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TITLE:

Boom and Bust: Is Stavanger becoming the New Detroit?
- A Comparative Empirical Analysis of a Cornerstone Economy

AUTHOR		ADVISOR:
Student number:	Name:	**Klaus Mohn**
203648 …………………	**Evelyne Sander N´guessan** …………………………………….	
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Stavanger, 15/06 2015 Signature administration:……………………………

Summary

The purpose of this thesis is to examine whether Stavanger Region are showing indications of being on the same path as Detroit.

An Error Correction Model is estimated on two datasets concerning Stavanger Region and Detroit. Each dataset consists of employment as the dependent variable and other macroeconomic variables. The model distinguishes between short-term and long-term dynamics. The sample period is 1999-2013 and 2003-2014 regarding Stavanger Region and Detroit respectively.

The oil and gas industry in Stavanger Region and the automobile industry in Detroit are both vital in terms of regional economic growth.

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Foreword

This thesis represents the final work of a two-year master´s degree program in Business Administration with a specialization in economic analysis at the University of Stavanger. This thesis examines whether Stavanger Region are showing indications of being on the same path as Detroit.

Choice of subject comes from own personal interest in the importance of the importance of booming economies. The oil and gas industry in Stavanger Region and the automobile industry in Detroit are both vital in terms of economic growth.

I would like to thank my supervisor Klaus Mohn for great constructive criticism and encouraging feedback.

Finally I wish to thank my husband for all the love and support during this process.

Stavanger, June 2015

Evelyne Sander N´guessan

1. Introduction

Stavanger Region is central to the Norwegian oil industry and is regarded as the country´s oil capital. The petroleum industry is Norway´s largest in terms of value creation. Stavanger Region has the largest number of people employed in the oil and gas industry.

Stavanger has experienced strong economic growth since the oil adventure began in 1969 and nearly 40 per cent of all Norwegian oil service companies are based in Rogaland county. Stavanger region being the largest in terms of both employment and revenue generated from the oil industry the last development in the oil price has affected Stavanger Region the worst. The oil price went from being historical above 100 dollars per barrels to fall significant from June 2014. Since then companies have had to cut cost permanently by letting people go.

Detroit was regarded as the automobile capital during the 1960. The city experienced great economic growth during the booming years. The United States has one of the biggest automotive markets in the world and the automotive industry is one of the most important industries in the U.S. economy in terms of value creation.

Motivation for this thesis is Stavanger and Detroit are both examples of two booming economies. Both cities have dominated their respective industry measured by employment and value creation, and Stavanger Region still dominates. However, dependency upon one industry exposes the economy to some degree of risk. Unlike Stavanger Detroit is the biggest city in the U.S. to ever file for bankruptcy.

Research question:

Main objective in this thesis is to examines whether Stavanger Region are showing indications of being on the same path as Detroit?

A booming economy is characterized by industries experiencing unevenly distributed rates of growth. In this thesis employment is used as an economic indicator of growth in a booming sector. In order to capture the linear relationship between the variables in the model an Error Correction Model chosen.

The chapters are organised as follows: chapter 2 provides the theoretical framework of a two-speed economy and empirical research. Chapter 3 provides the case presentation of Stavanger versus Detroit. The econometric analysis and results are presented in chapter 4 followed by a discussion and conclusion and in chapter 5.

2. Theory

A two-speed economy is characterized by industries experiencing unevenly distributed rates of growth. In this thesis employment is used as an economic indicator of growth in a booming sector. The theory consists of labour demand and a theoretical framework regarding the effects of a booming sector.

2.1 Labour Markets

There are three leading actors in the labour market: workers, firms and the government. Workers seek to optimize their own well being while firms seek to maximize profits. Government regulations determine the set of boundaries that will help guide exchanges of demand and supply in the labour market.

2.1.1 Labour Demand

A firm´s demand for labour is specified by a simple two-input production function:

$q = f(k, l)$

The production function shows maximum output (q) of a good produced by a single firm using different combinations of the two inputs, capital (k) and labour (l) in the production process. A firm has the option of either increasing their capital stock or increasing the number of workers hired. The marginal product of the production inputs is defined as the change in output resulting from one more unit of input while holding other inputs constant. Hence, the marginal product of both capital and labour are as follows (Snyder & Nicholson, 2012):

Marginal product of capital = $MP_k = \frac{\partial q}{\partial k} = f_k$

Marginal product of labour = $MP_l = \frac{\partial q}{\partial l} = f_l$

The law of diminishing marginal productivity states that increasing one input, while holding other inputs constant, will eventually result in a decrease in output produced. The marginal productivity of one additional worker hired or a unit increase in capital stock will eventually have a negative effect on quantity produced. Firms seeking to maximize profits will ensure the optimal combination of inputs at given prices. A firm´s decision to hire workers in the short run differs from the decision to hire in the long run (Borjas, 2013).

2.1.2 Labour Supply

The labour supply is given by adding up number of person's decision to enter the workforce in the population. The economy´s labour supply consists not only of the number of persons who enter the labour market, but also the quantity and quality of the skills available to employers. Individuals seek to maximize their utility (well being) by consuming goods and leisure. In order to consume goods, individuals are required to work. The economic trade-off individuals face is whether to consume goods (to work) or leisure (not work). A persons wage rate and income affects the decision of allocation of time between work and leisure. A person´s labour supply decision is affected at any given point in time, and the allocation of time towards leisure changes over a person's life cycle (Borjas, 2013).

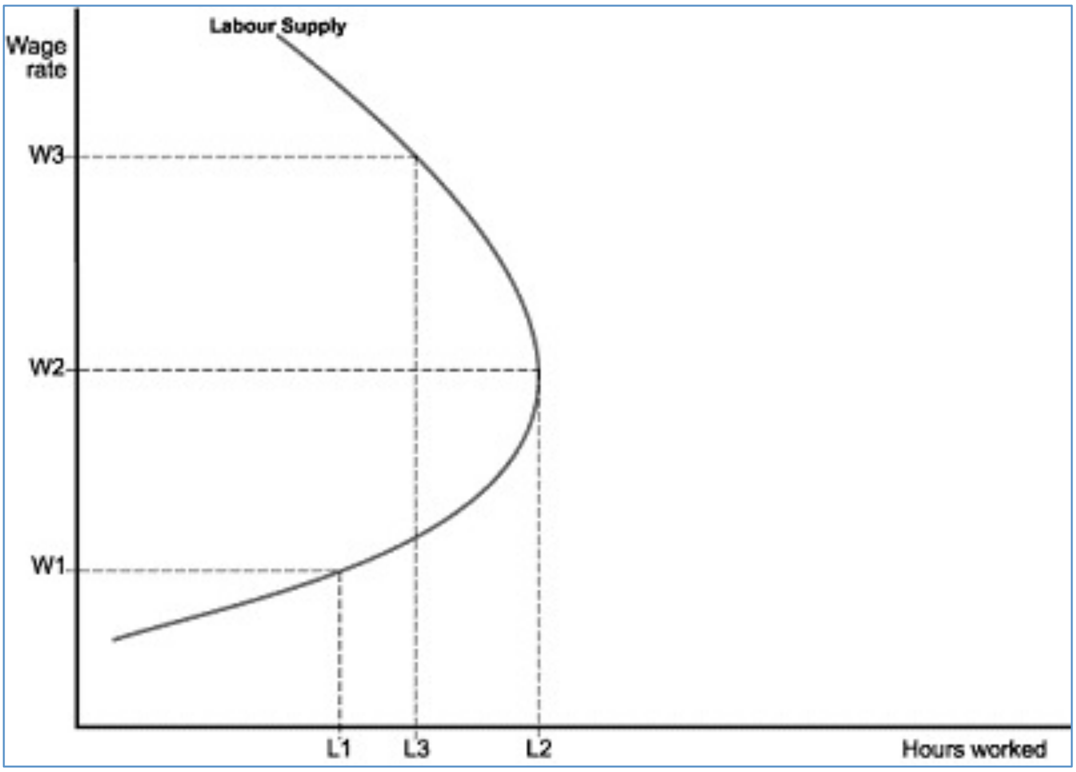
The neoclassical model of labour-leisure choice isolates the factors that determine whether a person chooses to work and the number of hours worked. Individuals' utility function assumes the individual receives satisfaction from both consumption of goods and consumption of leisure, denoted C and L respectively. The utility function measures a person's level of satisfaction constrained by time and income:

$$U = f\,(C, L) \quad \text{s.t. } C = wh + V$$

A portion of income is independent of number of hours worked, nonlabour income denoted as V. Wage rate is denoted as w and h represents number of hours allocated towards work. The impact of a change in number of hours worked holding wages constant is called the *income effect*, which implies that an increase in nonlabour income, while holding wage constant, reduces the number of hours worked. When wage increases, holding nonlabour income constant reduces the demand for leisure and increases number of hours worked. Substituting away from leisure and towards consumption of goods is called the *substitution effect.* The income effect and substitution effect dominates each under different circumstances. If an increase in wage rate increases number of hours worked, the substitution effect dominates the income effect. And when an increase in wage rate reduces number of hours the income effect dominates the substitution effect.

The utility-maximization framework generated produces a supply curve for every individual in the economy. The labour supply curve for a worker will eventually bend backwards and have a negative slope as shown in figure 1.

Figure 1 Labour Supply Curve for a Worker



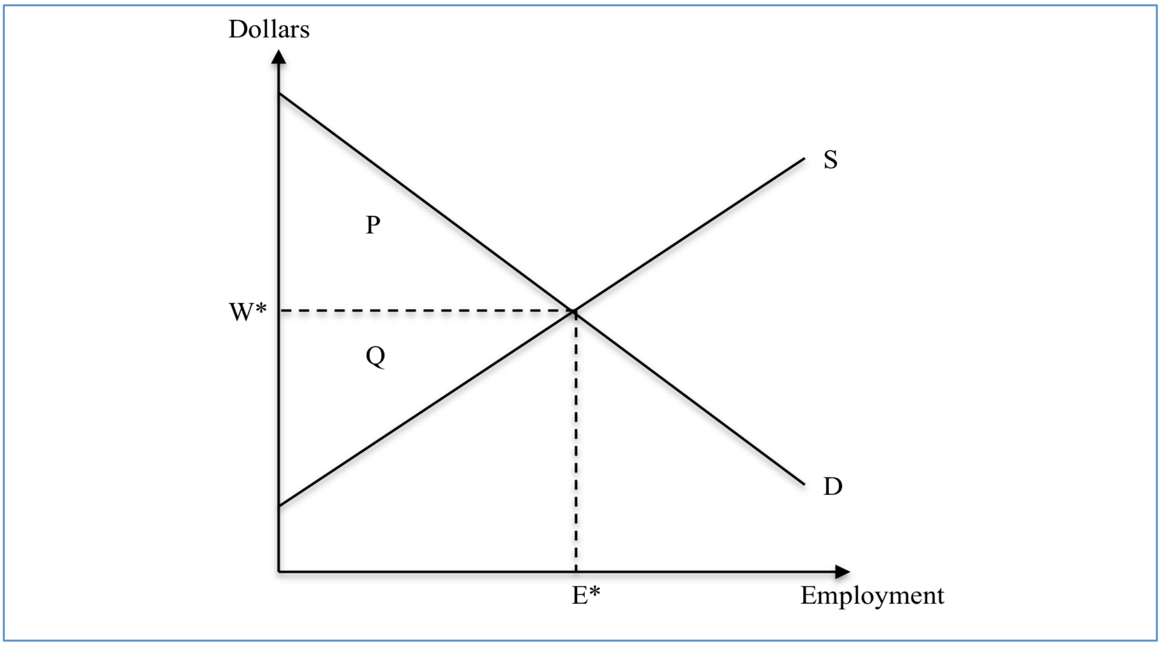
Source: Borjas (2013)

The upward sloping part of the labour supply curve indicates that the substitution effect is stronger than the income effect. The backward-bending part of the labour supply curve implies that the income effect will eventually dominate. The aggregate labour supply curve constitutes all individuals willingness to work at a given wage in the economy as a whole.

2.1.3 Labour Market Equilibrium

The labour market consists of workers willingness to supply their skills and firms desire to hire workers at a given market wage. Firms prefer to hire when the market wage is low, while workers prefer to work when the wage is high. The labour market equilibrium balances out these conflicting interests by determining the market wage and the number of employed workers in a competitive labour market (Borjas, 2013).

Figure 2. Equilibrium in a Competitive Labour Market



Source: Borjas, (2013)

The figure shows the equilibrium in a competitive labour market. The labour supply curve *(S)* represents the number of hours workers in the economy are willing to supply at any given market wage. The labour demand curve *(D)* gives the total number of workers firms are willing to employ given the market wage. The equilibrium, where the two curves intercept provides an efficient allocation of the labour resources. The market demand curve denotes the value of the marginal product of labour. The triangle P represents the producer surplus accumulated by the firms operating in the market. The difference between the competitive wage a worker receives and the value of worker´s alternative use of time spent is characterized by the triangle Q. The total gains from trade in the labour market is equal to the sum of both triangles, P and Q (Borjas, 2013).

