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**TITLE**: Impact of Oil Price Changes on Wage Formation in Norway between 1970 and 2016.

A time series analysis of macroeconomic effects.


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## Preface

The years 2006 to 2016 has been rather unevenly shaped by both ups and downs in Norwegian economy. The global economic downturn of 2008, however, from which the world seems not to have recovered yet, has molded the downward-sloping demand curve for oil and thus, directly, affected Norway's economic growth. This paper studies exactly that: how closely correlated is the oil demand with the wage formation in Norway? Is the Norwegian population so dependent on the extremely volatile price of that very fossil fuel, or is the economy bound to 'bounce back' eventually, regardless of the global demand for oil?

This master thesis has been written as a part of the five-year university education within Business Administration, where interest and passion for macroeconomics were the main motivator behind the choice for the topic of my dissertation. Of methods used here, the cointegration analysis with error correction model (ECM), descriptive statistics and literature search may be mentioned.

I would like to thank Peter Molnar for his extremely vital assistance and Svein Olav Krakstad for his willingness to share his extensive knowledge of both economics and econometrics. His help was invaluable while writing this thesis.

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**Keywords:** *negative demand shock, oil price, ECM, cointegration, descriptive statistics, small open economy*

Abstract

How dependent is Norway's economy *really* on fossil fuels? Has oil been more of a blessing for the nation, or was it a curse, really, leading to a state wretched by the Dutch disease, with all its consequences? Is the fall in oil price disastrous, or simply a reminder of Norway's exposure, and the importance of a competitive mainland economy? Since the petroleum sector has been such a benchmark for Norwegian economy, affecting the aggregate consumption, wages, production costs and inflation, there is an ongoing debate in the society and between economists and analysts as to how the decline in aggregate demand for oil will shape the future of the Norwegian wage levels.

In this paper, I would like to shed light on the issue as to how the impact of fall in oil demand does affect the Norwegian wage formation in years 1970 to 2016, using a dataset to determine long-term relationships between chosen variables. The original assumption was that there is a long-term equilibrium. The uncertainty was connected to the question whether that equilibrium predicates wage changes.

The results show that indeed, oil price is an important driver of wage levels in a small open, oil-exporting economy, such as the Norwegian one. Long-run relationship between the movements in oil prices and wage levels have been detected through a cointegration method, using the error correction model estimation. Lon-run equilibria are detected, and determine that the negative oil demand shock affects the wage levels negatively through indirect and direct channels. The validity of this statement is confirmed by numerous ECM models, while allowing for interconnection between other macroeconomic variables. The increase in oil prices influence wage formation. A fall in the commodity price would not have the same impact on wage levels in Norway.

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# INTRODUCTION

The very objective of this thesis is to reveal the relationship between the oil prices and the macroeconomic situation in Norway. In a small open, oil-exporting economy, such as the Norwegian one, the main source of export will be constituted by the accessible primary resources. With relatively developed oil industry and high domestic deliveries, the oil industry is much more crucial for the Norwegian economy than for instance for the American, British, or Canadian markets (Mohn, 2015). Consequently, the macroeconomic variables within this economy will not only be affected by the volatility of the price of those resources, but the economy will be much more vulnerable to the volatility of the said commodity.

The vulnerability of the Norwegian economy to volatility of oil prices is even more exposed since both private and public sectors are subjects to public wage bargaining. And even though oil recovery does not add any value to an economy, the Norwegian model has managed, through taxes, Global Pension Fund and the Fiscal Rule ('Handlingsregelen') to channel the profits from oil-related activities into communal benefits. Regardless, the resource wealth countries, such as Norway, is bound to face the problem of rising costs of production, which again reflects further on economic activity. As the wage levels rise (Norwegian wage levels tend to lay approximately 60% above the average wages in European Union), the comparative advantage is weakened, until it is wiped out entirely (Mohn, 2015).

