the interview were categorized to fit the framework. Although, some questions were distinctive to the company and were not directly related to the framework or associated theories.

## 5. Data and analysis

In this chapter, the companies will be analysed in correspondence to existing theory. The three companies will be introduced before studying the factors in the framework. First, we look at why these companies initially chose to offshore their manufacturing. In addition, the rational challenges with outsourcing partners during and after the backshoring decision. Second, analyse the main strategic, factors for why these companies backshored. Third, look at the non-strategic reasons that reflect Norway as a location. The table below shows an overview of the key characteristics that was discussed in chapter 2.2.

Company	Neuman Aluminium	Hunton Fiber AS	Kleven Verft AS
	<b>Classifications</b>		
<b>Production type</b>	Mass production	Mass production	One-of
<b>Energy intensity (Barbara Breitschopf, Katharina Grave et al. 2016)</b>	~Medium-high	High	Medium-high
<b>R&amp;D intensity (Science 2011)</b>	Medium-high	Low	Medium-low
	<b>General</b>		
<b>Backshoring investment</b>	~50 million NOK	~100 million NOK	<i>Varied</i>
<b>Location</b>	Sunnmøre	Gjøvik	Gjøvik

Table 2: Overview of the case studies.

### 5.1 Raufoss Technology AS - A case of In-house reshoring

Neuman Aluminium Raufoss (Raufoss technology AS, NAR) is an Original Equipment Manufacturer (OEM) in the automotive industry. Companies in Raufoss has been involved in automotive components manufacturing since mid-1950's - and with aluminum extrusion based products since 1968. The suspension components products of today's Neuman Aluminium Raufoss started back in 1981. Thus, NAR has a profound heritage of specialist competence created in the Raufoss companies through more than 50 years of experience. Neuman Aluminium Raufoss has been a part of an Austrian company, Neuman Aluminium since July 2004. Neuman Aluminium is owned by Dr. Cornelious Grupp, who owns a wide range of companies that is manufacturing products such as toothpaste tubes, glasses, tire fibres, roof systems and more. They are a part of the CAG holding and consists of several firms within aluminium manufacturing, including NAR.

Neuman Aluminium Raufoss manufacture aluminium suspension parts for premium cars, and has wholly own facilities in China, Mexico, Canada and Norway. These factories manufacture similar products of different variants, although some are almost identical. The core development team and the testing team is in Raufoss. ExtruForm™ is their patented extrusion based technology for complex

formed rear axle spring links, offering a best cost versus weight saving ratio. Their suspension control arms are made up of ball-joints and small tolerances, serving as a safety critical product.

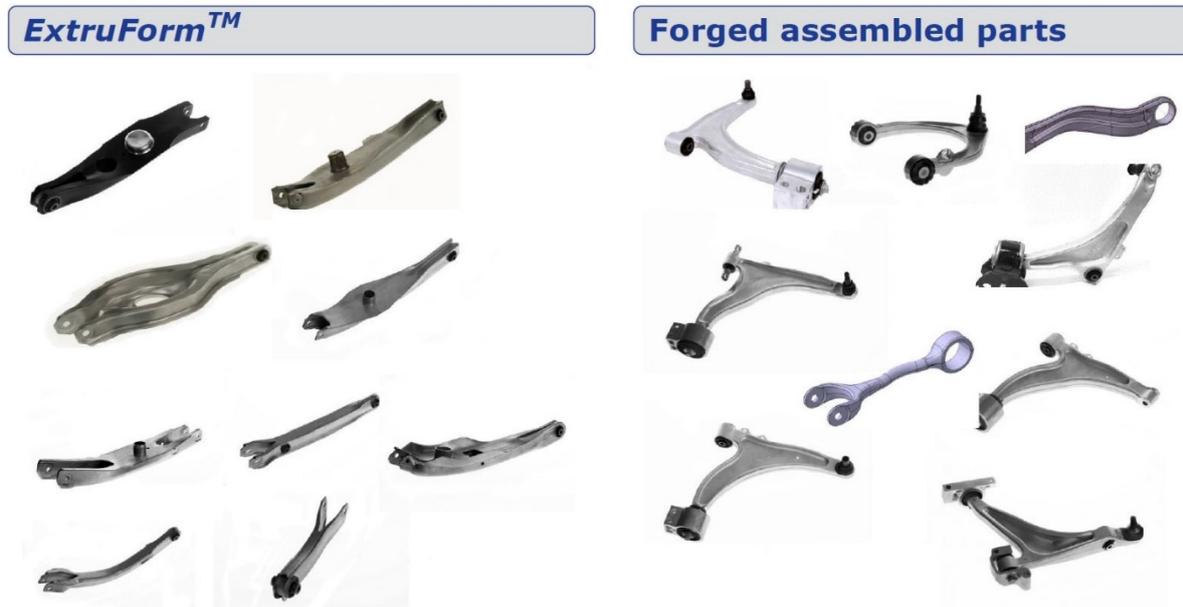


Figure 6: The product line of Raufoss Technology AS. (From interview Power point)

Neuman Aluminium Raufoss supply to a wide range of automotive manufacturers, including Volvo, Ford, Land Rover-Ford-Jaguar (TATA), Kia, Hyundai, BMW, Chrysler, GM, Daiamler, Mercedes and more. These are premium cars with an aluminium chassis, which has become a popular innovation in recent years.

NAR is a part of the NCE Raufoss cluster (Norwegian Center of Expertise), where the automotive industry is the most prevalent industry in the area. This is a highly competitive sector, but their long experience has given them the endurance to survive. Raufoss has become a centre for material science and manufacturing technology in Norway.

NAR is growing fast with a yearly turnover of about 455 million NOK and around 145 employees. They have built a new facility in Hunndalen, Gjøvik, backshoring from Suzhou, China. The manufacturing started in late 2016, but there are still some work to be done before the facility is fully operational. Neuman recently got new European contracts with Volvo for their XC-90 model and Jaguar. The factory was built in Norway partly due to higher demand from automakers in Europe.

#### The decision-making

Neuman Aluminium knew that they had to make a quick decision due to the high demand from Jaguar and Volvo in Europe. Initially, Neuman considered investing in China, but the costs and

distance made it apparent that they had to move their manufacturing back to Europe. Most employees at NAR predicted that they had to move to Slovakia, where there were low wages and already some automotive manufacturing by another daughter company of Neuman Aluminium. Against expectations, the Chairman of Neuman Aluminium in Austria, made the decision to build a new factory in Hunndalen.

### 5.1.1 Relational factors

#### The hold-up problem

Neuman Aluminium Raufoss has 20 Sub-suppliers for certain parts of their product line. Among them are a Chinese and Japanese manufacturer, supplying their second aluminium forging product to Volvo. Neuman is in the process of changing to a European manufacturer as they are reallocating, subsequently reducing the supply from their Chinese supplier. As a result, the cost pr. unit may go up, or the supply may be blocked within august. This could be problematic for NAR, because they will be dependent on a supply for the Chinese market for some time.