2.2 Economics of A Two-Speed Economy

Corden and Neary (1982) provide a theoretical framework for analysing the structural changes in a small open economy. The model demonstrates the effect of the term Dutch Disease, which originated in the Netherlands. The term Dutch Disease is used to describe the negative effects from the country's discoveries of natural gas, mainly the appreciation of the Dutch real exchange rate. The theory distinguishes between two main effects occurring from a boom: the spending effect and the resource movement effect (Corden, 1984).

2.2.1 The Basic Theoretical Framework

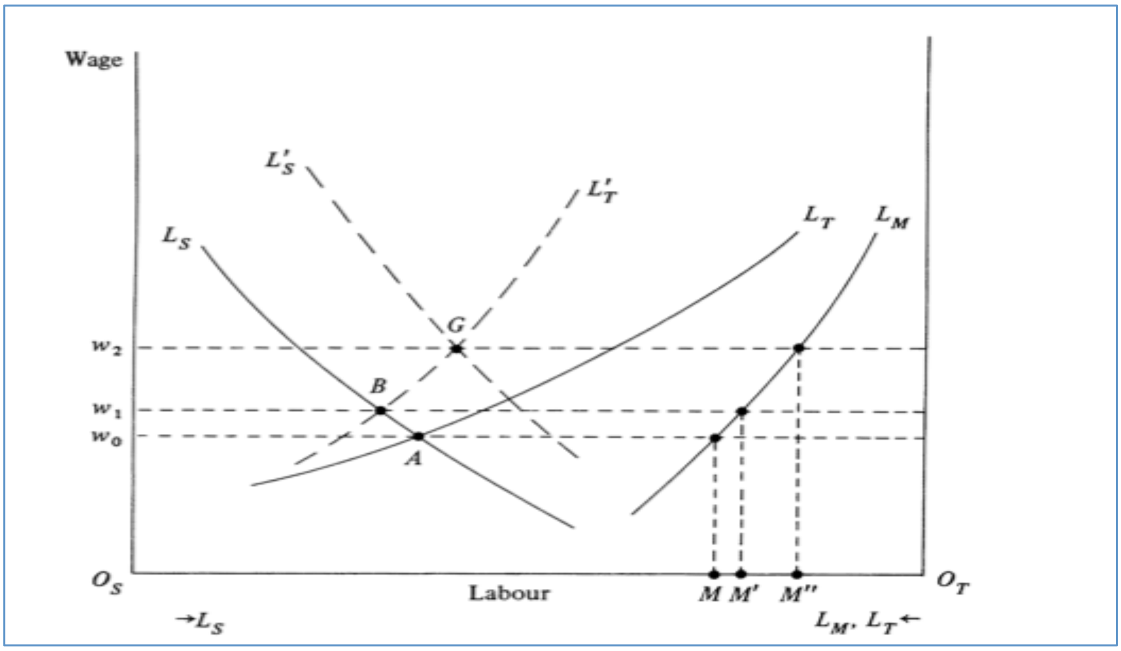
The model consists of three different sectors: one non-tradable sector and two tradable sectors: the booming sector and the lagging sector. Each tradable sector produces goods traded at exogenously given prices. The three sectors produce output using a single specific factor, such as capital, and a perfectly mobile factor, such as labour. The booming sector is regarded as the energy sector while the lagging sector is viewed as the manufacturing sector. The non-tradable sector is labelled as the service sector.

The framework examines the effect of a boom occurring in the energy sector and the impact it has on the manufacturing sector. There are different reasons for a boom to occur in the economy. One reason could be the result of an oil shock. Other reasons could be an exogenous technological improvement occurring in the booming sector or an exogenous increase in export prices. The theoretical framework assumes the boom occurs as a result of an exogenous technological improvement. In addition, the model assumes real magnitudes rather than nominal. In order to ensure full employment in the model the real wages are assumed to be perfectly flexible (Corden & Neary, 1982).

2.2.2 Labour as the mobile factor

The effect of a boom when labour is the only mobile factor leads to de-industrialisation. In each sector the demand for labour is defined as a decreasing function of the wage relative to the price of the output. Figure 2. shows the impact a boom has on the labour market:

Figure 3. The Impact on the Labour Market



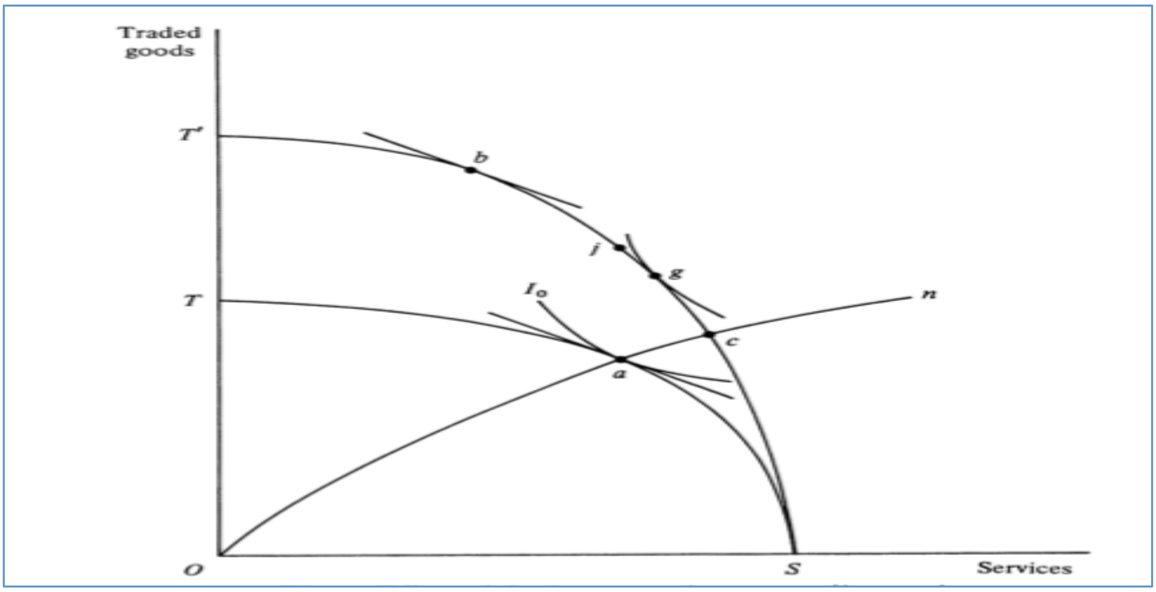
Source: Corden & Neary, (1982).

The wage rate in the market is located on the vertical axis, while total available force is on the horizontal axis, O_SO_T. Each sector has its own labour input into the production function. The labour input in the two tradable sectors, is the distance measured from O_T. The distance from O_S measures the labour input in the non-tradable sector. The curve L_S describes the labour demand for the non-tradable (service) sector, while the labour demand for the manufacturing (lagging) sector is given by the curve $L_{M.}$ The curve L_T on the other hand, denotes the total labour demand combined for the two tradable sectors, the manufacturing and the energy (booming) sector. Point A in the figure illustrates the pre-boom equilibrium in the labour market, the intercept between the demand curves L_T and L_S (Corden & Neary, 1982).

As previously mentioned, the theoretical framework distinguishes between the resource movement effect and the spending effect. A boom in the energy sector causes the marginal product of labour in the booming sector to rise, shifting the total demand curve from L_T to $L_{T'}$. The shift in total demand creates a new equilibrium in the market, located at point B. The increase in labour demand draws resources out from the other sectors in the economy into the production in the booming sector. These labour movements are known as *the resource movement effect*. *The spending effect* comes from a higher real income as a consequence of the boom, resulting in extra spending. The extra spending on services causes real appreciation, an increase in the prices (Corden & Neary, 1982).

A boom in the energy sector also has an effect on the production possibility curve in the commodity market, illustrated in the following figure:

Figure 4. The impact on the commodity market



Source: Corden & Neary, (1982).

The figure shows the production possibility curve of traded goods and services produced in the economy. The effect of a boom occurring in the energy sector does not affect the economy´s maximum output of services. Instead the boom increases the maximum production of traded goods, by shifting the production possibility curve from OT to OT´. The resource movement effect however, lowers the output of services illustrated in point b. The decrease in output of services produced creates an excess demand, which in return leads to a real appreciation. The spending effect alone also generates an excess demand, causing the price of services to rise. Combining the resource movement effect and the spending effect, both creating a real appreciation, figure 4, the commodity market will end up at the final equilibrium specified at point G (Corden & Neary, 1982).

The movement of labour out of the manufacturing sector into the energy sector results in a direct de-industrialisation, caused by the resource movement effect alone. The resource movement effect will lower the output of services in the commodity market, while the spending effect will increase the output. Both effects will create an excess demand, which will lead to real appreciation in order to restore the market equilibrium. The rise in the price of services causes the labour demand in the service sector to shift upward. This will create an indirect de-industrialisation in the manufacturing sector, by further lowering the employment (Corden & Neary, 1982).

2.2.3 The Impact on Real Wage

The real wage rises as a result of the resource movement effect alone. However, the spending effect will cause the real wage to either rise or fall. Considering both effects happening simultaneously, the effect on real wage is uncertain. Real wage is dependent on the relationship between the two effects. A boom in the energy sector will result in the real wage declining the *stronger* the spending effect is relative to the resource movement effect (Corden & Neary, 1982).

2.2.4 Capital as the mobile factor

When capital is the mobile factor the effects of the boom in the energy sector is extended to revolve around a longer time horizon. Assuming that capital is mobile between the two sectors not experiencing a boom, the effect of a resource movement changes. The two non-booming sectors vary the inputs of both labour and capital differently. One sector is capital-intensive while the other sector is labour-intensive. Instead of the resource movement effect causing de-industrialisation, it will lead to pro-industrialisation.

2.3 Empirical Evidence on Booming Economies

The literature regarding booming economies resulting from the discovery of natural resources is extensive. Several empirical studies have analysed the adverse effects from a country's discovery of natural resources and what impact fluctuations in world energy prices has on the economy.

Both oil importing and oil exporting countries are affected by fluctuations in the oil price. Jiménez-Rodriguez and Sánchez (2005) have empirically analysed the effects of oil price shocks on the real GDP growth of the main industrialised OECD countries during the period from 1972 to 2001 by carrying out a multivariate vector autoregression analysis (VAR) on time series data. By distinguishing between oil importing and oil exporting countries they found that an increase in the oil price had a negative impact on the GDP growth for all oil importing countries with the exception of Japan. The oil exporting countries were affected differently. An increase in the oil price was found to have a positive effect on the GDP growth of Norway, while having a negative effect on the GDP growth of U.K.

Davis and Haltiwanger (2001) studied the effects of oil price shocks on the creation and destruction of U.S. manufacturing jobs during the period from 1972 to 1988. By estimating a constrained panel vector autoregression model on sectoral job and destruction rates, results show that oil price shocks accounted for 20-25 per cent of the variability in employment growth in U.S. manufacturing jobs during the period from 1972 to 1988. Employment growth was found to respond asymmetrically to increases and decreases in the oil price. In addition oil shocks trigger significantly job reallocation activity. The oil price shock in 1973 was estimated to cause an 8 per cent decline in manufacturing employment within two years.

Bjørnland and Thorsrud (2014) examined the Dutch disease effect while accounting for productivity spillovers between the booming resource sector and other domestic sectors with regards to Australia and Norway during the period from 1991 to 2012 and 1996 to 2012 respectively. By estimating a Bayesian Dynamic Factor Model (BDFM) on quarterly data they find evidence of two-speed economies and that a resource booming sector has a substantial productivity spillovers on the non-resource sectors. Findings show that productivity and production in both Australia and Norway are both stimulated by the resource sector. The non-traded industries are found to be growing at a faster pace than the traded. With regards to Australia their findings reveal evidence of Dutch disease effect crowding out manufacturing. While in Norway they find no evidence of Dutch disease, revealing that both countries respond differently to a commodity price shock. Bjørnland and Thorsrud (2014) have used a very narrow definition of the Dutch disease. The Dutch disease consists of a much more wider aspect of symptoms. When using a wider definition it would not necessarily lead to the same conclusion (Mohn, 2015).

Beine, Coulombe and Vermeulen (2014) examined whether immigration could help mitigate the effects of the Dutch disease by estimating a dynamic panel-data model on regional data from Canadian provinces from 1987 to 2007. The paper focused on the spending effect, which results in an appreciation of the real exchange rate and a rise in the size of the non-tradable sector. The authors find evidence that aggregate immigration eases the Dutch disease effect. The booming provinces tend to experience an increase in the share of the non-tradable sector at the expense of the tradable sector. This impact is found to be lower due to the increase in labour supply from the immigration of workers into the booming provinces.

Structural changes in employment patterns across various regions in the booming energy sector of the province Alberta in Canada was examined by Brox, Carvalho and Mackay (2010). They studied how the energy boom affected the rates of employment growth in different occupations and industries across regions during the period from 1987 to 2006 by applying shift-share regression analogue. Findings indicate that growth was evenly balanced across all regions with the exception of one. In the region of Edmonton the growth rate of occupations within service, public administration and agriculture were significantly lower than the average growth rate of the economy as a whole. In addition occupations within in the oil and gas sector and technical services had grown faster than average.