However little visible during times of economic growth, the challenges connected to the state of the market become much more conspicuous during the times of decline. The welfare that Norwegian citizens have derived from the resource wealth, will not be easy to give up on during those times of economic downturn. Additionally, the high costs of production affect the costs of potential restructuring, with respect to learning, innovative and entrepreneurial activities. The multi-dimensional risk that the resource wealth represents, affects several macroeconomic factors. One of those factors, wage formation, will be a focus of this paper. The research question, which I will try to answer throughout the course of my argumentation, is whether, and to what extent, does the fall in oil prices affect the wage formation in Norway?

Inspired by the development of recent years, the wage change in Norway will be present in the public debate. Partially because it is a subject to pattern wage bargaining, where the unions stand stronger than in any other country, and, partially, due to the shift in the main factor behind the tremendous economic growth in Norway: oil demand. Only today's statements of the chief of NHO (Confederation of Norwegian Enterprise), the employers' main representative organization, seeks to reduce the real wages in order to spare what is left of Norwegian competitiveness in the international market and its competitive advantage (Haugan, 2017). For comparison, a selective list of hourly wage levels across Europe is presented: Norway is at the top of the list, with over five-fold higher hourly wage than the cheapest country on the list, Poland (132 NCU to 23 NCU).

The damaging effect to the industry of such high wages has been known to harm the Norwegian industry for years. However, the oil boom of early 2000's has only reinforced the high production costs, high wages, and, as a result, high inflation and price levels. In the times of downturn, which we now are experiencing, this development is no longer possible. The task at hand here is to find out how the wage levels are related to the oil price.

The disposition of the thesis will be as follows: first chapter provides an introduction to the topic. The second chapter serve as a deliberation on the theoretical framework for the petroleum industry, its impact on the macroeconomic variables, with focus on wage setting conditions in Norway. Moving on, chapter 3 provides the data for the econometric analysis, description of the dependent and independent variables, as well as input for the descriptive statistics. In order to perform the tests, the cointegration method will be used. The reasons for choosing that approach will be discussed in the same section. To obtain the results for the various tests, Stata/SE 11 has been used. The discussion of the results and conclusion are included in chapters 6 and 7.

# Section 2

## THEORY AND LITERATURE REVIEW

### 2.1 Survey of Previous Research

There is a substantial amount of research available on the topic of oil prices and their effect on the economic activity. Specifically, after the stagflation of 1970 that was mostly attributed to the oil price shock, the implications of such shocks have been a constant object of interest for the academic researchers, policy makers and economists worldwide. Although the effect of oil price shocks has been studied extensively, the results are often ambiguous and immense disagreements often accompany the actions conducted by the governments, thus making it the monetary policy and its role a debatable subject.

Schneider (2004) specifically points out the vagueness of the available research. In his debate on the impact of oil price changes and inflation, it is pointed out that the element of surprise plays a large role in the price shocks. Should a price increase befall after a continuous period of oil price stability, it has a larger impact than a price hike would cause after a period of cuts and downturns. However, one cannot state explicitly whether a negative oil price shock may have a devastating effect in itself, or is it the tightening monetary policy following the shock that causes much more severe impact. The research referred to by Schneider (2004) reports that the USA and Japan have experienced negative growth effect of approximately 0.1 percentage point, following a 10% oil price rise. In general, an oil price shock may have an economic impact on a country. Moreover, the monetary policy that followed in the wake of that change may have a stronger impact the oil price movement. The author further distinguishes between the nominal and real effects.

Naturally, a substantial amount of research available about oil price effects, concern the oil-importing countries, such us the USA and China, or perhaps oil-producing countries under a strict political regime, such as Russia or Kazakhstan. Thus, pronounced differences of the effects of oil price shocks among the countries are to be found across various reports (Baumeister and Kilian, 2015). To gain a clear picture of macroeconomic mechanism within a country, one should therefore apply approach and data specific to the country.

For instance, Ellen and Martinsen (2016) employed a structural vector autoregression model (SVAR) in order to investigate direct and indirect effects of oil price shocks to one of the financial variables, the Norwegian effective exchange rate. The reported result of direct and indirect effects of oil price changes on that specific variable is that they both have increased over time. A 10% increase in the oil price resulted in 0.2% increase on effective exchange rate in the period 1999-2002. The impact effect of the same change was five-fold bigger in the years 2013-2015. Uncertainty regarding the Norwegian economy, the future monetary policy and Norwegian trading partners may result in an increased impact on the Norwegian kroner due to oil price changes.