The Chinese supplier has expressed concern over Neuman cutting their production, due to lack of incentives to cooperate. The worst-case scenario is that they stop supplying the Aluminium forgings for Neuman's Chinese market. This supply cannot be exported from Europe without significant Chinese tariffs. The other scenario is that the marginal costs increase through cutting the production volume.

The supplier controls much of the adaptation process as they own the manufacturing equipment that Neuman is dependent on for a while longer, which means that they may impose adaptation costs towards Neuman. However, this is dependent on the density of the contract. In addition, the contractual hazards are affected by the dedicated asset specificity (the degree of bilateral dependency) and Strategic defection. The strategic defection depends on how high the stakes are, whether the supplier can sell, or is selling, these parts to other automakers – multilateral (Steven Tadelis and Williamson 2010). It is likely that the supplier is potentially multilateral, as they stated to Neuman that they had the opportunity to partner with a different buyer. The product is specific to Neuman, but the manufacturing equipment is not specific to the supplier. If the dedicated asset specificity is low, the supplier is in better circumstances to hold-up Neuman.

### 5.1.2 Cost factors

Neuman Aluminium Raufoss invested roughly 50 million NOK in the factory, which will manufacture suspension parts for Land Rover, Jaguar and Volvo.

#### Productivity

The factory in Suzhou and Raufoss was choking and new European product orders came from Jaguar and Volvo. This presented NAR with two options. Either invest 2.1 million Euro in Hunndalen, or invest 1.8 million Euro in a much less productive factory in Suzhou and increase transport to Europe.

*“China needed 15 workers on the factory floor, while Norway needed 3.5 for the same job. The wages in China has also doubled since 2008.”*

Their new facility is a 4.0 factory and one of a few in Gjøvik, and by far the most productive among their wholly owned factories. Saying it is one of the most efficient factories in Norway is an understatement. The industry in Norway is heavily regulated with wages amongst the highest in the world, and the automotive industry is highly competitive, being pressured by cost, pushing them in a race to innovate. Not only in terms of product innovation, but also manufacturing innovation, where customers are expecting better cars at a stagnant price. The interview subject added some humour to the degree of automation and explained,

*“We can’t even put the supplies into the machines.”*

#### Transportation costs and other operational costs

The backshoring to Hunndalen freed up roughly three million Euro in working capital, by not binding it to transportation costs. With all factors considered, the Internal Rate of Return (IRR) became significantly higher than it would be to manufacture the products in Suzhou and transport them to Europe.

#### Currency

Currency added considerable risks for NAR. There is not much else to add here, currency fluctuations are generally difficult to predict and there is not much to do about it. Hedging against exchange rates will be a losing game sooner or later, says Neuman.

### 5.1.3 Strategic factors

Neuman Aluminium Raufoss has generally become more hesitant to manufacture over long distances, but they must keep a global footprint as export to China is not beneficial either.

#### The global footprint

NAR manufactured the suspension control arms for the European market in the coastal city of Suzhou, China. The new facility shall produce parts for the European market, especially covering the

new orders from Jaguar and Volvo. However, the factory in China is still in operation, producing parts for the Chinese market, including Volvo.

A global footprint, being located close to the customer, is crucial. Automakers often manufacture the cars in several regions due to localization benefits, domestic import tax, logistics and currency risk exposure. It is also dependent on the end-customer's options for the OEMs parts. This is especially important for products specific to the customer because the cars go into production soon after the it has been ordered. For Volvo, the turnaround time for customer specific parts is 45 minutes, from the time the factory receive the order. The main production facilities of the automakers have limited storage capacity. It is not efficient to store bumpers of all colors and large interior cockpit or dash board assemblies.

NAR does not need to have their factory that close to the main automaker, as their product (suspension control arms), is less customer specific. These can be efficiently stored without being as negatively exposed, logistics wise. Lead times is still vital, it is required by the automakers that their OEMs is located in the same region, NAR could not backshore everything to Norway almost regardless of working capital. Their factory in Mexico, Canada and China is there because of many other automakers in the area, their customer base, which is why NAR manufacture quite similar products across all factories.

Neuman's customers are located there partly because of political tariffs and demand conditions in the region. An example is Neuman's facilities in Mexico and Canada, manufacturing parts for General Motors, BMW and Ford for the North American market. It is more profitable for them to be located there due to the North American Free Trade Agreement, a trading partnership which is lifting tariffs between the US, Mexico and Canada (NAFTA).

#### Lead times between China and Norway

For Neuman Aluminium Raufoss, the lead times are critical, it requires a high level of planning and coordination requirements, which is generally true for OEMs in the automotive industry.

It was a long process when Neuman had their factory located in Suzhou and received a new order to supply control arms to Volvo in Europe. First, the raw materials had to be sent to China from an expert supplier located in Czech Republic, as NAR's raw material supplier is Neuman, their parent company. This took 9 weeks from CR to China. The lead times is still relatively long for the Hunndalen factory, because they can receive aluminium beams from the Raufoss Industrial Park. Second step, is taking the materials through the Chinese toll, which is a long formal process due to import legislations. Third is to manufacture the parts in China, taking about 2-3 weeks depending on the order. Fourth, is sending the products back to Raufoss for re-packaging since Volvo does not do this themselves, where the transportation time is around 9 weeks. And lastly, it's sent to Volvo in

Sweden. This process takes around 25 weeks in total. If the order was urgent, or if Neuman Aluminium Raufoss experienced delays, the order must be sent by plane rather than ship, adding significant costs.

#### Flexibility and quality control

Neuman Aluminium Raufoss are largely vertically integrated, controlling both production and engineering for integrated optimization of the supply chain. It is vital for NAR to have integrated testing, product development and manufacturing. It allows for faster decisions and more efficient quality control in the development process. This integration of activities is a major part of building the competence that is needed to make fully functional components assemblies.

Neuman Aluminium Raufoss recently upgraded their testing capability along with their new factory, as a part of their backshoring process. Car manufacturers strictly monitor their OEMs in order to prevent recalls, which require continuous maintenance and monitoring. If the OEMs machinery is worn out, the consequence is that they will be downgraded from an A-supplier to a C-supplier, otherwise known as “non-sourcable”, triggering a new process of re-qualifications. Another source of re-qualifications for OEMs is that automakers often make changes to their vehicles. When changes occur, the product must go through extensive test loops that usually take around 6 weeks depending on the changes, but Neuman has been postponing products in approval loops for more than a year. Therefore, to maximize operational flexibility and develop core competencies, it is vital for NAR to have an integrated supply chain, with testing, product development and manufacturing.

#### 5.1.4 Non-strategic factors

The Raufoss Industrial Park is starting reach its full capacity in terms of available space for new factories, instead, more factories are localizing in Hunndalen.

Sintef Raufoss Manufacturing stated that there are no industrial railways available for transportation of goods in Gjøvik, which is why 3-4 of the biggest trucking companies in Norway are located there. Each day, 50 trucks visit the Raufoss Industrial Park to either deliver or pick-up goods. These trucks must drive through Oslo if delivering to Europe, which is both costly and time consuming. Their advantage is that they are close to the Gardermoen Airport.