While several empirical studies find similar results of the adverse effects of the Dutch disease Graham A. Davis (1995) finds evidence of the opposite. He examined the long-run economic and development performance of 22 mineral economies by collecting data on different economic and development indicators. The years selected for analysis are 1970, prior to the oil and gold boom and 1991, after the boom settled. The years were selected because these were unexceptional years in terms of mineral prices and therefore provide information on how the mineral economies have developed and coped with the mineral price shocks of the 1970s and 1980s. Results indicate no evidence of underperformance or a resource curse during the period from 1970 to 1991. Davis argues based on his findings that the adverse effects of the Dutch disease should be viewed as the exception rather than the rule. At the same time he does not rule out the possibility of dismissing the Dutch disease too early due to the fact that only one out of 22 mineral economies have moved on from being a mineral producer.

The Dutch disease may have a different effect on a developing country compared to a developed country. Benjamin, Devarajan and Weiner (1989) studied the impact of an oil boom in the developing country Cameroon during the period from 1979 to 1980 by simulating a computable general equilibrium model. Findings show that despite of the real exchange rate appreciation, not all traded goods sectors ended up contracting. Some sectors expand output as a result of imperfect substitutability between domestic and foreign goods. Results also reveal that the agricultural sector will end up contracting while the manufacturing sector actually will expand.

3. Case Presentation

3.1 Stavanger – The Oil Capital

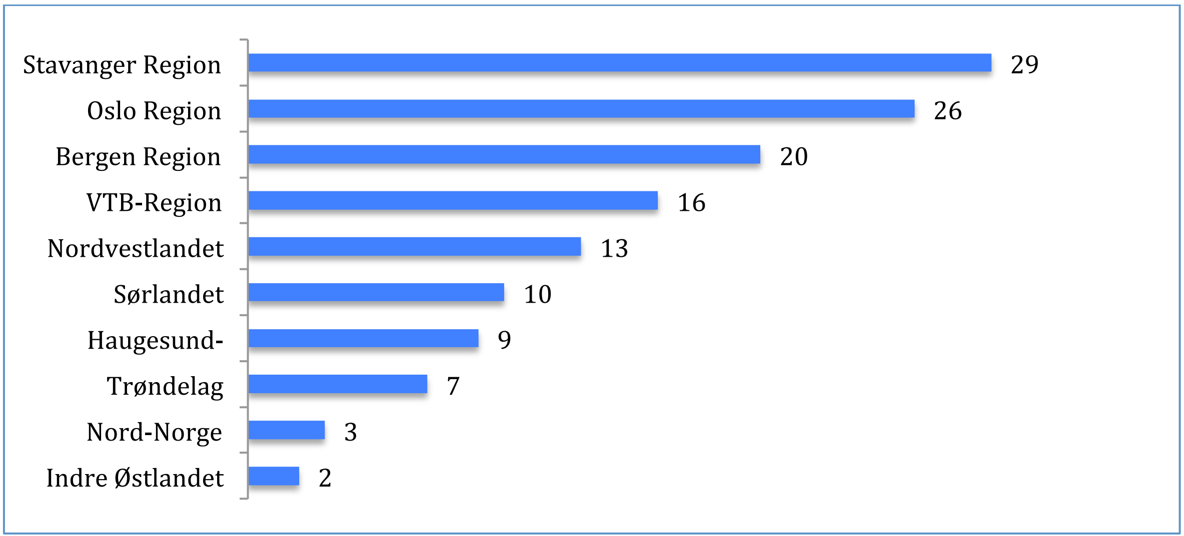
Stavanger is at the heart of the Norwegian oil industry and is regarded as the country´s oil capital. The first oil field was discovered back in 1969 and ever since production started in the early 1970s the petroleum industry has generated values in excess of NOK 12,000 billion in current terms. The Stavanger region has a cluster of strong petroleum expertise and employs the most people within the oil and gas sector. The Norwegian Petroleum Safety Authority, which is responsible for regulatory affairs, and the Norwegian Petroleum Directorate, which oversees the management and control of petroleum resources, are both located in Stavanger. Petoro, which is the licensee for The Sate´s Direct Financial Interests in production, licences, field, pipelines and land-based plants, have their office placed in Stavanger.

The petroleum industry is Norway's largest industry measured in value creation. In 2012 the industry accounted for 23 per cent of gross domestic product, which is more than twice the value creation of the manufacturing industry and 15 times the total value creation of the primary industries. If taken into account the effect of the petroleum industry´s demand on the overall economy, the number of people employed is close to 250,000. In 2014 investments amounted to over NOK 214,3 billion (SSB).

The Norwegian service and supply industry is Norway´s second largest industry. The industry includes companies that supply oil and gas related products or services to the upstream oil and gas industry. According to a report from Rystad Energy (2014) the industry consists of a total 1 300 Norwegian oil service companies. These companies supply services across the entire value chain. In 2012 the oil service companies employed a total of 162,000 people, where about 26 000 was permanently stationed offshore which accounts for 16 per cent of total employment within the oil service industry. Export

Stavanger region is Norway´s third largest region with a population of more than 300,000. Since the beginning of the Norwegian oil adventure the city has transformed itself from an industrial trading town into an energy centre. Stavanger region has experienced strong economic growth since the oil adventure began in 1969. All major international operators are present in Stavanger and nearly 40 per cent of all Norwegian oil service companies are based in Rogaland county region. There are approximately 338 companies located in the region. Stavanger region is the largest in terms of both employment and revenue generated from the oil service and supply industry, as illustrated in both figure 4 and figure 5.

Figure 5. Number of employees in Norwegian Oil Service Companies, expressed in thousands

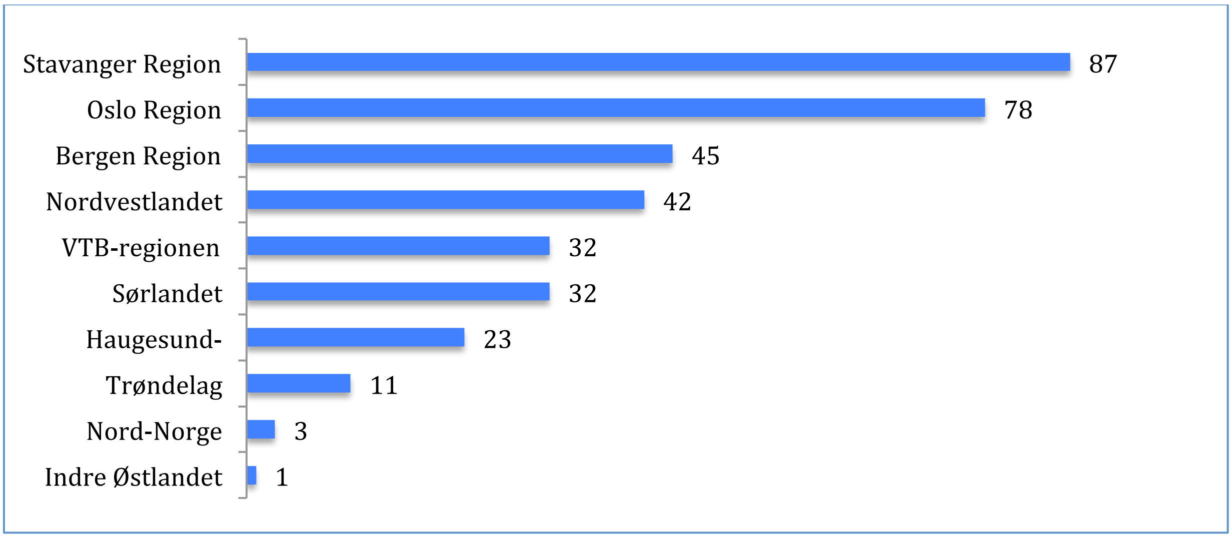


Source: Rystad Energy (2014)

In 2012 about 29 000 were employed in the oil service companies in the Stavanger region, which accounts for 15 per cent of total employment in the oil service industry. During the period from 2006 to 2008 Stavanger region experienced 7,1 % annual employment growth, the number of people employed increased from 19 000 to 29 000.

The Norwegian oil service industry generated revenue of NOK 355 billion in 2012. The industry has experienced approximately 10 % annual growth in revenue since 2006. From 2006 to 2008 the annual growth rate was even higher. The industry has benefited from 20 % annual increase in revenue before the effect of the financial crises of 2008. Measured by revenue Stavanger region is also the largest. I 2012 the revenue generated from companies in the region of Stavanger alone was close to NOK 90 billion, as illustrated in figure 5. The second largest region measured by revenue is Oslo region with NOK 78 billion in revenue, followed by Bergen region with NOK 45 billion in revenue.

Figure 6. Revenue from oil and gas sector, Norwegian Oil Service Companies in 2012 (excl. offshore, sorted by region)



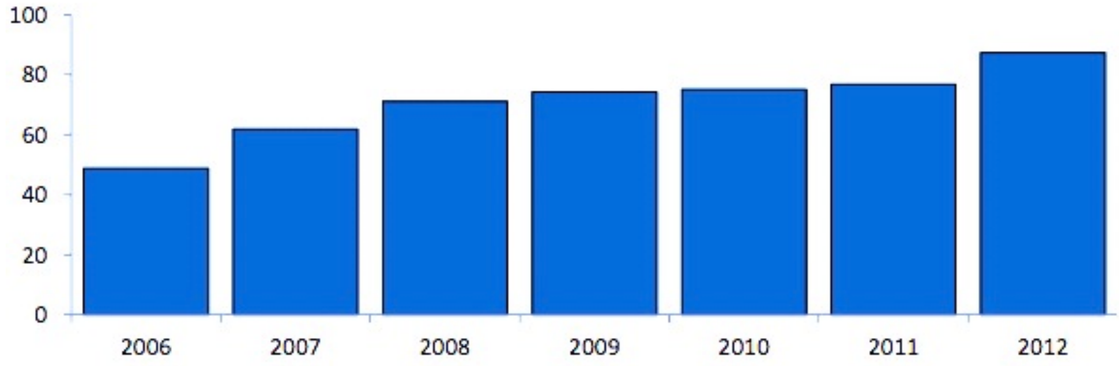
Source: Rystad Energy (2014)

Fig. 5 and fig. 6 combined demonstrates how vital the region of Stavanger is to the Norwegian petroleum industry. Norway is the largest holder of oil and gas reserves in Europe making the country an important supplier of both oil and gas. In 2013 Norway was the world´s third-largest natural gas exporter and the twelfth largest net exporter of oil. Nearly all the Norwegian gas is sold on the European market. The export value of crude oil, natural gas and pipeline transport services accounted for approximately NOK 564 billion in 2013 corresponding to 49 per cent of Norway´s total export value. Regardless of more than 40 years of production on the Norwegian continental shelf, approximately only 42 per cent of the total expected resources have been produced. Vast sums have been invested since the beginning of production in field development, exploration, transport infrastructure and onshore facilities (EIA, 2014).

The petroleum industry is in return also vital to the region of Stavanger. Figure 6 shows the revenue from Norwegian oil service companies in the region of Stavanger alone. From 2006 to 2009 total revenue had an annual growth rate of 15 per cent. In 2006 only a smaller fraction of total export revenues was generated from the Stavanger region based companies. Since 2006 the amount of export from the region has increased. In 2012, after the effect of the financial crises of 2008, total revenue from oil service companies in Stavanger region increased by 14 per cent where export accounted for 25 per cent of total revenue.

Figure 7. Revenue from Oil and Gas Sector, Norwegian Oil Service Companies, Excl. Stavanger Region

Revenue, billion NOK

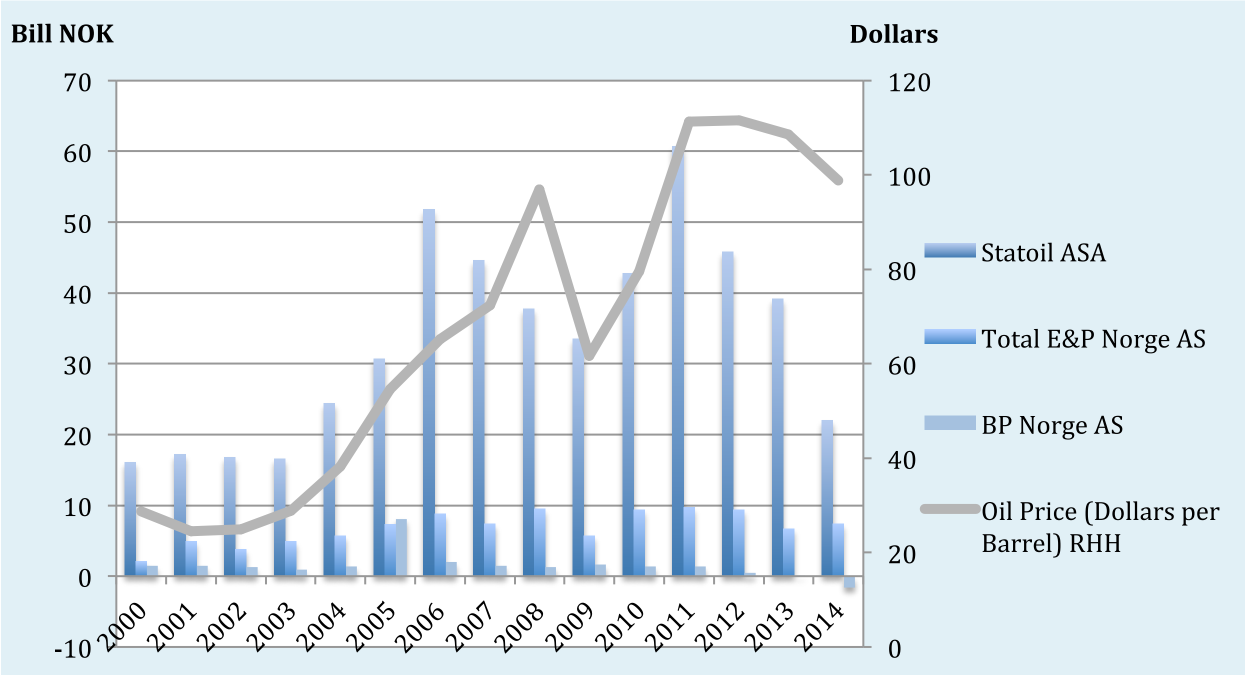


Source: Rystad Energy (2013)

The region of Stavanger is the largest in terms of both employment and revenue generated from the oil service and supply industry and consists of multiple districts. The primary districts are Stavanger, Sola and Sandnes. Together with Randaberg district, these four districts accounts for 94 % of total revenue generated from oil service companies in Stavanger region. In addition Stavanger region also is home to all major operator companies. Measured by companies´ production volumes in 2013, the largest company operating on the Norwegian continental shelf is Statoil. The Norwegian State is the largest shareholder in Statoil, with a direct ownership interest of 67% and has its headquarters in Stavanger.