Another research that applies SVAR approach to model the effects of oil price shocks on the overall economy, are van Robays and Peersman (2012). In the model, country-specific variables are: real GDP, consumer prices, interest rates and exchange rate, whereas the oil market variables are global oil production, crude oil price and world economic activity. The sample period is 1986-2010. The findings report that a persistent oil price decline of 25% due to a surge in oil supply would reduce the GDP in Norway by 0.8%, whereas the nominal effective exchange rate would depreciate with 2.5%. Should the price decrease be caused by a reduction in global demand, however, then, along with a similar drop in GDP, the exchange rate would depreciate by 2.2%. Thus, the research captures the difference in impact of changes in the oil price due to the reasons that have stimulated that change.

A similar contribution to the field has been proposed by Jimenez-Rodriguez and Sanchez (2005). Their approach entails a vector autoregression model, with data sample running from 1970 to 2005 (quarterly intervals) and includes oil-exporting and -importing, approximately equally industrialized countries within the OECD. According to their findings, net oil-importers are characterized by decreasing output and peeking inflation in respond to oil price increase. However, net oil-exporters, such as Norway, would be affected with a fall in mainland GDP up to 0.8%, should an exogenous fall in oil prices of 25% occur. Thus, Norway would not be affected to such a great degree by a potential fall in oil price. Canada would react negatively to the same factor, while the UK would respond in an oil-importing country sort of manner: by lessening the competitive power.

Furthermore, Rydland (2011) argues for a relatively weak effect on the Norwegian economy. With the SVAR model approach, it is pointed out that supply and oil-specific demand shocks affect unemployment and inflation rate, whereas the impact on interest rate depends on whether the shock is caused by a change in demand or supply.

## 2.2 Main Transmission Channels of Oil Prices

Oil price shocks influence the economy through numerous channels. Since the mid-1970s, movements of oil prices have been regarded by many analysts as a major source of business cycle fluctuations. As the dependence of the economies on oil grew stronger, it has therefore become crucial to investigate the mechanisms which may give us explanation about the current development (Lescaroux et. al., 2008).

Initially, the research was strongly focused on exploring the oil price shocks on the *demand* side. A spike in oil price was categorized either as a transmission of wealth from the importing economies to the exporting ones or an external price increase. Naturally, the intensity of the trade would play a role. Intensive or not, in the case of oil importers, the oil price spikes would normally cause, among others, slower domestic demand, with a flattening gross domestic product and employment rates, as well as a looming risk of inflation. With the rising general level of prices (inflationary shock), real disposable income sinks, along with aggregate demand.

Consequently, the inflationary shock may lead to a steady increase in the consumer price index. The degree to which this is the case will depend on how big percentage does the oil produce constitute of the consumption basket. In a long-term perspective, workers would demand higher wages due to the decline in their real income. A further price-wage circle is being generated (Lescaroux et. al., 2008).

A volatile oil price is also a cause for changes in the *supply* side of the economy. Supply is most likely to suffer in case of a movement in oil price, as production costs increase. This mechanism is logical, since energy is one of the main input in the manufacture. As long as one may assume reallocation of the means of production and substitution between production factors, the negative effects may be counterbalanced (Schneider, 2004). Usually, however, the output declines on the aggregate level.

In general, numerous transmission channels are present in the economy, through which oil prices may influence the economic activity. Various studies point out the relationship between the volatility of the commodity price and unemployment rate (positive relationship) and the oil price and GDP (negative relationship). As mentioned above, the supply side and the demand side of the economy is affected by changes in oil prices. The macroeconomic variables influenced by the changes mentioned in this subchapter will be a focus of this paper. Number of researchers have investigated the impact of oil price shocks in the wake of the shocks of both the 1970, 1990s and the more recent 2000s. Indeed, many studies have shown that the oil price-macroeconomic dependency has deteriorated since the first shocks. The different economic context, higher oil dependency and production intensity in the 1970s are the reason behind the obviously lower impact of volatile commodity prices nowadays on the macroeconomic variables.