#### Infrastructure

Short lead times from decision to start of production called for using existing manufacturing buildings in Raufoss. However, the space is limited in the Raufoss Industrial Park and there are many old buildings, where it is difficult to fully automate as these lack the architecture. Therefore, a new factory was built in Hunndalen and not in the Raufoss Industrial Park. A challenge for Neuman was the time it takes to construct a factory building in Norway. Neuman wanted to get the building up

quickly, so they could start installing the equipment. Norway tend to be quite slow when it comes to construction, in part due to the high level of regulations.

### Culture

The work culture is also important for Neuman. Norway generally has a low amount of strikes compared to many other countries. This is crucial to the automotive industry as one strike can add considerable uncertainty to their ability to supply, putting their partnership at risk.

It is not rare for Chinese workers to not return after a holiday season, such as the Chinese new year's. The workers often travel far from their family, often living in inland China, to work.

One notable difference from Norwegian and Chinese work culture is the way we follow instructions. Neuman has noticed that China is especially good at this, while Norwegians tend to make their own decision if they think something should be done differently. This has both upsides and downsides to it. However, Neuman Raufoss is very effective when it comes to making fast decisions, being independent and taking responsibility. This is relative to the flat organisational model in Norway.

Furthermore, is the repetitive tasks that often take place at assembly lines in China, which does not comply with the work mode of Neuman Aluminium, where all the processes are developed.

### Energy

The energy costs account for roughly 4% of the sales price. If the in-direct energy costs are included, being the processing of aluminium in Norway, it's around 6-7% of the unit sales price.

Neuman backshored from China, where the cost of energy is low, but mostly derived from coal. It is still difficult to argue that Norway has a substantial advantage over China in terms of cost.

## 5.2 Hunton Fiber AS - A case of Reshoring for Insourcing



Figure 7: Wooden fibre insulation boards (Hunton).

Hunton Fiber was founded in 1889 by Lars Amundsen Enger. They are based in Gjøvik and manufacture energy intensive fibreboard products for the construction industry, where most of their customers are in the Nordic countries. Their products include insulation and structural wall, floor and roof systems. Their product line strategy has recently changed from being focused on single products to a system of products. Hunton Fiber is in the process of going through many organisational

changes, from alliances to being more independent and R&D oriented. Focusing more on in-house sales, product development and a closer relationship with their customers.

Hunton Fiber is not a part of the Raufoss Industrial park, but like Neuman Aluminium Raufoss, they are a part of the NCE Raufoss cluster and collaborate with Sintef. They recently also became a part of a new cluster with 7 other companies in 2016, the Norwegian Wood Cluster, where NTNU Gjøvik is the core of R&D. The goal is to industrialize the value chain through innovation and competence to reach industry 4.0. The collaboration through clusters shall play an important part for the productivity of small companies.

Hunton Fiber decided to backshore from Poland a few years ago, establishing a new Industry 4.0 manufacturing facility in Hunndalen, Gjøvik. The product being backshored is Hunton Trefiberisolasjon<sup>tm</sup>. This will create about 40-60 jobs, today they are around 120 employees. The machinery will arrive in October and the factory building will be ready in autumn. The initial testing will take place next year, and according to plan, their production will start in 2018 with the primary goal of reaching a turnover of about 100 million NOK. The maximum turnover capacity of the factory should be around 250-300 million NOK. To my knowledge, the two largest known backshoring factories in Norway are both located in the small area of Hunndalen, Gjøvik.

### 5.2.1 Relational factors

Hunton did not experience any opportunism or relational hazards during the outsourcing.

### 5.2.2 Cost factors

#### Productivity

Like China, the wages in Poland is climbing, but factory jobs are still around one fourth of the wages in Norway. Similar to other examples in this thesis, Industry 4.0 is critical to the backshoring. The new factory is highly efficient, where the ratio of workers operating the manufacturing lines should

be about 2/9 of the factory in Poland. Although newer factories in Poland certainly more effective. The challenge will be to make the factory operate as intended, Hunton Fiber has never built a factory in this scale before.

#### Transportation costs

85% of Hunton's customers are in the Nordic countries. Construction products are quite heavy and has a low value/volume ratio, so transporting it from inland Poland, Czarnkow, to Scandinavia is not ideal.

*"It is very natural for us to manufacture such construction products close to the customer."*

Hunton is trying to ship as much as possible by train, but most of it is transported by truck from Poland. They will most likely continue to do so in Gjøvik because there is no industrial railway, but the distances will be much shorter.

### 5.2.3 Strategic factors

#### Environmental

Hunton Fiber's main strategy is to manufacture environmentally friendly and sustainable products.

Hunton is ISO 50001 certified for continually improving their energy efficiency. They often collaborate in projects with organisations such as Enova. Hunton's energy consumption has gone down from 87 Gwh in 2007 to 65 Gwh in 2016, while still increasing the production output.

Manufacturing in Poland has been an issue for Hunton's core values, as most of their energy sources are coal. While all the energy consumption during wood processing come from hydro power in Gjøvik, which also make it easier for Hunton to market themselves as a green company.

The transportation from inland Poland does also have a significant environmental impact, CO2 footprint.

#### Flexibility and control

The reason Hunton Fiber decided to outsource their production was to test their product in the market and gradually build up the volume. This was because of high market uncertainty for insulation products in Scandinavia. To reduce risk when entering the market, they primarily produced their product in smaller volumes through the supplier, who was already manufacturing similar products for other customers. Today, Hunton is more familiar with the market risks associated with their product. Since the product was successful, they could take the real option of a large capital investment in Norway because the low market uncertainty allows for lower risks.

Hunton Fiber backshored partly to achieve more control of product development and more operational flexibility by owning the facility and manufacturing close to R&D. Hunton Fiber currently

manufacture their insulation systems in Poland, the manufacturing is by the German company Steico. They had a lot of issues with making changes to their product, not only because it is another country, but also because Steico is a supplier for several firms.

Hunton Fiber's supplier faced challenges with product development because their supplier was in a multilateral relationship. Changing the production line for Hunton's innovations would mean making changes for other buyers of the same product. Wooden fibre boards are categorized as low R&D/technology-intensity, which are products that is often mass-produced through economies of scale. As such, Hunton Fiber may not be significant to the customer base, making investments in product development costly. Subsequently, Steico may not be suited to invest in specific dedicated assets. If Steico were to make changes to their production assets, they would have to be buying new dedicated specific assets for Hunton, as they could not apply Hunton's changes without switching current manufacturing equipment. Steico lacked the operational flexibility, meaning that they could not react to changing customer demands without sacrificing costs, a critical factor in industry 4.0. Subsequently, Hunton lacked control over their production process.

#### Core competencies

Hunton fiber has been manufacturing in Norway since they began, but the backshoring of their Insulation fibreboard production is a significant part of their product line. Hunton Gjøvik has unique competence when it comes to sustainable building solutions, and their new factory will have an important role preserving it.