The petroleum industry has also been vital to the financing of the Norwegian welfare state. The State´s tax revenues from petroleum activities are transferred to the Government Pension Fund Global. In 2013 total revenue from the petroleum sector was about 29 per cent of the State´s total revenues. The fund is integrated into the government budget. The government may spend only the expected real return of the fund, estimated at 4 per cent per year. This budgetary rule is a fundamental principle of Norwegian fiscal policy, allowing oil revenues to be gradually phased into the economy. The fund´s market value in 2014 was 6,431 billion NOK, delivering a return of 544 billion NOK. By spending only the return, the fund will secure and benefit future generations after the oil runs out.

Figure 8. Net Income of Oil Producing companies and oil price, Period 2000-2014



Source: Proff, Brønnøysunregistrene, Annual Accounts

Figure 8 shows net income of three selected oil producing companies, Statoil Total and BP during the period from 2000 to 2014. All three companies are located in Stavanger. As mentioned Statoil has its headquarters located in Stavanger whereas BP and Total has its Norwegian headquarters placed in Stavanger. The grey line represents the oil price during the same period.

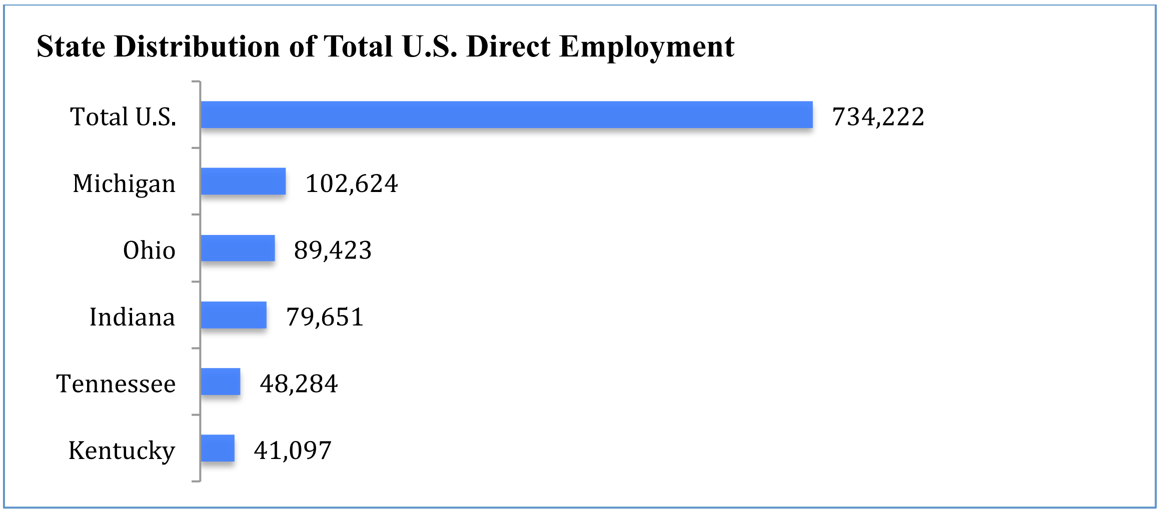
3.2 Detroit – The Automotive Capital

Detroit is home to the three big U.S. auto companies: General Motors, Ford and Chrysler. Detroit was regarded as the automobile capital and the symbol of the American dream of economic growth and prosperity during the 1960s. Detroit is located in Wayne County in the state of Michigan. During the period between 1900 and 1930 Detroit experienced tremendous population growth. The city increased from 305,000 to a population of 1,837,000 caused by the concentration of the automobile industry around Detroit. The city became the automobile centre by 1909 and later evolved into an oligopoly dominated by General Motors, Ford and Chrysler. Firms in the Detroit area dominated the industry. The U.S. automobile industry was one of the earliest examples of an agglomeration industry and also one of the most extreme (Klepper, 2007).

The United States has one of the biggest automotive markets in the world. The automotive industry is one of the most important industries in the U.S. economy in terms of value creation, and the industry extends to every state in the country. Periods of growth in the automotive manufacturing industry are closely linked to periods of growth in the overall economy. Consequently, the manufacturing and automotive industry serves as an indicator of the condition of the economy as a whole (Hill, Menk, Cregger, & Schultz, 2015)

In 2012 the motor vehicle supply industry and the automotive aftermarket directly employed over 734,000 people across the whole country, as shown in figure 7. Michigan is one of top five states that made up almost 50 per cent of total direct employment in the auto manufacturing industry. In 2012 Michigan alone employed 102,624 people, equal to 14 per cent of total direct employment. If taking into account the indirect and induced effects from the auto manufacturing industry, the impact of the industry is far greater. The indirect economic impact at the national level resulted in total 1.27 million employees, whereas the induced effect resulted in 1.62 million employees. Consequently, the U.S. automotive manufacturing industry supported a total of 3.62 million jobs in 2012. All three effects combined generate nearly 355 billion dollars in added value, equal to 2.3 per cent of U.S. GDP (Robinez et al. 2013).

Figure 9. State distribution of five states of total direct employment in the U.S. Motor Vehicle Supply Industry, in 2012

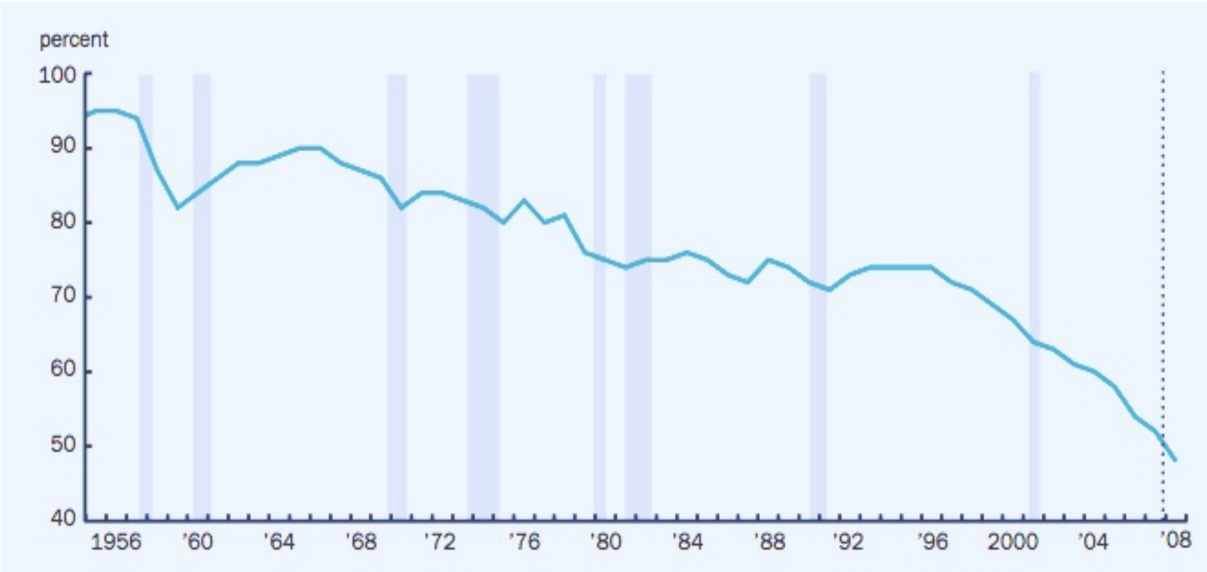


Source: Robinez et al. (2013)

Michigan is the largest state contributor of total national employment. In addition to direct employment of 102,624 people, the indirect effect is equal to 118,705 employees whereas the induced effect results in 164,886 employees. In total Michigan accounts for 386,215 employees, which is approximately 11 per cent of the total national employment contribution (Robinez et al. 2013).

During the period from mid 1950s through 2008 the big three Detroit automakers lost over 40 percentage points of market share in the United States. The decrease in market share was a result of an increase in competition. The U.S. auto industry lacked competitiveness during the 1950s and 1960s as a result of the industry being concentrated around a few number of companies. The shift in market share resulted in regional economic implications. The automotive activity in the Midwest was heavily affected. Between 2000 and 2008 the auto industry lost a total of more than 395,000 jobs. In Michigan alone 42 per cent of the job losses occurred. The recession of 2008 reinforced the downturn. Figure 8 shows the decline in market power for the three Detroit automakers during the period from 1955 to 2008. Three different periods had an impact on the decline in market share of the three Detroit automakers. The first phase was from the mid-1950s to 1980, second phase from 1980 to 1996, and the third phase from 1996 to 2008 (Klier, 2009).

Figure 10. The Three Detroit Automakers U.S. Market Share, Market share measured for passenger cars. Period 1955-2008.



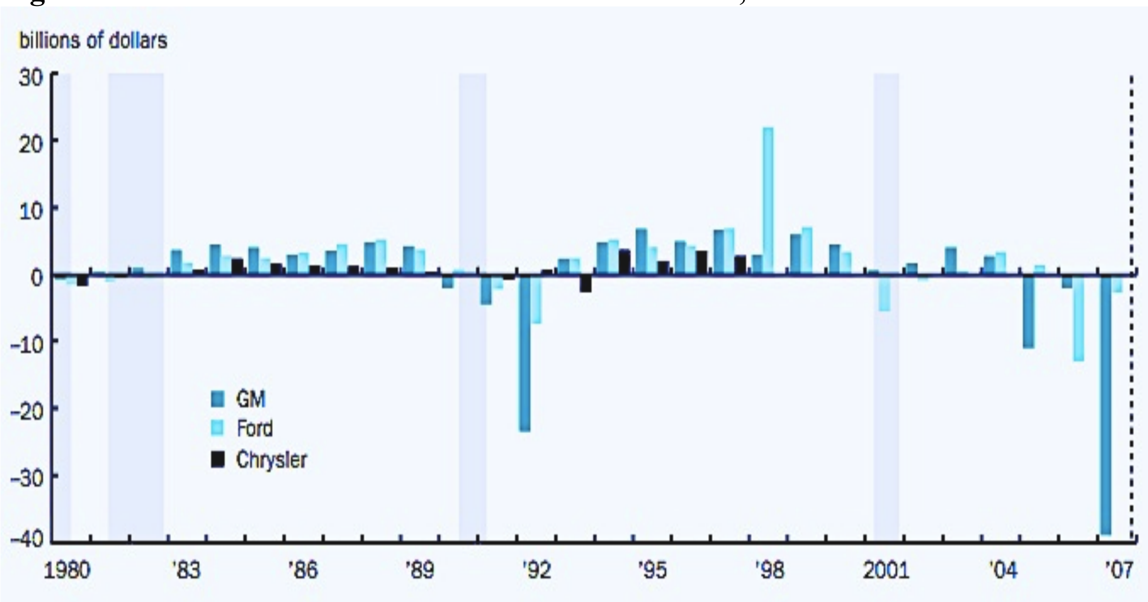
Source: Klier (2009)

The light shaded areas in the figure 10 indicate official periods of recession. The first phase, from mid-1950s to 1980 was characterized by challenges from imports and oil shock. Imports had captured nearly 15 per cent of sales by the end of 1960. The oil price shock that occurred in 1979 caused the price of gasoline to increase 80 per cent between January and March that same year. Consumer demand shifted towards more fuel efficiency and better quality cars, which were not being produced by the Three Detroit automakers at the time. During the first phase their market share fell to 73 per cent (Klier, 2009).

The Second phase, from 1980 to 1996 the Detroit manufacturers gained from the recovery in economic activity in the early 1980s. A rapid decline in the price of gasoline combined with recognising and adapting to changes in consumer preferences the three Detroit automakers were able to benefit from the market. Between 1980 and mid-1990s their U.S. market share were stabilized and all three companies generated profits.