## 2.3 The Nature of Business Cycle

It is a known fact that all economics fluctuate over time. Such GDP growth path is characterized by elements such as recovery, peak and decline. It is those fluctuations in the economy, measured by GDP, that are referred to as the business cycle. A business cycle may be global, as well as it may apply to a country, geographic region or industry. Thus, they will differ across borders, sectors or continents. Major geopolitical events, such as The Great Depression or World War I represent key disturbances in the country's (global) economy. However, a country's declining business cycle will sooner or later affect other countries, as growing interdependence and cooperation is becoming apparent.

Discussing a negative demand shock for oil, shifts in the consumption demand for crude oil connected to the movement in the global business cycle, has been one of the most important element for determining the impact. In the times of development, the seemingly insatiable demand for energy sources and raw materials causes the oil price to increase. Actual price of oil is naturally also influenced by expectations concerning the direction of the future oil price movements. One speculates, but one also wishes to hedge oneself against potential future shortage of the commodity. For instance, in times when global economy was expected to thrive, the demand normally peaks (Baumeister and Kilian, 2015).

Global and country specific business cycle is thus crucial for predicting the forming of oil price, as well as its impact on other macroeconomic variables and vice versa.

Meaning that a macroeconomic analysis of oil price changes is only as precise as the prediction concerning the growth of the business cycle. This poses serious issues in forecasting the macroeconomic conditions even at short horizons. Baumeister and Kilian (2015) for instance reports that when one needed to measure the impact of the Chinese economic growth on the oil price increase, the forecasters have severely misjudged the range of development in China. That particular case shows the vulnerability of any econometric approach to the research in the field.

The business cycle affects other macroeconomic analyses and variables alike. It may also help determining which variables are not good proxies for economic activity of a country. Rydland (2011) reports findings that the Norwegian business cycle may differ from that of other countries. For instance, recession in the mid-1980's that never fully emerged in Norway may support that fact. Consequently, lagged effects from the increase in global demand may be the reason for a lack of response in the Norwegian macroeconomic variables.

Moreover, seeing as the petroleum industry has a pro-cyclical character, the government has made attempts at trying to control those recurring properties. A typical business cycle will respond to government policies, even though they may have not strong enough or even unintended effects. Such need for controlling the business cycle and cyclicality of an industry is a complex task. Total demand from the petroleum activity may be divided into three sub-categories of demand: demand from investments related to searching and development, demand for workers and demand for goods and services for continued operations. Such subdivision makes it more difficult for the government to control the effects from the sector.

As discussed above and in the preceding sub-chapters, the research connected with the macroeconomic impact of oil prices is a complex task. Disentangling the oil price, however, is crucial for correct estimation of its impact. More recent economic techniques, such as multivariate regime switching models are said to better represent the changing aspects of the business cycles (Cologni and Manera, 2005).

## 2.4 Wage Formation and Oil Price

The labour market in Norway is characterized by a strong position of trade union and employers' organizations. The unionization rate in Norway is high compared to other OECD countries, but still lower than the other Nordic countries (52%). For years, the

Norwegian wage formation system has been based on collective wage bargaining which is coordinated centrally (Nergaard, 2009). Local bargaining, on the other hand, includes the enterprise level. There is a close cooperation among the strong public actors, such as the government, the employers' organizations and trade unions. Approximately 70% of workers of the public sector, and 100% of the public sector, are covered by the collective agreements (ibid). As a result, the Norwegian labour market may be characterized by universal welfare, with a substantial public sector. The collective bargaining explains small wage differences between the workers and among sectors and institutions. There are no regulations concerning the minimum wages. Wage formation is passed on to the collective agreements in most of the branches.

In the two recent decades (1996-2016) the annual wage increases stretch from 3 up to 5% across and within sector, even though after 2006, the economy was strong, resulting in a tight labour market. No notable individualization of payment setting has been recorded. Relatively high wage increases have been noted in the years 2007-2008 dictated, as mentioned, by good economic results.