*"It is very important that we develop our own core competence to get a competitive advantage."*

Hunton outsourced mainly to mitigate market uncertainty, favouring Real Options. After it came apparent that the market demand sufficient, Hunton gained control of the supply chain by backshoring, favouring the Resource-based view.

#### 5.2.4 Non-strategic factors

Hunton's new factory is located in Skjeven, Hunndalen, about 3 km away from Neuman who is localized in the urban area of Hunndalen. Gjøvik has one of the largest land and forest municipalities in the Oppland area, where 74% of the land is forest and 94% of that land is spruce forest.

Hunton is collaborating with the Gjøvik region (municipality) to build better Infrastructure for their new factory (kommune 2017). The roads must be built to industry standard so that goods can be transported efficiently. 36 000 square meters are to be paved and the water and sewage plants will be upgraded.

## Energy

The company that stands out in terms of energy costs is Hunton Fiber, who consumes enough energy to install a separate electro plant designated solely for their new factory.

The energy consumption of Hunton Fibre was 65 Gwh in 2016, this is a considerable improvement since 2007, where the consumption was more than 80 Gwh. Hunton Fibre is continuously working on projects to reduce the energy consumption without cutting production. 65 Gwh would cost around 19.5 million NOK if the end user energy cost is 0.30 NOK/Kwh, which was the average energy price for energy-intensive industries in Norway according to SSB 2016 (Thomas Aanensen and Olaisen 2017). The backshored Hunton factory will also use roughly 17-18 Mwh, according to a secondary source, NCE Raufoss (Raufoss 2017). This is at the maximum capacity, where the facilities turnover is between 100-150 million NOK. Hunton and Statkraft signed a long-term energy contract in 2011 to ensure stable energy costs until 2021.

According to Skattedirektoratet (Skattedirektoratet 2016), special tax exemptions §4, energy-intensive woodworking industries that are a part of an energy efficiency program (ISO 50001) can be exempt from electricity fees. This law has existed in Norway for many years and is there to make Norway competitive as an industrial location.

In contrast to China, the energy costs in Poland are considerably higher and both Kleven (partly) and Hunton are operating there. Poland recently adopted a similar law to Norway, that will go into effect in July 2017 (Żelich 2016). This means that companies in Poland can cut their taxes considerably. It will apply to energy intensive companies that uses environmentally friendly production methods, regardless if their energy originates from coal power plants. The average energy cost in Poland was in 2016 0.55 NOK/Kwh (0.0596 Euro/Kwh) for energy intensive industries (70 000 Mwh < consumption) according to Eurostat, which is a very significant difference. This excludes Value Added Tax (VAT), so even with the new law in place, Poland would have a considerably higher cost.

### 5.3 Kleven Verft AS – A case of Reshoring for Insourcing

Kleven Verft is a shipyard founded in 1944 and located in Ullsteinsvik, Sunnmøre. They are a subsidiary under Kleven Maritime AS, together with Myklebust Verft AS. The shipyard has about 340 employees with a turnover of about 3 billion in 2015 and 2014. Kleven recently acquired a new contract with Hurtigruten to build two new ships, where 70-80% of the construction will take place in Norway. To do this, they have built many new facilities in the area.

Kleven are one of few shipyards that build in modules, meaning that they split the ship into four to six sections and build each section at a time. Kleven construct their modules through contractors overseas, each contractor working on a different module for the same ship before they are sent to Ullsteinsvik. This is gradually changing as more construction is taking place domestically.



*Figure 8: This is the new Hurtigruten Kleven will build, Sunnmørsposten (Helgesen 2016).*

Kleven started by backshoring the most advanced section, the engine module, from Poland in 2013. Since then, they have increased their reshoring activities, producing more in-house than ever before, where Hurtigruten is their most ambitious in-house project yet.

However, the portion of the ship Kleven choose to build in Norway are still dependent on their project or contract. It depends on how complex the construction is in certain areas, or if it has been done before. For. Example. Kleven does not construct the ship bows in-house because the geometry is highly complex, labour intensive.

#### 5.3.1 Relational factors

Kleven has outsourced a high number of ships to Eastern Europe in the past, often to several shipyards simultaneously. Although a large portfolio can be more difficult to monetize, they rarely have problems. Kleven have had some minor conflicts of interest in terms of their contract density, but has never been in a legal dispute. When outsourcing to a shipyard, the cost they charge is usually

dependent on weight, meaning that the supplier can charge more for heavier ships. Furthermore, heavy components are often cheaper to build. Therefore, building heavy parts can be preferable to the supplier, while it goes against Kleven's interests. As previously mentioned, heavier ships are less fuel efficient, slower and has a bigger impact on the environment.

The reason for these price clauses could be that the density of their shipbuilding contract is low, meaning that the contracts clauses or obligations does not account for this loophole. The way Kleven's contracts are setup often changes between shipyards, and Kleven tend to shift their outsourcing between different shipyards. Also, their contracts are relatively short term if their supplier is building a single module. It is shown that contract duration is positively correlated with the contract density (Jerome Barthelemy and Quelin 2001).

One can also look at this differently by not basing this on a problem of contract density, but rather a lack of incentives. The supplier clearly does not gain anything from building lighter ships.

### 5.3.2 The cooperation

Kleven collaborated with Sintef Raufoss Manufacturing and the furniture manufacturer Ekornes. The interview subject did not have an overview of the extent of the collaboration between Ekornes and Kleven at the time, although there are some information in a report by the Norwegian Confederation of Trade Unions (LO 2014). However, Kleven does not have the resources for long term R&D, they rather focus on projects. In the process of automating their manufacturing lines, they put emphasis on technology that works, rather than trying to invent a new method. Although, one could argue that this is relative, as they are the world's first shipyard to fully automate hull construction.

*"This is very specialized technology that cannot be bought. There will always be need for strong cooperation when adopting a system with an advantage. "*

Kleve further state that the Norwegian flat model is a strong contributor to making this possible. It has led to a knowledge sharing and development capability that few can compete with.

### 5.3.2 Cost factors

In a tough market, innovation has allowed Kleven to achieve better capacity utilization and created more employment in the last few years. While many shipyards in Europe are struggling, and closing down.

#### Productivity

Kleven is the first in the world to fully automate ship production. Klevens robotics manage to weld together many various parts, each having their own design. These robots can interpret CAD models, removing the need for manual programming for each part. This make the construction of the modules fast and highly productive. Productivity can vary between ships, but about 90% of the ships

superstructure is atomized. That is the initial steel work, Kleven still employ welders to implement the structure into the hull of the ship. In most cases, the robots cannot work efficiently while being placed inside the ship. However, one of their robots can weld together two pipes in 20 minutes, which would take a whole day for the manual worker.

Kleven stands out from the two other cases in this thesis. Unlike the automation of mass production, what Kleven has achieved is the automation of one-of products. This reflects the mindset of industry 4.0, and Kleven is the first shipyard in the world to automate shipbuilding. Kleven automated while keeping a healthy balance of manual labour for tasks that are not easily accessible by robots.