The third and last phase was from 1996 to 2008. While the industry sales volumes of vehicles continued to rise until the year of 2000, the Detroit automaker's share fell by 26 percentage points from 1996 to the end of 2008. The two best-selling years were 1999 and 2000. The Detroit automakers were able to stay profitable despite the market share decline as a result of rising sales volumes. The price of gasoline increased significantly again in 2007, and in the beginning of 2008. Consumer preferences changed similarly to the previous increase in gasoline prices. The price of gasoline increased 80 per cent in 2007-08 as well as it did in 1979-80, which resulted in consumer demand for more fuel-efficient cars (Klier, 2009). Figure 9 shows net income of the three Detroit automakers during 1980 to 2007. The light shaded areas in the figure indicate official periods of recession.

Figure 11. The Three Detroit Automakers Net Income, 1980-2007



Source: Klier (2009)

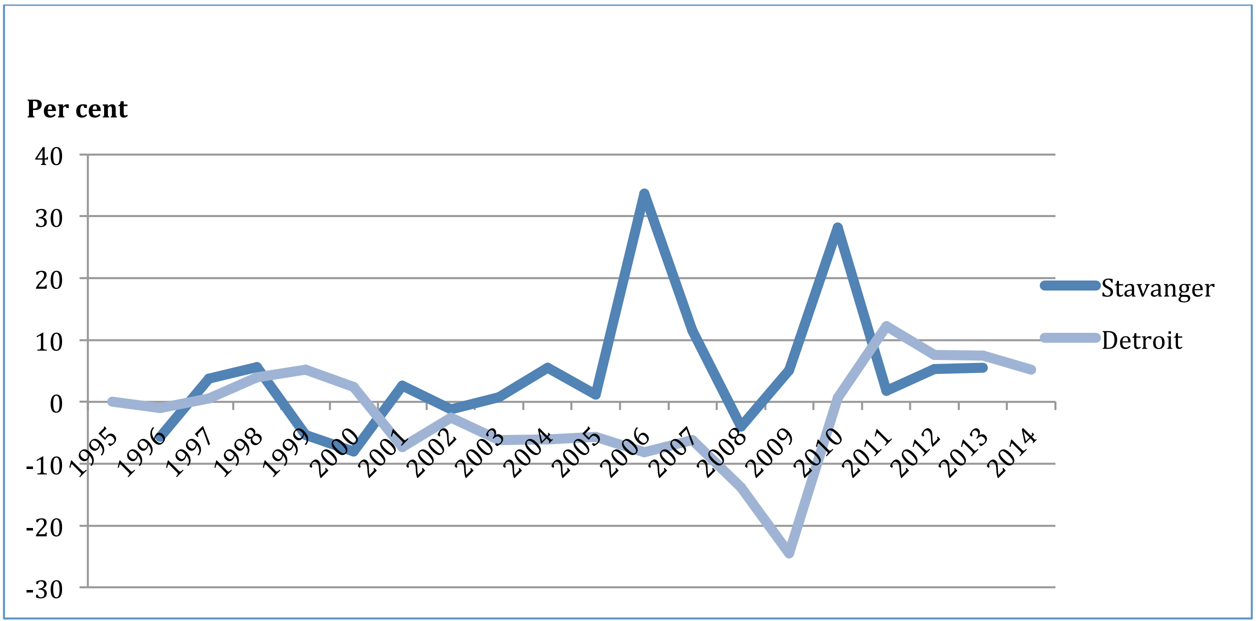
During the end of 2008 the economic conditions for the three Detroit declined rapidly. The effects of the financial crises of 2008 caused a sharp contraction in automotive sales. Vehicle sales declined 40 per cent in 2009. Even though the automotive industry has been restructuring for several years the financial crisis resulted in further contraction. Chrysler and General Motors received nearly 25 billion dollars in financial assistance from the federal government in 2009. Further assistance was given in light of additional decline in vehicle sales during the beginning of 2009. May 2009 Chrysler filed for bankruptcy. A period of dominance by just a few auto companies is part of the past. The U.S. auto industry today is far more international (Klier, 2009).

3.3 Stavanger versus Detroit

Stavanger and Detroit are both examples of two booming economies. Both cities have dominated their respective industry measured by employment and value creation as illustrated previously. However, dependency upon one industry exposes the economy to some degree of risk. Unlike Stavanger Detroit is the biggest city in the U.S. to ever file for bankruptcy.

Both booming industries have experienced in increase in wages and employment. Figure 12 shows percentage change in industry employment during the period from 1995 to 2014.

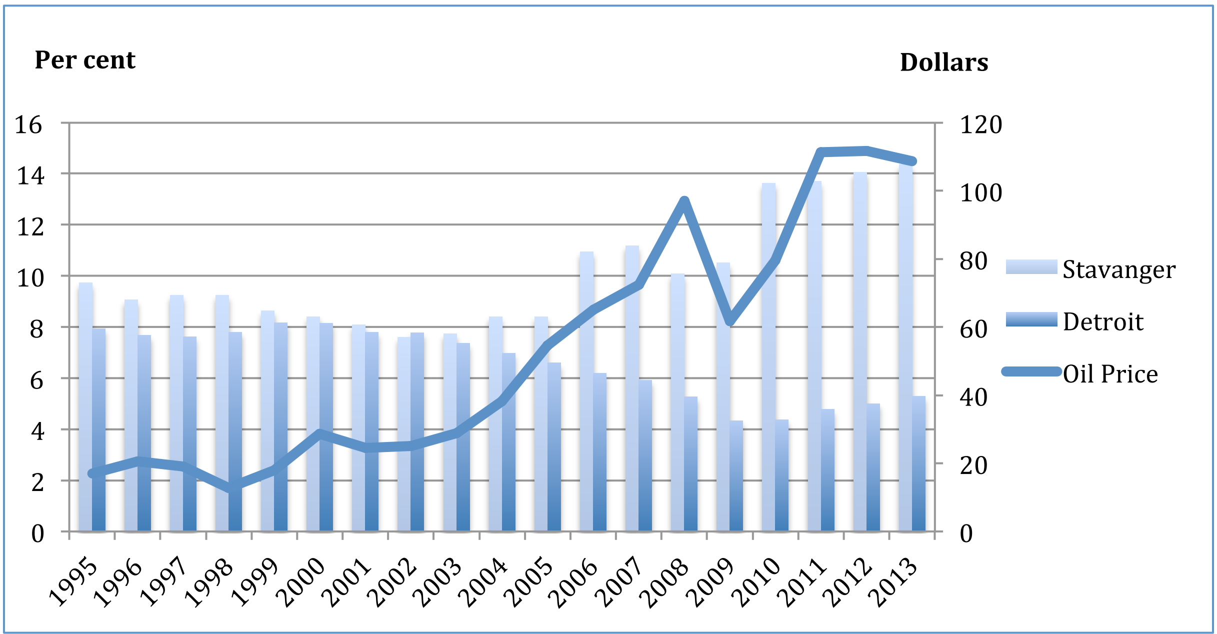
Figure 12 Per cent change in employment, period 1995-2014



Source: Statistics Norway and Bureau of Labour Statistics

The figure shows that per cent change in Stavanger Region and Detroit tend to move in opposite directions. From 1997 to early 2000 Detroit experienced a positive percentage change. From mid 2000 to 2011 however, Detroit has experienced a negative percentage change in employment. The industry faced different difficult faces of restructuring and increased competition. From 2012 the industry has managed to generate a positive per cent change in employment. Stavanger Region has experienced mostly positive percentage change in employment but also periods of negative change. In 2006 and 2010 Stavanger region experienced an increase of 34 and 28 per cent change.

Figure 13. Industry share of employment and oil price, period 1995-2013



Source: Statistics Norway, Bureau of Labour Statistics, Energy Information Administration

Figure 13 shows share of employment within each city´s respective industry and the oil price during the period from 1995 to 2013. The effect of the financial crises in 2008 had an effect on both industries. During the period from 1995 to 2005 both industries have a similar share of employment. The oil price during the same period is relatively low compared to more recent years. During the period between 2004 and 2008 the oil price increased from 38.26 dollars to 96.94 dollars per barrel. The industry share of employment in Stavanger Region also experienced an increase, with the exception of 2008. Industry share of employment I Detroit decreased during the same period. The effects of the financial crisis in 2008 affected the oil price and employment in both cities. Nonetheless, Stavanger Region suffered minor contraction compared to Detroit.

4. Econometric Analysis

In order to best capture and measure economic growth of a booming economy, employment is chosen as the explained variable with four other explanatory variables. A multivariate time series model is chosen to describe the linear relationship among the variables.

4.1 Dataset

The data material is obtained from different data sources. Data concerning Stavanger is collected from Statistics Norway (SSB) while data regarding Detroit is obtained from U.S. Bureau of Labor Statistics (BLS) and The Federal Bank of St. Louis (FRED). The oil price is from the U.S. Energy Information Administration (EIA). Due to limited data sources the period of examination is 1999-2013 for Stavanger and 2003-2014 for Detroit. Preferably the frequency of both datasets would have been quarterly, but because the dependent variable was unattainable in quarterly terms regarding Stavanger, the frequency of both datasets is annual instead. Obtaining 2014 employment data on Stavanger Region was not possible because the material does not get published until mid June. The sample size of Detroit is limited by the variable wage which historical data only goes back to 2003.

4.2 Variable presentation

The dependent variable in each case is employment. The dependent variable is sorted by booming sector employment, oil and gas industry in Stavanger and automobile manufacturing industry in Detroit. The independent variables chosen are oil price, wage, national industry investment level and gross domestic product (GDP). Overview of chosen variables with notation is shown in table 1.

Table 1. Variables with Notation

	Notation Stavanger	Notation Detroit
Dependent Variable		
Employment	EmpS	EmpD
Independent Variable		
Oil Price	Oilp	Oilp
Wage	WageS	WageD
Investment	InvS	InvD
GDP	GdpNO	GdpUS

Oil price is chosen because both economies are affected by oil price shocks, which are expected to have an impact on employment. A positive (or negative) oil price shock is expected to increase (or decrease) employment in Stavanger, whereas in Detroit the opposite applies. A positive (or negative) oil price shock is expected to have a negative (or positive) impact on employment in the auto industry. Increasing in wage levels are an effect of booming economies and are also expected to have a positive effect on employment. GDP are included as a business cycle indicator. The employment rate is affected by fluctuations around the economy's trend line in the form of expansion or contraction and the rate of employment is procyclical.

4.3 Descriptive statistics

Descriptive statistics of Stavanger and Detroit is presented in table 4 and table 5 respectively. Both dataset consists of the same variables with different notations.

Table 2. Descriptive Statistics Stavanger

Variable	Obs	Mean	Std. Dev	Min	Max
Emps	17	13607	5038	8554	23673
WageS	17	46059	10545	30243	63800
InvS	17	102.14	46.02	53.59	211.88
Oilp	17	56.29	35.33	12.75	111.63
GdpNO	17	1521.2	213.9	1201.7	1850.6

The oil price (Oilp) for both datasets is spot price of crude oil measured in U.S. dollars per barrel. Employment (EmpS) is number of persons working in Stavanger Region within oil and gas. Wage (WageS) is monthly earnings measured in NOK while investment is national investment level within oil and gas measured in billion NOK. Gross domestic product (GdpNO) is Mainland Norway measured in billions chained 2005 NOK.

Table 3. Descriptive Statistics Detroit

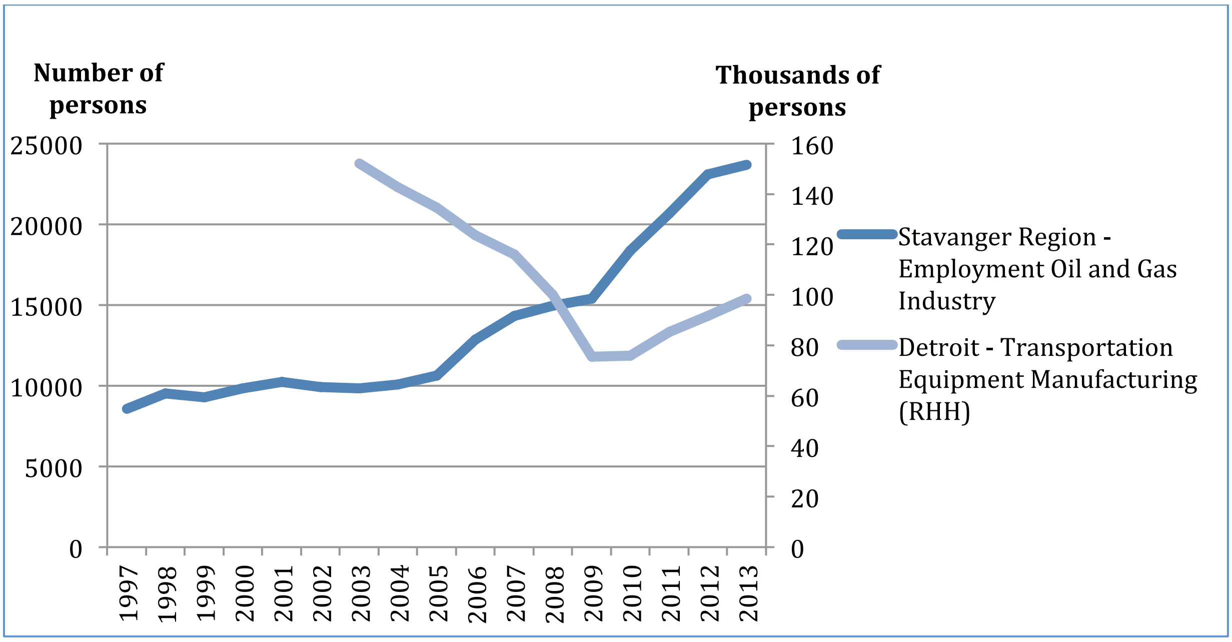
Variable	Obs	Mean	Std. Dev	Min	Max
EmpD	12	108	26	75	152
WageD	12	1239	42	1155	1285
InvD	12	183	49	71	258
Oilp	12	77.33	28.55	28.85	111.63
GdpUS	12	14749	782	13271	16086

Employment (EmpD) is number of persons working within transportation equipment manufacturing, measured in thousand units. Wage (WageD) is average weekly earnings in dollars. National level of investment (InvD) within the auto industry and gross domestic product (GdpUS) are both measured in billions of chained 2009 Dollars.