When it comes to the influence the oil price has on the wage formation, various transmission channels have been proposed (see subchapter 2.3). The supply channel serves as the most common explanation for that dynamic. Increase in the oil price would account for scarcity of the commodity, thus reducing the output and economic activity. Decrease of economic activity then reduces the real wage growth, and, as a result, unemployment increases. Those changing aspects seem to be unquestionable. However, reports are available on the decreasing relationship between the oil prices and macroeconomic variables. Hamilton (1983) suggests decreasing impact in the years 1940s to 1970s of the oil price shocks on the US economy, a development mentioned before. The available material would hence suggest that the impact on employment and wages also has decreased.

## 2.5 Challenges Connected to the Research

Researching the macroeconomic effects of oil shocks has certain caveats. Comparative analysis across countries entails the fact that one compares counties that are very diverse with respect to the political regime, economic freedom and development and industrial structure of the given countries. Nations differ with regard to the role oil plays in their economies, whether the country is an exporter or importer, and the relevance of the non-petroleum related activities (Peersman and Robays, 2011). Coming to conclusions using results from research concerning other countries than the one in question, would be unfortunate. It is therefore of a great importance to investigate the effects of oil price shocks with country-specific data and assumptions, even with regard to the prevalent global financial integration (Yildrim et. al., 2015).

Another challenge that the research may pose is the importance of distinguishing between several different kinds of shocks, specifically focusing on the underlying source of the oil price change (Peersman and Robays, 2011). Sources of oil shocks may be divided into three categories. The first category, oil *supply* shocks, will most likely cause a permanent decline in economic activity and price increase for an oil-importing country. For an oil exporter, the output will increase, with decreasing or constant price levels. The second category entails oil demand shocks driven by economic activity. This phenomenon causes output and price levels increase on a global level. The third kind of shock is an oil-specific demand shocks. It involves a temporary decline in economic activity on a global level. Most of the variations in the oil prices after the 1970's can be explained by the variations in demand.

Moreover, the time variation will play a role in investigating the crude oil market. Reduced impact of oil price shocks has been reported in several studies (ibid). One explanation behind it is the reduction in dependency on crude oil as energy source. Declining reliance on a commodity makes the country less exposed to volatile market of that commodity. Thus, a time factor is crucial: attempting to explain future potential impact of oil price change and the behavior of a market that is constantly subjected to structural change, based on the past data, may lead to distorted results

# THE IMPACT OF PETROLEUM INDUSTRY ON NORWEGIAN ECONOMY

The European, and thus Norwegian, economy has been shaped by the various geopolitical events through the last centuries. The World War II and its aftermath has introduced some dramatic changes to the Norwegian government budget. However negative, the budget balance was kept at a relatively steady track. For many years, the Norwegian population's wage levels have been lower than those of its neighbors, Sweden and Denmark. The industry structure was primarily anchored in the primary sector, with fishing as main source of income for many.

This situation has been a reality for many decades. It changed abruptly in the autumn of 1969. The oil resources have been discovered in the Norwegian administrative area (Olsen, 2008). The starting era of the petroleum activity on the Norwegian shelf initially required tremendous investments, loans and purchase of licenses, explaining the delay in the impact in the GDP figures. In a small economy, such as the Norwegian one, it is customary to represent changes in GDP divided into mainland GDP, and that coming from the petroleum activities, as on the graph above.

The economic growth, measured by the GDP, has had a great, many-fold increase in the twentieth century. Also in the decades from the 1970's and upwards, the mainland GDP has had a growing trend, with a slight flattening out in 1990 and around year 2005. A slight stagnation in mainland GDP may also be observed in 2008, in contrast to a sharp decline in oil GDP, which was caused by the global financial crisis.

The petroleum industry has not only been a factor for an (almost) uninterrupted economic growth in the country. In addition to attracting the foreign work force, with their knowledge and experience to Norway, thus through immigration increasing population, other important macroeconomic factors play role in the 'oil adventure' as it is often called. Discovery of oil has forced the government to take full control of the reservoirs, production and licensing. A stately owned oil company has been established, which then has participated in major foreign direct investment projects on every continent.