According to Professor Shih from Harvard University, vertical integration will free up productivity that can be re-directed towards other valuable tasks (Shih 2014). He wrote about a similar case of a Danish company, arguing that backshoring manufacturers does not necessarily lock into a high degree of automation because of high wage costs. Suggesting that companies with a high frequency of changover, such as Kleven, would combine manual labour and automation to maintain a high degree of flexibility. Managers should think twice about fully automating, even considering the easier installation and the reduced changeover times for newer robotics. The risks of vertically integrating in the shipyard industry are low flexibility when it comes to fluctuating demand, because of the uncertainty of going from one contract to another.

Kleven also noticed some unanticipated competitive advantages because of robotizing their manufacturing. When steel is welded manually it is slower, which means that more heat will be absorbed by the metal. If enough heat is applied, it will change the structural properties of the alloys, depending on temperature and cooldown speed. This can create brittle alloys that are fragile to cracking. Robots evenly distribute the weld evenly and quickly, applying a minimal amount of heat, leaving a smooth surface.

When welded manually, they must use thick and heavy steel plates to make up for human error, with robots, they can use thin plates. This results in a significant weight reduction of the ship, reducing both environmental impact and fuel costs. They can also build new variants or types of construction.

Furthermore, Kleven emphasized that automating the process has been highly demanding, Kleven has re-drafted and re-worked the production lines of their manufacturing halls many times, to make their robots perform their assigned task. Even though automating their manufacturing has already given them significant advantages, the facilities are still under development, where there is always room for improvement.

*“Buying the robots is simple, but using them for their intended purpose is a long and complicated process”*

#### Transportation costs

The outsourced modules are tugged by boats from Eastern Europe to Sunnmøre. There tend to be many delays due to bad weather, but this is expected. Kleven also has an advantage when outsourcing. It is not rare that the operating draft of a ship is too deep, and the depth by the shipyard is too shallow. This problem is rare for Kleven as their ships are transported in smaller modules.

As explained, Kleven usually build their ships faster when they outsource modules to several suppliers. This is possibly a downside of manufacturing most of the ship in-house, depending on Klevens capacity and flexibility. Overall, Klevens transportation costs and time to market has not noticeably affected the sourcing decision.

#### 5.3.3 Strategic factors

##### The distinctive competitive advantage of Kleven

Kleven stands out from their competitors by building the ships in modules or sections, instead of constructing the entire hull as one part. This means splitting the entire ship into about 4-5 assemblies depending on the ship. Other shipyards build the entire hull as one piece. The problem with this is accessibility, they often have to cut a hole through the hull to install larger equipment. Klevens modules make it easy to access the inner space and install machinery before mounting the modules together.

Kleven tend to outsource modules, or sections of the ship, to several shipyards so that they can both spread the economic risk across shipyards and save time. One ship can have modules from 3-4 different shipyards, and the more shipyards that work on the construction simultaneously, the faster the lead times.

##### Core competencies

The core competence of Kleven is steel, or steel construction. They have a long tradition of welding and shaping stainless steel of different compositions. Building a ship require a combination of specialized theoretical and practical knowledge. Kleven started gradually backshoring to maintain their competence and become better at what they do.

*“One does not become great at building ships if one does not understand steel and how the building process is done. If you buy solely from your supplier, you’ll never become very good at it”*

### 5.3.4 Non-strategic factors

Kleven must transport their ships through Stadhavet, which is one of the harshest seas along the Norwegian shore. Kleven stated that they could do with a ship tunnel through to Sunnmøre and that is already being planned (Reksnes 2016). Kystverket will start the construction of the 1700m Ship tunnel between Moldefjorden and Kjødepollen in 2019, which will finish in 2022. It will facilitate for the transport of goods and ships by reducing safety risks and make shipping traffic significantly more efficient. It will cost 2.3 billion NOK.



*Figure 9: Stadship tunnel, designed by Snøhetta (Stad 2017).*

#### Competence

Kleven value education as the most important factor for making Norway an attractive location for manufacturing. Kleven is collaborating and recruiting apprentices from TAF, an interdisciplinary study between practice and engineering as it allows admission to further theoretical courses. Kleven has worked hard to keep TAF in Sunnmøre, as they need a hybrid workforce that not only understand theory, but also practice.

#### Energy

Kleven Verft had an energy consumption of 26,2 Gwh in 2016, classified as medium-high energy intensity (Barbara Breitschopf, Katharina Grave et al. 2016).

#### 5.4 Other examples of backshoring to Norway

There is limited research on reshoring in Norway, but reshoring has become a hot topic in the media lately. Looking at interviews from Teknisk Ukeblad and articles from Sintef, automation seem to be having a significant role in the decision of reshoring in Norway. None of the quantitative studies conducted by Needham, Dach and Fraticchi used new development in automation as a dependent variable, while all the studies focused on manufacturing.

Company	Product	Origin country	SRM
<b>Teknotherm</b>	Electric boards	China	
<b>I.P Huse</b>	Winches for ships	Russia, Ukraine, Czech	
<b>Berry Alloc</b>	Aluminum Trims	China	x
<b>Steipner Motor</b>	Winches for boats	China	
<b>Kværner</b>	Oil&Gas parts	Dubai and China	
<b>ForaForm</b>	Furniture moulders	China	
<b>Globus</b>	Excavator buckets	Baltics	x
<b>Plasto</b>	Parts for fishing cages	China	x

Table 3: Companies that has backshored to Norway (Stensvold 2016).

This table shows an overview of other companies that has backshored to Norway. This sub-chapter with semi-quantitative data is included to back up the evidence found in this study, using secondary data from Teknisk Ukeblad and other sources. The “x” symbol signifies a reason for why the company backshored. The “\*” symbol does not imply that the company did not backshore for given reason, but that the effect of the variable is unknown.

Neuman Aluminium Raufoss, Hunton Fiber and Kleven Verft are more closely studied. The degree of the importance of the factor is rated as Low/Medium/High. This is simply based on my subjective impression from the interview. “-“ means that it was not an important factor for the backshoring.

<b>Reasons for backshoring</b>												
Company	Costs				Strategic					Non-strategic		
	Automation productivity	Currency	Transportation costs	Coordination costs	Operational flexibility	Lead times	Core competencies	Quality	Vincinity to R&D	Education	Lack of infrastructure	Energy costs
<b>Neuman Aluminium</b>	Medium	High	Medium	Low	Medium	High	Low	-	High	Low	-	Low
<b>Hunton Fiber</b>	High	-	High	High	Medium	Medium	Medium	Medium	Medium	-	Medium	High
<b>Kleven Verft</b>	High	-	-	Medium	High	-	High	Medium	-	Medium	Low	Low
<b>Teknotherm</b>	*	X	*	*	*	*	*	X	*	*	*	*
<b>I.P. Huse</b>	X	X	*	*	*	*	*	X	*		*	*
<b>Berry Alloc</b>	X	*	X	*	*	*	X		X	*	*	*
<b>Sleipner Motor</b>	X	X	*	*	X	X		X	*	*	*	*
<b>Kværner</b>	X	*	*	*	*	*	X	*	*	*	*	*
<b>Fora Form</b>	X	*	X	*	*	X	*	*	*	*	*	*
<b>Globus</b>	X	*	*	*	*	*	*	*	*	*	*	*

Figure 4: Reasons for Backshoring.