4.4 Graphical Illustration

Figure 14 – figure 18 gives a graphical illustration of the key variables in the model regarding Stavanger and Detroit. Each figure illustrates each variable concerning both Stavanger and Detroit with the exception of figure 14, which shows the development of the oil price. Further investigation of how the variables move together is given in the correlation matrix.

Figure 14. Booming Sector Employment Stavanger Period 1997-2013 and Detroit Period 2003-2014

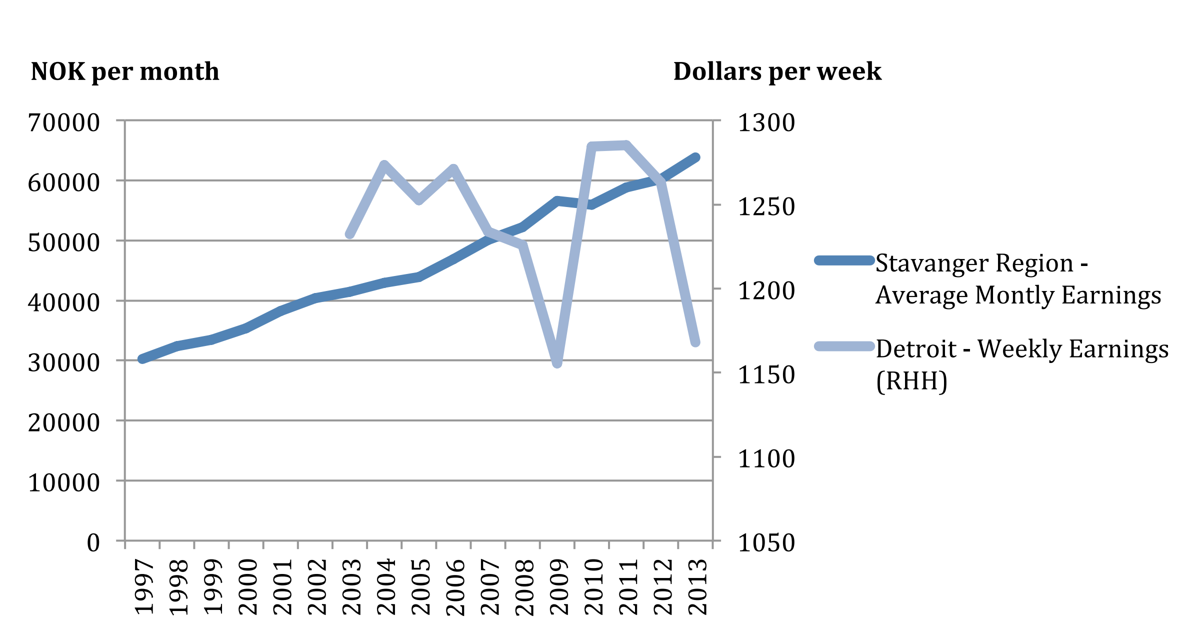


Source: Statistics Norway (SSB), U.S. Bureau of Labor Statistics (BLS)

Figure 14 shows employment in both booming sectors during their respective sample period. Employment in Stavanger Region has an upward trending. From 1999 to 2005 employment has increased but remained fairly stable with employment around 10 000. During the period from 2005 to 2007 Stavanger Region experienced a peak in number of persons employed before the effects of the financial crisis in 2008. From 2009 to 2012 the number of people employed increased significantly from approximately 15 000 to 23 000.

The development in employment is of the opposite in Detroit. From 2003 to 2009 employment has decreased from 152 000 to 75 500. The effects of the financial crises contributed to the decreasing effect. Since 2010 employment has increased and are showing signs of continuing an upward trend.

Figure 15. Wage Stavanger Period 1997-2013 and Detroit Period 2003-2013

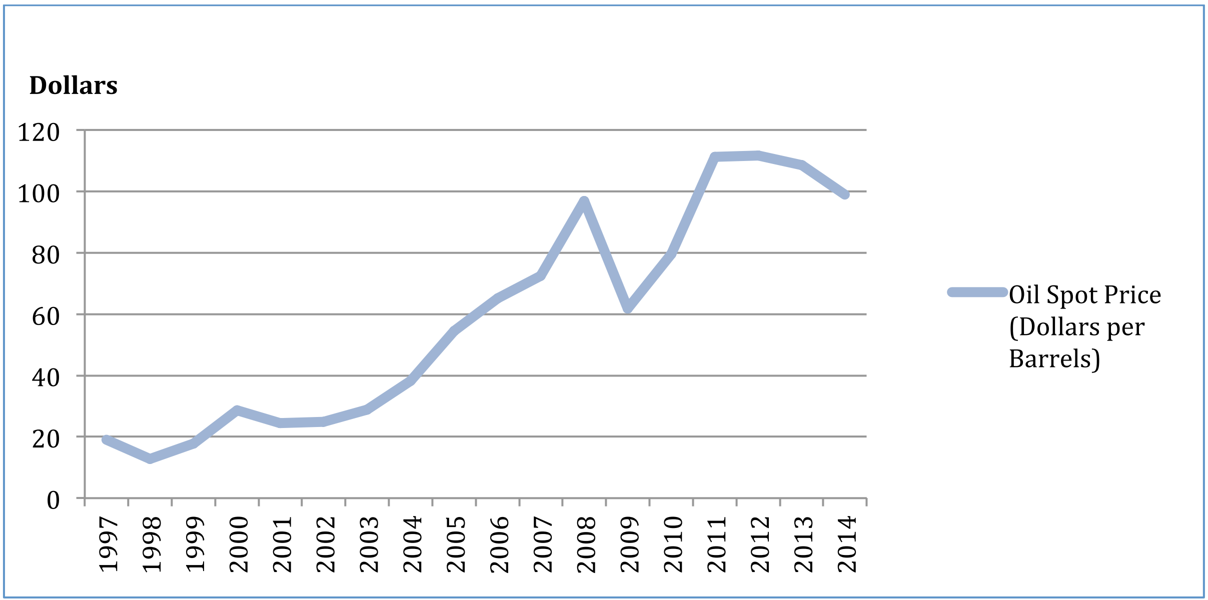


Source: Statistics Norway (SSB), The Federal Bank of St. Louis (FRED).

Figure 15 shows monthly earnings in Stavanger Region and weekly earnings in Detroit. Monthly earnings in Stavanger region from 1997 to 2013 have a clear upward trend. The development in monthly earnings is consistent with the characteristics of a booming sector.

Weekly earnings in Detroit has both increased but mostly decreased. The effects of the financial crisis in 2008 have had a clear negative effect. From 2009 to 2010 Detroit experienced a peak in weekly earnings. Weekly earnings have since fallen from 1286 dollars per week in 2011 to 1168 dollars per week in 2013.

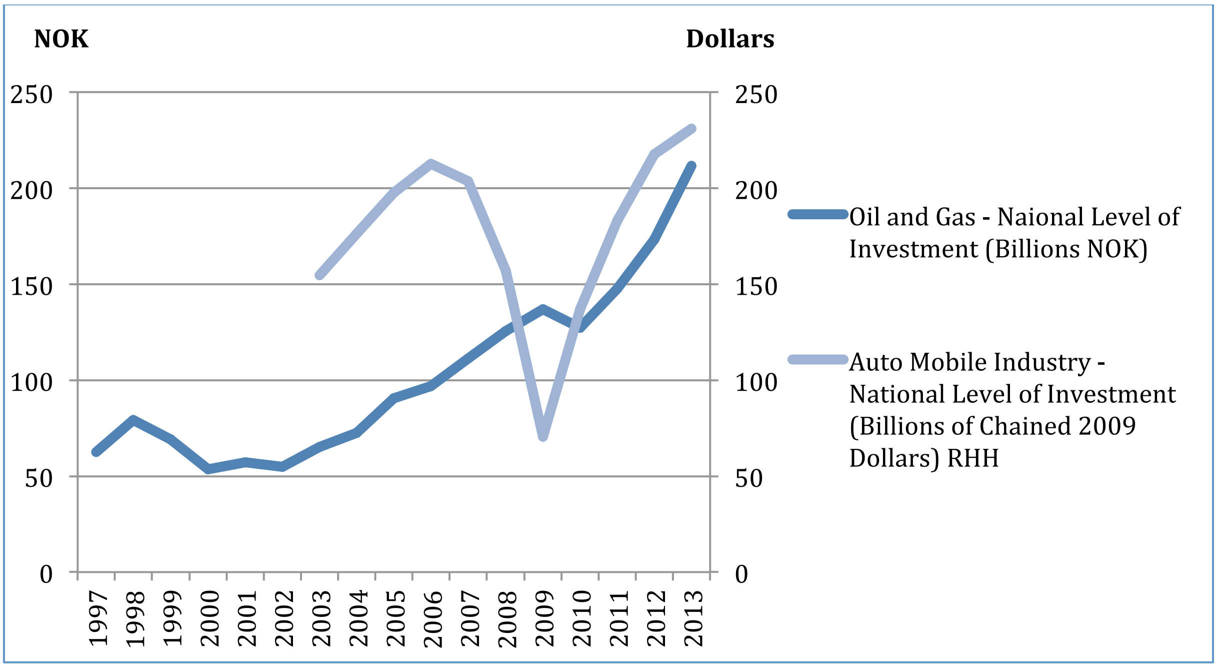
Figure 16. Oil Spot Price, dollars per barrels Period 1997-2014



Source:Energy Information Agency (EIA)

Figure 16 shows the development of the oil spot price during the period from 1997 to 2014, measured in dollars per barrels. The oil price is upward trending. The oil price was at its lowest in 1998 at 12.79 dollars. During the period from 2000 to 2007 the price increased significantly before reaching a peak of 96.94 dollars in 2008. The effect of the financial crisis resulted in the oil price decreasing to 61.74 dollars in 2009. Since then the price of oil has increased again with the exception of recent events of late 2014.

Figure 17. Booming Sector Investment, National levels Stavanger Region Period 1997-2013 and Detroit Period 2003-2014

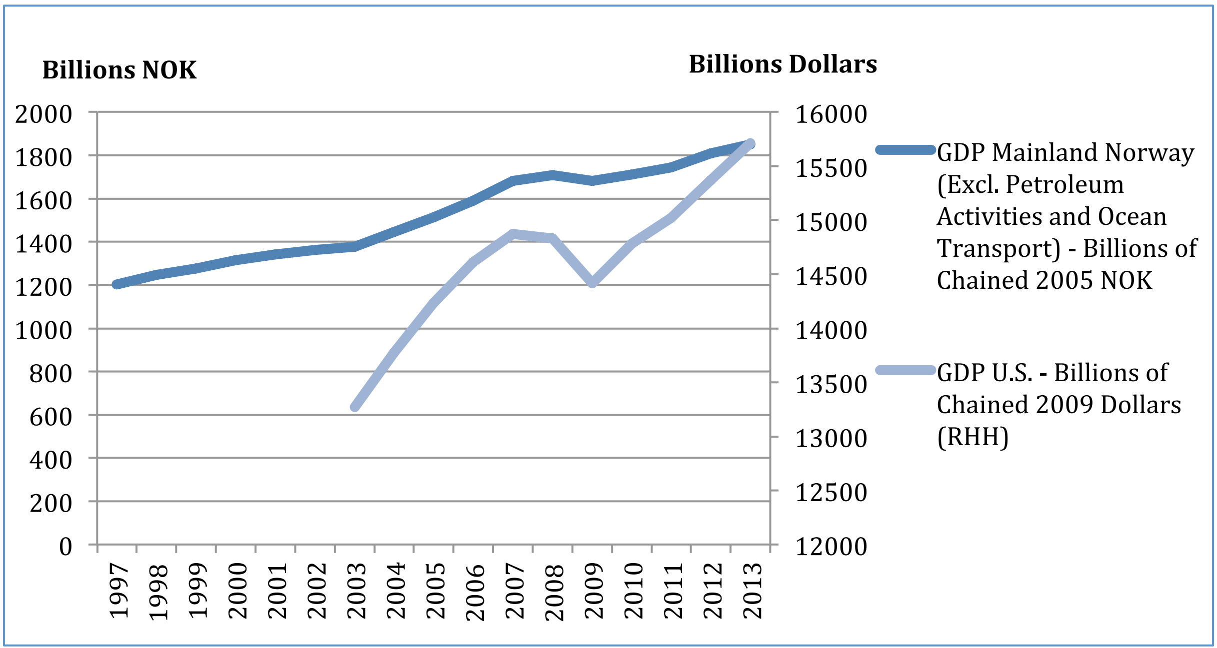


Source: Statistics Norway (SSB), The Federal Bank of St. Louis (FRED).