Naturally, monetary policy and incentives introduced by the Norwegian government is crucial in securing the petroleum revenues and its use for the benefit of the society. For instance, the reason behind 78% tax on petroleum revenues is to ensure that those revenues are ‘returned’ to the society in the form of government spending. Establishment of the Government Pension Fund Global was one of the long-term strategies securing the management of the petroleum revenues, and it is a fully integrated part of annual budget. The petroleum revenues have also played a role of a ‘cushion’ for the Norwegian economy in the wake of the financial crisis of 2008, and as a result, the country has not been affected as severely. One of the reasons behind that is that the Fund protects the economy from the volatile revenues from petroleum activity.

In general, oil resources have eased the stabilizing policy. Moreover, the industry has served as an ‘entrance ticket’ to technology development and productivity (Olsen, 2008). The last 40 years has been without a doubt strongly affected by the expanding production on the Norwegian continental shelf.

## Section 4

## METHODOLOGY

The main purpose is to see how oil price changes affect wage changes. However, before we can do it, we need to consider other variables which may have an influence on the wage formations. Those time series need to be stationary. Otherwise, the result may be spurious regression. When using time series, we need to determine whether the variables are stationary and we do it by using Dickey Fuller unit root tests. Next, we test for cointegration between some of the variables. Last, we estimate the ECM. In this study, error correction model is employed to analyze the collected yearly data ranging from 1970-2016. Within the framework, short and long-term restrictions are imposed into the estimation process. The key target is to determine whether the oil price changes.

To specify the correct model, one determines the unit root properties of the time series that are included in the model. A commonly used model for that purpose is the augmented Dickey-Fuller test (ADF). The model will be tested for cointegration vectors using the widely applicable Johansen test. After estimating the long-term equilibrium, a VECM may be generated (Engle and Granger, 1987).

To regress a nonstationary variable Y upon a nonstationary variable X may lead to tests and estimates that are deceptive (spurious regression). Applying nonstationary variables often generates the danger of producing invalid estimators. However, in case where two or more variables are connected by a certain linear relationship, that relationship could make the residuals stationary (Verbeek, 2004). It is common to apply the VAR model. Dealing with two variables, $X_t$ and $Y_t$, VAR can be defined with two equations as follows:

$$Y_t = \delta_1 + \theta_{11} Y_{t-1} + \theta_{12} X_{t-1} + \varepsilon_{1t}$$

$$X_t = \delta_2 + \theta_{21} Y_{t-1} + \theta_{22} X_{t-1} + \varepsilon_{2t}.$$

Here, the reduced form errors are represented by the joints $\varepsilon_{1t}$ and $\varepsilon_{2t}$, which may or may not be correlated. If, for instance, the constant $\theta_{11} \neq 0$, then there is a probability that variable $X$ may explain changes in $Y$. To arrive at a general VAR model for a vector that has k dimensions, we may write the following equation:

$$\vec{Y}_t = \delta + \theta_1 \vec{Y}_{t-1} + \cdots + \theta_p \vec{Y}_{t-p} + \vec{\varepsilon}_t$$

where $\vec{Y}_t$ is a k x 1 vector of time series , and the coefficient matrices are denoted by $\theta_1, \theta_p$. The reduced form error $\vec{\varepsilon}_t$ is a k x 1 unobserved white noise. The predicted value of $\vec{Y}_t$may be estimated if we assume stationarity. The VAR equation can be given another representation, that of a VECM (Vector Error Correction Model), which is simply derived by subtracting $Y_{t-1}$ on both sides of the VAR:

$$\Delta Z_t = \pi Z_{t-1} + \Gamma_1 \Delta Z_{t-1} + \cdots + \Gamma_{p-1} \Delta Z_{t-p+1} + \varepsilon_t$$

The analysis will be conducted in four stages. First off, to determine whether the exogenous variables are stationary, the augmented Dickey-Fuller test will be carried out. The cointegrating relationship between the variables will be checked. Secondly, the number of lags applicable in the model in the model will be decided. As a third step, Johansen test will be carried out to determine the rank of the Π-matrix. The last step is to estimate the error correction model.