#### 5.4.1 Teknotherm - *Reshoring for Insourcing*

Teknotherm backshored the manufacturing of electrical boards for cooling systems that are to be installed in ships from China (Olsen 2016). The production accounts for about 300 million NOK of their turnover. The backshored manufacturing is dedicated to the European market, and are now located in Halden.

Unpredictable currency was one of their main reasons for reshoring, but they also manufacture their products at a lower cost in Norway, while maintaining better quality control. Teknotherm stated to Teknisk Ukeblad that they could easily manufacture their products in China with lower cost, but this would have a significant effect on product quality. This supports Hongyi Sun's theory, suggesting that high quality products manufactured in China could be made with the same costs in Norway (Sun 2000).

Teknotherm is also considering taking more production to Norway, including the products that are dedicated to the Chinese market. As previously mentioned in, China has stiff regulations when it comes to importing products.

#### 5.4.2 I.P. Huse - *Sourcing type unknown, but domestic production is wholly owned*

I.P. Huse backshored the manufacturing of winches for anchor vessels. They have moved almost all production from Czech Republic, Poland, Ukraine and Russia back to Ålesund, Norway.

I.P. Huse has achieved faster lead times and better quality at a lower cost, through the integration of production and product development (Haugen 2017). They wanted to obtain better quality control, even though they were generally satisfied with the quality from Eastern Europe. Furthermore, was the unpredictability of currency.

I.P. Huse operate with a high degree of automation and state that technology is what made the backshoring possible in the first place. However, they stressed the fact that automating the process was a challenging interdisciplinary task. Every part had to be re-designed so that they are robot friendly (Stensvold 2016).

#### 5.4.3 Berry Alloc - *Outsourced reshoring*

Berry Alloc backshored their outsourcing contract from a contractor in China to a highly automated Sapa factory in Magnor, Norway (Stensvold 2016). Sapa has a large global footprint with aluminium extrusion facilities in more than 40 countries (Sapa). Berry Alloc backshored the manufacturing of aluminium lists for wet room panels and laminate flooring. Sapa are to manufacture 35,4 million lists for Berry Alloc, their machinery that can sort 4500 aluminium trims in one hour, which equals almost one year of continuous production.

Sintef Raufoss Manufacturing is the lean project manager for Berry Alloc, setting up their

manufacturing lines at the Sapa facility (Byggeindustrien 2016). However, they are not in any official R&D collaboration with Sintef, nor are they a part of a cluster. Berry Alloc also collaborate with Tronrud Engineering to make specific equipment for the extrusion of aluminium, who I interviewed at the SSV Conference in Fornebu.

CEO of Sapa, Egil Hogna, stated to Teknisk Ukeblad that smarter production through investments in competence and intelligent machinery is the key for industry growth in Norway. Berry Alloc reshored to lower transportation costs and better integrate product development. John Vonli of Berry Alloc stated:

*“I think it’s exciting that smart use of technology and automation can make it both profitable and appropriate to move the production closer to our customers and business activities.”*

5.4.4 Sleipner Motor - *Sourcing type unknown, but domestic production is wholly owned*  
Steipner Motor Manufacture a wide range of parts and thrusters for consumer boats, located in Fredrikstad, Norway.

Their strategy is based on the integration of product development, sales, and manufacturing (Stensvold 2016). The backshoring occurred based on this strategy because they bought a company that had 50% of the manufacturing in China. As of July 2016, almost all the manufacturing activities where brought back to Norway and they are gradually backshoring. Arne Kai Skauen also state that the quality and the delivery times from China is not sufficient.’ Further stating that the key to backshoring is as follows:

*“They key lies in the competence of the employee’s, combined with an automated and flexible manufacturing park that allows for fast changeover times.”*

They fit the Norwegian industrial stereotype, with manufacturing a wide range of products in small volumes. They are considerably different from other examples, because they do not have many industrial robots replacing basic labour, but rather CNC machines that manufacture custom parts. They are however planning to build a new 11 000 m<sup>2</sup> shore factory with integrated R&D. They need easy access to the shore for testing, and are now located 200m away with several buildings and streets between them.

5.4.5 Kværner - Reshoring for Insourcing

Kværner is backshoring the steel base construction of the Johan Sverdrup process oil rig, taking place in Verdal, Norway (Stensvold 2016). It was planned to construct twelve 800-ton platform support legs for three platform bases, but four of them are now being constructed in Norway.

This scenario is similar to Kleven Verft, where they backshored due to robot advancements that allow for more flexibility, conducting previously manual labor such as cutting and welding. Also similar to Kleven, referencing the modular hulls, Kværner has developed a new base construction that allow for a modular platform deck. This allows for faster serial production according to Kværner, as the base can be constructed in Dubai and Norway simultaneously. Furthermore, is capacity utilisation, Kværner will be able to train 120 new apprentices and allow for more contracts for sub-suppliers in Norway.

#### 5.4.6 Fora Form AS – *Outsourced reshoring*

Fora Form is a furniture supplier in Sunnmøre, manufacturing chairs and tables among other. They backshored a simple plastic casting for the manufacturing of one of their chairs (Sæbønes 2015). The activity is now done by a supplier in Norway. They have also changed several sub-suppliers from Asia to Northern Europe. Their main objectives for backshoring are shorter lead times and high transportation costs.

#### 5.4.7 AKVA Group - *Outsourced reshoring*

AKVA Group backshored components for their fish farming cages. The components were outsourced to a Chinese supplier, then domestically outsourced to Plasto, a plastic manufacturer in Åndalsnes. They also work closely with Sintef through SFI Manufacturing. Silje Helene Aschehaug, from SRM, stated in an interview with Plasto that they are the optimal example on how a partner collaboration should be executed in a research project (Plasto).

#### 5.4.8 Globus – *Sourcing type unknown, but likely reshoring for insourcing*

Globus is a small company with 26 employees that backshored the manufacturing of excavator buckets from the Baltics. There is very little information available about their reshoring, to my knowledge. They are however, a part of TOTAL-gruppen with Sintef Raufoss Manufacturing.

## 6. Discussion

To start off in this chapter, I will reflect on the findings, before discussing the potential of backshoring to Norway.

### 6.1 Productivity allows for backshoring

Neuman Aluminium Raufoss experienced that the difference in productivity between China and Norway was excessive, and Kleven outsourced to shipyards where labour was almost entirely manual. All three companies stated that new technology allowed for better productivity, which was a requisite for the backshoring. The same is stated by the secondary companies, such as I.P Huse(Stensvold 2016), Berry Alloc(Stensvold 2016) and Kværner (Stensvold 2016).

I think the impact of automation will grow exponentially as technology progresses, and hopefully, capital requirements to enter the robotics market will decrease. If not it will be a huge competitive disadvantage for smaller manufacturing firms and start-ups, or it will at least force many to outsource.