Booming sector investment on a national level regarding both Stavanger Region and Detroit is shown in figure 17. National level of investment within the oil and gas industry is measured in billions of chained 2005 NOK and has a clear upward trend. Total investments in oil and gas have increased significantly during the period from 1997 to 2013. From 2002 to 2009 investments increased from 54.9 billion NOK to 137.1 billion NOK. With the exception of a slightly decrease from 2009 to 2010, from 137.1 billion NOK to 136.9 billion NOK, investments has continued rising. In 2013 investments amounted to 211.8 billion NOK.

National level of investment within auto industry is measured in billions of chained 2009 dollars. Investments in 2003 amounted to 154.8 billion dollars and increased to 212.6 billion dollars in 2012. As a result of the financial crisis investments within the auto industry fell from 203.6 billion dollars in 2007 to a staggering 70.6 billion dollars in 2009. Since then investments has experienced a significant increase. In 2012 investments amounted to 217.6 billion dollars and is showing and upward trend.

Figure 18. GDP Norway Mainland Period 1997-2013, GDP U.S. Period 2003-2014



Source: Statistics Norway (SSB), The Federal Bank of St. Louis (FRED).

Figure 18 illustrates the development in gross domestic product (GDP) of both Norway and U.S. In Norway GDP is measured in billions of chained 2005 NOK accounts only for mainland activity, excluding both petroleum activities and ocean transport. GDP mainland gives a more realistic picture of how the overall Norwegian economy is performing. In 2012 GDP amounted to 1201.7 billion NOK. The GDP has an upward trend and in 2013 GDP was a total of 1850.6 billion NOK.

The U.S. economy has experienced growth. From 2003 to 2007 GDP increased from 13271.1 billion dollars to 14873.8 billion dollars. Nonetheless the impact of the financial crisis in 2008 affected the U.S. economy more compared to the Norwegian economy. A contraction in GDP occurred from 2008 to 2009. Since then the economy has been experiencing an upward trend.

4.5 Correlation

The correlation coefficient is a measure of the strength of linear relationships. The correlation does not depend on the units of measurement and is bounded between -1 and 1. Table 4 and table 5 shows the correlation between variables regarding Stavanger and Detroit respectively.

Table 4. Correlation Matrix Stavanger

	EmpS	WageS	InvS	Oilp	GdpNO
EmpS	1.000				
WageS	0.9324	1.000			
InvS	0.9577	0.9158	1.000		
Oilp	0.9314	0.9385	0.9064	1.000	
GdpNO	0.9126	0.9830	0.9080	0.9633	1.000

The correlation matrix reveals that all explanatory variables are positively correlated with employment (EmpS). A positive correlation exists when one variable increases (or decreases) the other variable also increases (or decreases). The possibility of multicollinearity is present among the explanatory variables, meaning that X_j has a strong linear relationship with the other independent variables (Wooldridge, 2013).

The correlation between employment in Detroit and oil price is -0.72 meaning that the two variables move in opposite directions. This is expected as previously explained the impact historical high gasoline prices had on consumer behaviour.

Table 5. Correlation Matrix Detroit

	EmpD	WageD	InvD	Oilp	GdpUS
EmpD	1.000				
WageD	0.2016	1.000			
InvD	0.2554	0.2029	1.000		
Oilp	-0.7179	-0.0588	0.4032	1.000	
GdpUS	-0.6177	-0.2006	0.5649	0.8907	1.000

GDP is surprisingly negatively correlated with employment. The negative correlation could be explained by the fact that the effects of the financial crisis of 2008 primarily dominated the sample period regarding Detroit. Even though the U.S economy has been slowly improving, the auto industry in Detroit particular has been suffering from restructuring and further contraction.

4.5 Model Specification

In order to capture the dynamic features of a multivariate regression an Error Correction Model (ECM) is estimated. The benefits to estimating an ECM are the possibility of capturing and distinguishing between the long run and the short run dynamics of the model and allows for interaction between long run and short run dynamics. An ECM is a representation used to characterize the cointegrated variables, which is a stationary linear combination of two or more non-stationary variables.

The long run equilibrium relationship in the model is represented by equation (1):

$$y^E = \alpha + \beta x^E \qquad (1)$$

In addition to be a way to avoid non- stationary process the short run dynamics is obtained by regressing the first difference of y_t on the first difference of x_t given by equation (2).

$$\Delta y_t = \delta_0 + \delta_1 \Delta x_t + \nu_t \quad (2)$$

$$y_t = C + \delta_1 x_t + \delta_2 x_{t-1} + \mu y_{t-1} + \nu_t \quad (3)$$

$$y_t - y_{t-1} = C + \delta_1 x_t + \delta_2 x_{t-1} - (1-\mu)\ y_{t-1} + \nu_t$$

$$\Delta y_t = C + \delta_1 x_t - \delta_1 x_{t-1} + \delta_1 x_{t-1} + \delta_2 x_{t-1} - (1-\mu)\ y_{t-1} + \nu_t$$

$$\Delta y_t = C + \delta_1\ \Delta x_{t-1} - \lambda\ (y_{t-1} - \alpha - \beta x_{t-1}) + \nu_t$$

where $\lambda = 1- \mu$, $\beta = \frac{\delta_1 + \delta_2}{1-\mu}$ and λ = the speed of error correction

If a long run relationship between y_t and x_t exist the expression in the last line in equation (3) will be cointegrated, represented by the term in the parenthesis. The term λ is defined as the speed of error correction mechanism, and indicates the speed of which the variables in the model adjust to any type of disequilibrium.

4.6 Estimation

The Error Correction Model is estimated using ordinary least squares (OLS). The regression analysis is conducted using STATA. All variables in each dataset with the exception of oil price (oilp) are transformed to logarithmic form.

$$\ln(yt) = \ln(\alpha) + \beta_1(X_{1t}) + \beta_2\ln(X_{2t}) + \beta_3\ln(X_{3t}) + \beta_4\ln(X_{4t}) + \ln(u_t)$$

In order to run ECM all variables are further transformed into logarithmic changes. Also, with the exception of the variable oil price which is only transformed into changes.

$$\Delta y_t = \ln y_t - \ln y_{t-1}$$
$$\Delta X_t = \ln X_t - \ln X_{t-1}$$

As previously mentioned the dependent variable in each case is employment while the independent variables are oil price, wage, national industry investment level and gross domestic product (GDP).

The Engle-Granger single-equation approach is used for testing variables for cointegration. Engle and Granger (1987) proposed a two-step procedure to determine whether two variables, y_t and z_t, are integrated of the same order and if there exists an equilibrium relationship among the variables. The two-step procedure actually consists of the following four steps (Enders, 2010).

The first step in analysing is to pretest each variable in the model to determine their order of integration. Cointegration requires the variables to be integrated of the same order. An Agumented Dickey-Fuller unit root test is used to pretest the variables. Integrated times series data that are stationary after being difference *d* times are integrated of order d: I(d). Data that are said to be stationary after being first-differenced are integrated of I(1) which is common in time series data. The source of integration is the effect of past shocks, which is permanently incorporated into the memory of the series (Enders, 2010).

Step two is to estimate the long run equilibrium relationship if the variables are found to be integrated of the same order I(1) in step one. The long run equilibrium relationship is estimated using ordinary least squares (OLS):

$$y_t = \beta_0 + \beta_1 Z_t + e_t$$

In order to determine if the variables are in fact cointegrated the residuals (denoted $\hat{e}_t$) from the estimated long run equilibrium relationship should be stationary. The residuals are deviations from long run equilibrium. If the residual are found to be stationary by using an Augmented Dickey-Fuller test, the y_t and z_t, are cointegrated.

The third step is to estimate the Error Correction Model by estimation the first difference variables and including the deviations from the long run equilibrium as a variable. Non-significant coefficients are then removed step by step until we are left with a final estimated equation.

The fourth and final step is to assess the model adequacy. Test for autocorrelation and normality is performed. If the residuals are serially correlated, the lag lengths could perhaps be too short.

4.8.1 Stationary

Stationary is an important concept when estimating time series analysis. In order to have a linear relationship between the dependent and the independent variables in the model all series have to be stationary, meaning that the series are invariant over time.

4.8.2 Lag selection

In order to test for cointegration it is necessary to specify number of lags to include in the model. The corresponding vector error correction model is always one lag less than the underlying vector autoregressive model (VAR). Lag selection for the underlying VAR model regarding Stavanger and Detroit is 2 meaning that lag selection in ECM is 1. The lag selection when testing for unit root is also 1 in order to account for serial correlation.

4.8.3 Augmented Dickey-Fuller Test

In an augmented Dickey-Fuller test (ADF Test), the regression is augmented with lagged changes. The inclusion of these lagged changes are to avoid any serial correlation in Δy_t. The more lags included in the regression, the more of the initial observations is lost. By including too many lags the small sample power of the test will generally suffer. Including too few lags will also influence the test. As mentioned the lag selection in the ADF tests are 1.

The augmented Dickey-Fuller test that a variable follows a unit-root process. The null hypothesis states that the variable contains a unit root and the alternative hypothesis that the variable is generated by stationary process. The augmented Dickey-Fuller test provides four options: exclude the constant, include a trend term and include lagged values of the difference of the variables in the regression. By supressing the intercept (the constant) in the model indicated that the process under the null hypothesis is a random walk without drift. Including a trend term indicates that the regression is a random walk, perhaps with a drift. By including a drift suggests that the process is a random walk with nonzero drift. The four different cases is summarized in table 6:

Table 6 Four different cases – Augmented Dickey-Fuller Test

Case	**Process under the null hypothesis**	**Regression restrictions**
1	Random walk without drift	$\alpha = \delta$, $\delta = 0$
2	Random walk without drift	$\delta = 0$
3	Random walk with drift	$\delta = 0$
4	Random walk with or without drift	(none)

The null hypothesis is that the variable contains a unit root, and the alternative hypothesis is that the variable was generated by a stationary process.

H_0: Unit root
H_A: No Unit root

The absolute value of the test statistics generated from the Augmented Dickey-Fuller test is then compared to the critical value. The more negative the test statistics is the more likely it is to reject the null hypothesis of the variable containing a unit root.

4.9 Results

The results from the econometric analysis on each dataset are presented separately and stepwise according two the Engle-Granger procedure.

4.9.1 Stavanger Region

The results from pretesting the variables on levels to determine whether they are stationary are given in table 7.

Step1:

Table 7 Results from Augmented Dickey-Fuller Test on levels

Variables	**No Constant**	**Default**	**Including Drift**	**Including trend**
	Test Statistics (p-value)	*Test Statistics (p-value)*	*Test Statistics (p-value)*	*Test Statistics (p-value)*
EmpS	1.785 (0.098)	0.800 (0.439)	0.800 (0.439)	-1.933 (0.079)
WageS	4.156 (0.001)	-0.971 (0.351)	-0.971 (0.351)	-1.878 (0.087)
Oilp	-0.345 (0.736)	1.321 (0.209)	-0.345 (0.736)	-3.099 (0.010)
InvS	1.397 (0.186)	0.761 (0.461)	0.761 (0.461)	-3.711 (0.003)
GdpNO	1.908 (0.079)	-0.500 (0.626)	-0.500 (0.626)	-2.621 (0.024)

** Significant 90% CI **Significant 95% CI *** Significant 99% CI*

All variables are not significant at any confidence interval in any four cases, meaning that we are unable to reject the H_0 in each case. The results are as expected. All variables are non-stationary processes at levels regarding Stavanger Region.

Table 8. Results from Augmented Dickey-Fuller Test on first-differences

Variables	No Constant	Default	Including Drift	Including trend
	Test Statistics (p-value)	*Test Statistics (p-value)*	*Test Statistics (p-value)*	*Test Statistics (p-value)*
EmpS	-1.238 (0.239)	-2.368 (0.037)	-2.368 (0.037) **	-2.570 (0.028)
WageS	0-678 (0.511)	-2.404 (0.035)	-2.404 (0.035) **	-2.539 (0.029)
Oilp	-2.975(0.012)***	-4.516 (0.001)***	-4.516 (0.001) ***	-4.527 (0.001)***
InvS	-1.332 (0.207)	-2.034 (0.067)	-2.034 (0.067)**	-2.493 (0.032)
GdpNO	-1.101 (0.292)	-2.458 (0.032)	-2.458 (0.032)**	-2.425 (0.036)*

** Significant 90% CI **Significant 95% CI *** Significant 99% CI*

Table 8 provides the results from the Augmented Dickey-Fuller Test (ADF Test) when the variables are transformed into first-differences. The number of stars (*) indicates the level of significance. The p-value is given in the parenthesis. In case 1 when supressing the intercept, the variable oil price is the only significant one. The variables are all significant when including a drift, suggesting that the time series are random walk with or without drift. Oil price is the only variable significant at 99 % confidence interval, the rest are significant at 95% confidence interval. The test statistics in all variables are strong enough resulting in rejecting the H_0. When fist-differencing the processes they contain no unit root, meaning that all variables are stationary and integrated of same order, I(1).