## 4.1 Unit Root Testing

In order to test all the variables for unit roots, the augmented Dickey-Fuller (ADF) test will be carried out. The hypothesis of a unit root implies that the intercept term should be zero (Verbeek, 2004). The ADF is often used in testing for unit root, however, those tests apply under strict assumption that the errors are statistically independent and have a constant variance. Consequently, if the null hypothesis cannot be rejected in the time series, but can do so in a differentiated time series, then it may be described as integrated of order 1. The test's results are presented in the Result section.

## 4.2 Johansen Test

A straightforward approach to testing for potential presence of cointegration is the widely-applied Engle-Granger approach (Engle and Granger, 1987). Shortly described, it leads to testing for a unit root in the residuals by means of regression of $Y_{1t.}$ ADF and OLS might be easily used to do that, and as a result the unit root hypothesis may or may not be rejected (Verbeek, 2004). The Engle-Granger method poses some serious glitches that are too severe for us to apply in the presented paper.

A method that does not pose the same flaws and which can be applied to test for the number of cointegration vectors was proposed by Johansen in 1988. 2 years later, a detailed presentation was offered by Johanes and Juselius (1990). In the cointegration literature, it is common to take out the mean of the cointegration relationships, which follows the seminal paper of Engle and Granger (1987); a good discussion can also be found in MacKinnon (1996). We have applied this transformation to our paper. The method originates in a VAR representation in equation 2. Under the assumption that $\vec{Y}_t$ is a vector of I(1) variables, one can define that

$$\pi = y\beta'$$

where β and Y are of dimension k x r, with β denoting the matrix of cointegrating vectors, whereas Y denotes the matrix of weights that enter each of the $\Delta\vec{Y}_t$ equations (Verbeek, 2004).

The first step in this method is to test the hypothesis that the time series does not include any additional cointegrated relationship between the variables. Should the test reject the null for zero cointegrated relationships, at least one cointegration is present. Should the rank be zero, then the Johansen test resulted in no cointegrated relationships between the variables.

## 4.3 Error Correction Model Estimation

After determining the number of cointegration vectors, the error correction model can be estimated. It is reasonable to include variables that are argued to be associated with the wage formation in the short-term perspective. The ECM in its univariate form with one lag looks as follows:

$$\Delta y_t = \beta_1 \Delta y_{t-1} - \alpha(y_{t-1} - \theta x_{t-1}) + e_t$$

The term $\Delta y_t$ is the dependent variable which we are trying to explain. Further, $\beta_1 \Delta y_{t-1}$is the explanatory variable where β is the slope coefficient and is later to be estimated to represent the long-run equilibrium. The term $\alpha$ is a constant, the term $(y_{t-1} - \theta x_{t-1})$ describes the gravitation towards the equilibrium between the variables and $e_t$is a shock term controlling for random variables affecting the system.

The model shows the degree to which $y_t$ responds to short-term changes in $x_t$ and deviations from the long-run equilibrium, with the presence of other variables and lags. Hence, the ECM model shows that the wage level in $y_t$ is explained by the changes in $x_t$, and the historical development in the disequilibrium between those variables. In case when $\alpha<1$, then $y$ rises when when $\Delta y_{t-1}<\bar{y}$ and $y$ falls when $\Delta y_{t-1}>\bar{y}$. Moreover, the model assumes that the variables are cointegrated of order 1. If $\beta=0$, no ECM may be estimated (Engle and Granger, 1987).

# THE DATA AND THEIR PROPERTIES

The data analyzed in this paper are annual time series of the various variables concerning macroeconomic and financial variables in Norway between 1970 and 2016. It would perhaps be more accurate to use a longer time series, as they normally provide more consistent estimates. Expanding the analysis to years before 1970 would imply different economic conditions and structure of oil market, which is, as already mentioned, constantly changing.