### 6.2 Why Backshore to Norway?

Two of the three companies do not plan to return all manufacturing back to Norway. Neuman Aluminium Raufoss must be where the market is located, while Kleven Verft wanted to build a network with other shipyards and achieve shorter production lead times by building ships simultaneously through several shipyards. Furthermore, all three companies backshored to integrate product development and manufacturing to rapidly adapt to customer demands and develop core competency. In addition, some of the companies had some difficulties with their suppliers when it came to control and contractual hazards.

Problems with lead times, operational flexibility, adaptation costs, and control can be said to be universal to all locations, required that their customer base is in near proximity to their manufacturing, culturally and physically. Meaning that Norway as a location, does not directly affect these factors. So, what factors allows for backshoring to Norway? That would arguably be demand conditions for the specific product in Europe. More importantly however, is our ability to obtain competence, which is gathered through domestic rivalry, culture and the related and supporting industries. All three companies found the process of backshoring to be highly challenging, especially for Hunton Fiber and Kleven Verft as they have had little experience in automating a production line. Even though robotics has become more flexible and user friendly. Hunton Fiber put it this way,

*“The challenge is to make the factory do what it is intended to do, there are many examples of facilities failing to do their intended purpose.”* – From the interview with Hunton Fiber

Even though Hunton's CEO is in a critical phase of being the pilot in the plane, findings in all three cases suggest that Backshoring to Norway offer substantial benefits. We see a potential for companies operating within sectors such as the shipyard, automobile and woodworking industry covering both "one of" and mass production, in addition to other examples in the secondary data. During the three interviews, I asked some questions related to Porter and macro perspective. They all generally agreed that competence and infrastructure was an advantage, but there where one concern that repeatedly came up. When I asked the question "*What attractors are important to make Norway a better location for manufacturing*" all the answers were, surprisingly for me, the same. The Norwegian tax system must stop favouring real-estate. The payback for investments in manufacturing is too low, mainly due to property tax on production equipment. This hinders new investments in technology that are vital to stay competitive. This is especially problematic for Raufoss because most of these firms have foreign ownership, including Neuman Aluminium Raufoss. Foreign owners have expressed little understanding of such taxations.

### 6.3 The importance of supported industries – Open Innovation and Porter

All three firms that where interviewed in this thesis and several firms from secondary sources, underlined the challenges of acquiring the right expertise. As such, competence is an enormous factor for making backshoring possible for those who doesn't have much resources for R&D. I have found that several sectors are working together when it comes to manufacturing technology. Furthermore, and more significant, I did not expect that R&D institutions such as Sintef and public sector agencies and universities, had such a large impact on companies backshoring to Norway. The question that I ask myself is whether this type of cooperation is a competitive advantage that is not as prevalent in other high-cost economies. As previously discussed, technology, especially when it comes to manufacturing, is transferrable between industries, such as a furniture manufacturer and a shipyard. Backshoring manufacturing to Norway as a SME is to a large extent dependent on a joint competence centre and cooperation between industries.

The advantage of R&D availability for smaller firms (SMEs) is rarely considered in backshoring research, but open-innovation has been a popular subject in academic literature. This was not a subject that I found relevant for backshoring when I started writing about this phenomenon in Europe. However, cooperation seems to be critical for firms in Norway. Backshoring to a high wage economy is about reaching a certain level of productivity, in other words, building a 4.0 factory i.e. a Smart factory. In addition to bringing back the workforce and supplier base. It requires a certain amount of R&D, a resource that is not easily available for small companies.

## Industrial clusters - NCE Raufoss

Both Hunton Fibre and Neuman Aluminium is a part of the NCE Raufoss cluster (Norwegian Centre of Expertise Raufoss). The cluster is an initiative is not only for the Raufoss Industrial Park, but also other manufacturers around Gjøvik. NCE is the strongest initiative in Norway for keeping companies competitive, and 14 clusters in Norway has earned this status. Sintef Raufoss Manufacturing (SRM) is the core of the collaboration, functioning as the R&D unit between many small-to-medium sized companies within the cluster. The Raufoss cluster calls this a “*sharing economy*”.

*“We want to be a national node for sharing expertise on productivity, materials, and efficiency. In a structure with so many small companies, one must compensate by making centres where they can utilize R&D. They are not sustainable without it.” -From the interview with Sintef Raufoss Manufacturing.*

Christopher Braaten of Neuman Aluminium Raufoss noted the following in an interview with TV2:

*“One of our secrets is that we have product development, processing and production at the same spot. Everyone can buy a robot, but it’s about seeing everything in context. The collaboration with Sintef and NTNU is highly integrated, which is vital for our decision to venture in Norway” (Expertise , SINTEF 2016).*

The manufacturing productivity for companies in NCE Raufoss has gone up with an average of 5% each year, with continuous manufacturing innovation. In addition, the general productivity pr. worker at the Raufoss Industrial Park has gone up by 60%, from 1,6 million NOK in 2004 to 2,6 million NOK in 2016.

What may set Norwegian manufacturing culture apart may be their ability to cope with open-innovation or more accurately when it comes to Sintef, Open-R&D. I talked to Rune Almsbakken at the SSV Conference 2017, a researcher at Sintef Raufoss, who told me that Raufoss Automotive OEM’s are quite different from others in terms of the competition. Companies in the Raufoss Industrial Park compete vigorously between themselves locally, while also cooperating. Sintef Manufacturing Raufoss was working on the materials science and the production line of both Benteler and Neuman Aluminium. They were competing for the same contract, producing suspension arms for the Audi Q5, where Benteler won the contract. There are few places today that manage this level of competition, while also maintaining strong collaboration. The Raufoss cluster could be characterized as a rare mix, with brutal competition between them, while they are still banding together and supporting each other.

The automotive industry is known for closed innovation and are believed to reach a discontinuity due to high competition and saturated R&D. Toyota, Ford and Volkswagen are among the companies

who spend the most on own R&D, but they're nowhere near the most innovative according to strategy& (Barry Jaruzelski and Hirsh 2015). Original Equipment Manufacturers (OEMs) in the automotive industry can achieve tremendous benefits from open innovation, according to a study conducted by Ili, Albers and Miller (Serhan Ili, Albert Albers et al. 2010). They explain that open-innovation has been thriving in some industries, but the automotive industry is far behind.

*“The cultural change due to Open Innovation in R&D should not to be underestimated. Both researcher and developer need to open up their entrepreneurial responsibility. As long as there is no change in the mindset of how to create and profit from technology, the R&D management will not benefit from the powerful opportunities of Open Innovation.”* (Serhan Ili, Albert Albers et al. 2010)

Sintef Raufoss Manufacturing extend far beyond Raufoss

Kleven Verft collaborate with SRM researchers to fully automate the hull production for their ships (LO 2014). SRM is working on projects with a wide range of companies in Norway, through several research agencies, to make their manufacturing more efficient. Their largest partnership is the Centre for Research-based Innovation Manufacturing (SFI Manufacturing). SFI is hosted by Sintef Raufoss Manufacturing and consists of NTNU Gjøvik and 13 companies across Norway, including Neuman Raufoss. Their vision/strategy is the following according to their website (Manufacturing):

*“SFI Manufacturing's vision is to show that sustainable and advanced manufacturing is possible in high cost countries, with the right products, technologies and humans involved.”*

SFI's main research area is robust and flexible manufacturing. SRM are developing technologies such as “vision”, a way for robots to recognize objects. In addition, they are researching new ways for soft materials and robots to interact.