Step2:

Since the variables are found to be integrated of the same order we can proceed to step two. The results from estimating the long run equilibrium relationship is presented in table 9.

Table 9. Results from Estimating Long Run Relationship – Stavanger Region

Variables	**Coefficient**	**Std. Error**	**t**	**(P-value)**
Constant	6.9397	3.8284	1.81	0.095
Oilp	0.00568	0.0022	2.58	0.024**
WageS	1.25856	0.52930	2.38	0.035**
InvS	0.33260	1.1289	2.58	0.024**
GdpNO	-2.0617	1.1275	-1.83	0.092
Adj. R-squared	0.9417			

** Significant 90% CI **Significant 95% CI *** Significant 99% CI*

The estimated long run equilibrium relationships:

$\ln(yt) = \ln(\alpha) + \beta_1(X_{1t}) + \beta_2\ln(X_{2t}) + \beta_3\ln(X_{3t}) + \beta_4\ln(X_{4t}) + \ln(u_t)$

$\rightarrow$

$EmpS_t = 6.94 + 0.0057\ Oilpt + 1.26\ WageS_t + 0.33\ InvS_t - 2.06\ GdpNO_t + \hat{e}_t$

The variables oil price, wage and investment level are significant at 95% confidence interval. One dollars increase in oil price per barrel increases employment by 0.0057 per cent. The variable wage also has a positive impact on employment. One per cent increase in monthly pay increases employment by 1.26 per cent. These results are expected to occur in a booming sector. 1 per cent increase in the investment level also has a positive effect on employment, increase of 0.33 per cent. GDP is found to have a negative effect; one per cent increases leads to a decrease in employment by 2.06 per cent. The overall goodness of fit of the model is 0.94, meaning that the variability accounted for in the model is 94 per cent.

In order to determine whether the variables are cointegrated the ADF test is performed on the residuals.

Table 10. Result from Augmented Dickey-Fuller Test on Residuals - Stavanger Region

Variables	No Constant	Default	Including Drift	Including trend
	Test Statistics (p-value)	*Test Statistics (p-value)*	*Test Statistics (p-value)*	*Test Statistics (p-value)*
Residuals_S (Levels)	3.046	1.275	1.275	-2.520
Residuals_S (Difference)	-1.527 (0.153)	-3.552 (0.005) (**)	-3.552 (0.005) (***)	-6.302 (0.000) ***

** Significant 90% CI **Significant 95% CI *** Significant 99% CI*

The results in table 10 reveal that the residuals on levels are not stationary. The residuals on first differences are found to be stationary when including a trend. The stars in the parenthesis indicate significance level if the test statistics were compared to the critical value of the Dickey-Fuller distribution. The residuals contain the estimated values of the deviations from the long-run relationship. The critical values are then compared to the Engle-Granger distribution for cointegration, which depends on the sample size and the number of variables. The residuals on first differences are found to be stationary when including a trend.

Step3:

After determining that the variables are cointegrated, the third step is to estimate the Error Correction Model, the short-term dynamics on first differences and including the residuals, deviations from the long run equilibrium:

$\Delta y_t = \Sigma_j \, a \, \Delta y_{t-j} + \Sigma_j \, b_j \Delta x_{t-j} + \lambda \hat{e}_{t-1} + ut$

The changes in $EmpS_t$ is a function of the changes in the dependent and independent variables and the deviations from the long-term equilibrium, represented by the term $\hat{e}_t$.

The equations is stepwise reduced by removing the least and non significant variables from the equation. The results are presented table 11.

Table 11. Results from Error Correction Model - Stavanger

Variables	Coefficient	Std. Error	z	(P-value)
ECM-term	-0.7189	0.5468	-1.31	0.189
Δ EmpS	0.2925	0.4115	0.71	0.477
Δ GdpNO	-2.15097	1.2563	-1.71	0.087
ê (residuals)	-0.2205	0.26144	-0.84	0.399
Log-likelihood	85.197	σ	1.04e-09	

** Significant 90% CI **Significant 95% CI *** Significant 99% CI*

The speed of adjustment, the error correction term, is negative but not significant. Non of the variables are significant at any given confidence interval.

Step4:

The results indicate that non of the variables are significant. When having a small sample size the risk of ending up with weak estimates is present. The final step is assessing model adequacy by testing for serial autocorrelation in the residual and normality. Due to small sample size the model adequacy is not satisfactory. Serial correlation is present and normality test is unable to run because the dependent variables or their lags may not be collinear with the dependent variables.

Collinearitty does not violate any Gauss-Markov Assumptions. Hence it does not bias the fitted coefficients of the model. Nonetheless, when two independent variables are highly correlated it can be difficult to estimate the partial effect of each. In effort to reduce collinearity dropping other independent variables from the model or increasing the sample size may resolve the problem. However dropping a variable that belongs in the population model can lead to bias and sometimes increasing sample size is not possible due to limited data resources (Wooldridge, 2013).

4.9.2 Detroit

Step1:

The results from the pretest on levels is given in table 12:

Table 12. Results from Augmented Dickey-Fuller Test on Levels – Detroit

Variables	No Constant	Default	Including Drift	Including trend
	Test Statistics (p-value)	*Test Statistics (p-value)*	*Test Statistics (p-value)*	*Test Statistics (p-value)*
EmpD	-0.551 (0.597)	-1.922 (0.096)	-1.922 (0.096)**	-1.300 (0.241)
WageD	-0.399 (0.700)	-2.548 (0.038) *	-2.542 (0.039)**	-2.469 (0.049)
Oilp	0.589 (0.572)	-1.699 (0.133)	-1.6999 (0.133)*	-2.867 (0.029)
InvD	0.225 (0.828)	-1.791 (0.116)	-1.791 (0.116)*	-1.659 (0.148)
GdpUS	1.308 (0.227)	-0.527 (0.614)	-0.527 (0.614)	-2.290 (0.062)

** Significant 90% CI **Significant 95% CI *** Significant 99% CI*

The variables employment and wage are both significant when including a drift at 95% CI, and the variables oil price and investment level are also significant at 90% CI. Table 13. shows the result from ADF test on differences.

Table 13. Results from Augmented Dickey-Fuller Test on First-Differences – Detroit

Variables	No Constant	Default	Including Drift	Including trend
	Test Statistics (p-value)	*Test Statistics (p-value)*	*Test Statistics (p-value)*	*Test Statistics (p-value)*
EmpS	-1.628 (0.148)*	-1.551 (0.172)*	-1.551 (0.172)*	-2.323 (0.068)
WageS	-2.467 (0.043)**	-2.328 (0.059)	-2.328 (0.059)**	-2.130 (0.086)
Oilp	-2.451 (0.044) **	-2.955 (0.025)*	-2.955 (0.025)**	-2.971 (0.031)
InvS	-2.299 (0.055)**	-2.154 (0.075)	-2.202 (0.079)	-2.154 (0.075) **
GdpNO	-1.431 (0.196)	-1.877 (0.110)	-1.562 (0.179)	-1.877 (0.110)*

** Significant 90% CI **Significant 95% CI *** Significant 99% CI*

The results from Augmented Dickey-Fuller test on firs-differences regarding Detroit indicates that the variables are stationary as sown in table 13. The variables employment, wage, oil price and investment are all stationary in case 1, random walk without a drift. The variable GDP is stationary when including a trend but only at 90% confidence interval.

Step2:

The next step is to estimate the long run equilibrium relationship among the variables regarding Detroit. The results are shown in table 14.

Table 14. Results from estimating long run relationship - Detroit

Variables	Coefficient	Std. Error	t	(P-value)
Constant	43.720	10.6468	4.11	0.005***
Oilp	-0.0033	0.0014	-2.34	0.052*
WageD	-1.9146	0.6013	-3.18	0.015**
InvD	0.6562	0.0656	10.00	0.000***
GdpUS	-2.976	0.8477	-3.51	0.010***
Adj. R-squared	0.9458			

** Significant 90% CI **Significant 95% CI *** Significant 99% CI*

The estimated coefficients give the following long run equilibrium relationships:

$\ln(yt) = \ln(\alpha) + \beta_1(X_{1t}) + \beta_2\ln(X_{2t}) + \beta_3\ln(X_{3t}) + \beta_4\ln(X_{4t}) + \ln(u_t)$

$\rightarrow$

$EmpD_t = 43.72 – 0.0033\ Oilpt – 1.91\ WageD_t + 0.66\ InvD_t – 2.06\ GdpUS_t + \hat{e}_t$

All variables are statistically significant at different confidence intervals. The adjusted R-squared is 0.95 indicating that 95% of total variability is accounted for by the model. Nonetheless, when estimating on levels the risk of incorrect standard deviations is present, indicating that the goodness of fit, adjusted R-squared should be interpreted with caution. Both the oil price and wage has a negative effect on employment. One dollar increase in oil price per barrels reduces employment by 0.0033 per cent. One per cent increase in wage reduces employment by 1.91 per cent. Oil price having a negative effect on employment is expected. Increase in wage is expected to increase together with employment in a booming sector. Wage represents a cost for all type of firms. Increases in costs for a profit-maximizing firm, especially during restructuring, will most likely reduce employment. The estimated long run equilibrium also show that 1 per cent increase in investment increases employment by 66 per cent whereas one per cent in GDP decreases employment by 2.06. GDP having a negative effect on employment is unexpected, but could be a result of the sample period and small sample size. The U.S. economy has been recovering from the financial crisis since 2008.

The results from the ADF test on the residuals are given in table15.

Table 15. Result from Augmented Dickey-Fuller Test on Residuals - Detroit

Variables	**No Constant**	**Default**	**Including Drift**	**Including trend**
	Test Statistics (p-value)	*Test Statistics (p-value)*	*Test Statistics (p-value)*	*Test Statistics (p-value)*
Residuals_D (Levels)	-0.544 (0.601)	-1.659 (0.141)	-1.659 (0.141)(*)	-1.208 (0.272)
Residuals_D (Difference)	-1.540 (0.167)	-1.537 (0.175)	-1.537 (0.175) (*)	-2.139 (0.085)

** Significant 90% CI **Significant 95% CI *** Significant 99% CI*

In order to determine if the variables are in fact cointegrated the residuals from the estimated long run equilibrium relationship should be stationary. The star in the parenthesis indicates significance level when comparing the test statistics to the Dikey-Fuller distribution, and the residuals on levels are significant on 90% confidence interval. Nonetheless, when comparing The test statistics to the Engle-Granger distribution the residuals are not strong enough for the null hypothesis to be rejected. Meaning that there is no cointegrating relationship among the variables. The risk of making a Type II error is failing to reject the null when it is true. Failing to reject the null is a risk when having a small sample size. Assuming that Type II error is present, since the sample period regarding Detroit is relatively small and far less small than Stavanger Region, is a likely scenario. When failing to determine that the variables are cointegrated, the next step is to run a regular VAR model instead. This procedure has not been carried out. The probability of not getting strong estimates is equally present when estimating a VAR model due to the sample size.

5. Discussion and Conclusion

The main objective in this thesis is to examine whether Stavanger Region are showing indications of being on the same path as Detroit.

In order to capture the dynamic features of a multivariate regression an Error Correction Model (ECM) was estimated to capture and distinguishing between the long run and the short run dynamics of the model. The variables regarding Stavanger were found to be cointegrated. The variables regarding Detroit was not. This is most likely a result of small sample size due to limited data resource.

The results from the econometric analysis were not significant. However, the latest development can provide an indication. Since the decrease in oil price Stavanger Region have been affected the worst.

In a short-term perspective the demand side of the economy is central in determining the overall level of employment. In a long term perspective the supply side becomes increasingly more important. The supply side determines the production capacity and the ability of long-term economic growth. Consumption, investment and government spending are important demand side factors whereas access to human capital (labour), natural resources and technology development are key long-term supply side factor (Opstad, 2010).

When one economy is largely is dependent and surrounded around one industry, when that industry is longer the engine of growth the consequences can be devastating for the economy. The auto industry in Detroit went from being a solid booming industry to become an industry that struggles to restructure and regain growth. The recipe is cost efficiency and standardizing manufacturing process. These lessons should be applied to the oil and gas industry. It is important to have a long perspective during a recession. Letting go highly competent workforce may be a short term reduction in costs which can end up costing even more in the long run.

When a booming industry goes bust is has spillover effects. Other industries also suffer when the demand decreases. The government looses tax income and is forced to make budget cuts.

Stavanger Region in the short term are showing indications on being on the path of Detroit. However, when the oil price increases, investment and oil and gas activity will regain to a new equilibrium.

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