#### 6.4 The potential for widening the industrial structure

Norway has a highly-educated population and a flat culture that allows factory workers to adapt and make fast decisions. It is still important to consider that the population is quite small and the industrial structure is also narrow. Typical mass producing Industries such as electronics (Stensvold 2016), textiles (soft material automation) and pharmaceuticals (Vespestad 2014) are close to non-existent and many of those which exist tend to be manufacturing specialized or one-of products. Norway may not have the know-how and population required to mass produce within these industries. However, according to Teknisk Ukeblad, the backshoring trend has made the electronics manufacturer Noratron in Norway more profitable (Stensvold 2016), due to a higher demand for robotics. Maybe this is a domino effect that can create growth in demand conditions and new industries, but it's too early to speculate.

Another challenge is packaging, economies of scale in manufacturing is limited in Norway. This has been a considerable problem for Norway second biggest industry, where fish is sent to China for packaging. However, Findus is considering shoring to Norway, focusing on quick lead times to improve the quality of their products (Rein 2014, Armstrong 2015).

### 6.5 Core reasons for backshoring – In Conclusion

There are no findings in this thesis that are quantifiable enough to suggest anything beyond what has been covered in previous research on backshoring. Also, the findings are very similar to those by Arlbjørn (Jan Stentoft Arlbjørn, Teit Luthje et al. 2013), Needham (Needham 2014), Dachs (Bernard Dachs and Zanker 2014) and Kinkel (Kinkel and Maloca 2009). However, other than the research conducted by Agder Research (Bram Timmermans, Sissel Strickert et al. 2016), there is little on Norway, at least specifically. What separates this study from those above, is the heavier focus on non-strategic resources and location theory in relation to backshoring. These are the findings I will discuss in this chapter because it could hold some value for further research.

In all three cases, none of the companies backshored because they had a major problem with their supplier in relation to quality, although transportation costs did affect the decision for Hunton and Neuman. While operational flexibility was an important factor for all three.

However, none of the companies specifically stated that these issues were unexpected and further triggering the outsourcing decision. Hunton Fiber knew their products would be costly to transport and they knew that operational flexibility would be an issue when they were multilateral. The strategy of Kleven has always been directed towards competence when it comes to steel construction, but automation presented an opportunity to automate and backshore more activities. The same can be said for Neuman Aluminium Raufoss, where it was possibilities in automation and domestic competence, not transportation costs or post-backshoring contractual hazards, that fundamentally triggered their backshoring decision. Although, it can be argued, in contrast to Hunton and Kleven, that their decision to backshore was partly unexpected due to a choking capacity in China because of new customer orders. However, that led to the opportunity to better utilize R&D capabilities in Raufoss, rather than locating a facility in Austria or investing in a less productive facility in China.

In conclusion, the decision to backshore was triggered by opportunities rather than unexpected costs. In other words, the manager's decision is not driven by failure to realize the risks of hidden transactions costs when outsourcing/offshoring, but rather that they have *created* an opportunity.

## 6.6 Policy implications

Mass production industries such as the automobile sector is relatively rare in Norway, but their manufacturing know-how has proven useful for businesses across the country because it is transferred through open-R&D. Government funding for both private and public research institutions are vital for SMEs to comprehend manufacturing technology and for the backshoring phenomenon to grow (Tønseth 2013).

Furthermore, is building a digital infrastructure and promote education that meet the growing demand for digital expertise. This is the core requirements for industry 4.0 (Sharma 2017).

That automation is affecting the manufacturing jobs in Norway is likely not the case - as of now. This is due to the low domestic demand conditions and the high amount of exports. It could be argued that offshoring should be prioritized over exports for those companies that must be in close proximity to their customers. However, if automation is a core reason for the backshoring trend, as this study implies, it will create more competence-intensive employment. Therefore, will education become more important, and should be directed towards digital competence.

It should be mentioned that this depends on how fast the technology develops. There is little doubt that more and more jobs will be replaced by robotics, meaning that a universal basic income will likely be the only option.

## 6.7 Business implications

This study implies, for the cases studied, that backshoring manufacturing to Norway reduces overall cost, and that this will strengthen as technology progresses. Although, this is a qualitative study, so it is difficult to make the argument more than an opinion. Furthermore, companies have many different reasons for offshoring, such as a mandatory global footprint, or know-how or other resources that are not domestically available.

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## 8. Appendices

### Appendix 1: What is Artificial Intelligence and big data

*This is not directly relevant to the thesis, so I added it in the appendix.*

John McCarthy proposed the following definition (John McCarthy, Marvin L. Minsky et al. 1955),

*“Every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it. An attempt will be made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves”*

Artificial Intelligence is a machine that can solve problems that are usually solved with natural human intelligence, when a machine learns how to improve itself. The rest of the definition on how to simulate functions of the human brain and even our intuitive knowledge of consciousness is not that relevant.

The technology that is starting to become disruptive in the context of automation, is deep machine learning through big data. Deep learning is a branch of AI derived from neural networks, inspired by mimicking neurons in the biological brain. Deep learning can recognize patterns in digital representations of handwriting, images, music or other data (Hof 2013). The more data the more learning, which is where the term “big data” comes in.

Deep learning requires massive amounts of computational power when it comes to graphical/visual processing. Even though the use of this technology is still in a primary stage of research, Nvidia stocks has skyrocketed since 2015. Some predict that the market cap of Intel, central processing, will be reduced by Nvidia, as cloud based servers and data centres using graphical processing will take over much of the market. Cloud infrastructure and cyber security will become an important part of industry 4.0.

One example of big data is the Tesla model S, which collects a phone’s signal data from any location. Tesla has a more detailed coverage map of Norway than Telenor. Another example, in practice, Sintef has researched something called “Vision” for Neuman Aluminium Raufoss so that their industrial robots can recognize objects to sort parts among other things.

## Appendix 2: Research agreement request

This master thesis or research will study the critical factors that allows Norwegian companies to move their manufacturing from low-cost economies to Norway. About 3-5 companies will be interviewed.

*Main Issue: What factors affect firms' decision to backshore their product manufacturing to Norway and what factors allows for backshoring to Norway?*

### **General information**

The interview will be recorded.

The only one who will have access to this information is Geir O. Aamlid and the supervisor for the thesis, Anders Lunnan.

Personal information will be handled as confidential.

The informer will not be identified in the publication released the 15<sup>th</sup> of May.

The data will be saved without the name of the informer, but the names may still be recorded in the sound file if mentioned. The sound file will be deleted after the information has been converted into written format.

It is voluntary to participate in the study and the informant can withdraw from consent at any time. All information about the informant and data acquired by the informant will be deleted if the informant withdraws.

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