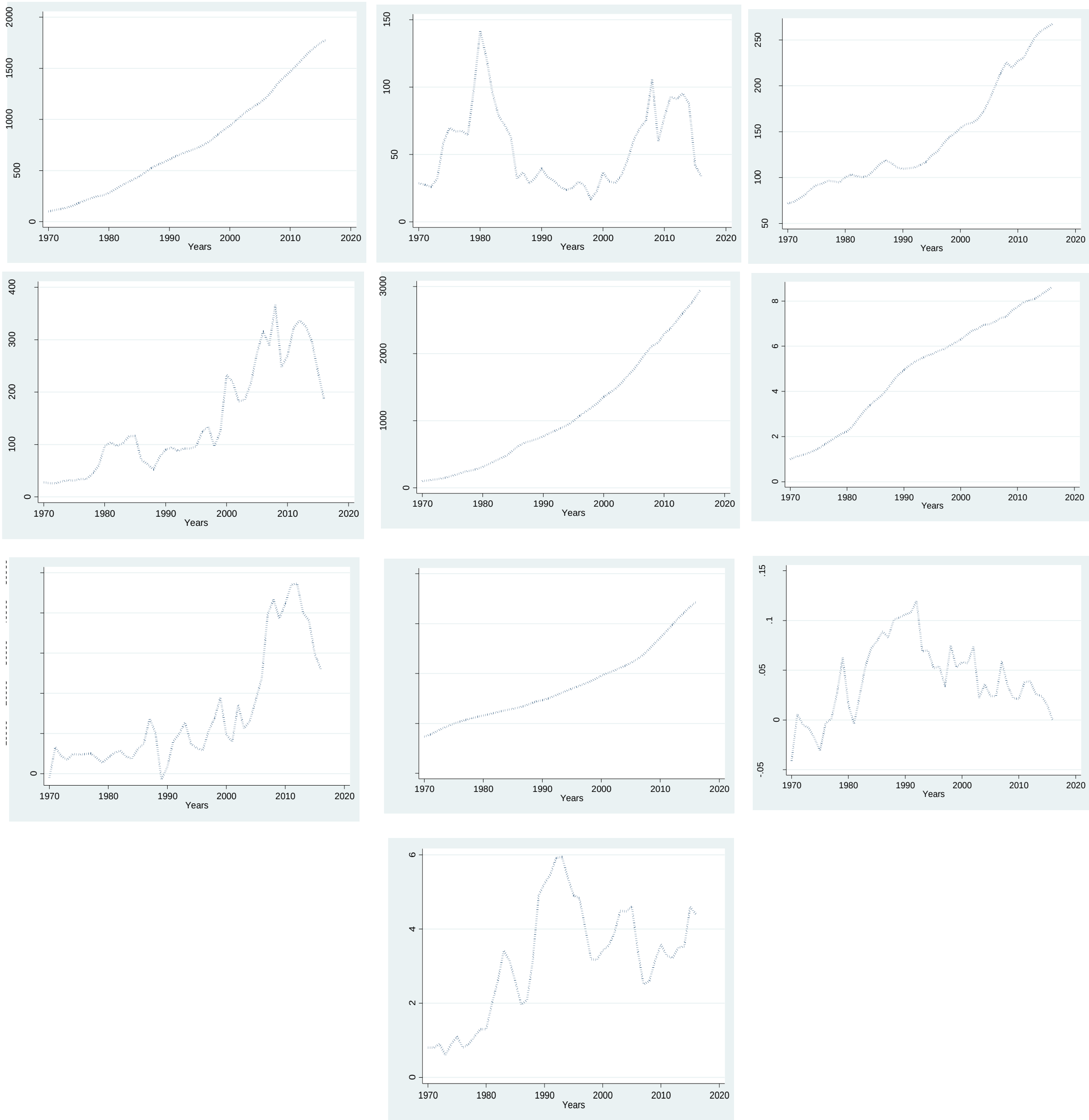
The included variables are annual crude oil prices, annual wage levels, net immigration, population, mainland GDP, GDP from petroleum activities and ocean transport (oil GDP), real interest rates, Consumer Price Index (CPI), unemployment rate and household consumption. The set of variables is consistent with similar research conducted on related topic on impact of oil prices on various macroeconomic aspects (Zaytsev, 2010, Sigurdson, 2016, Lescaroux and Mignon, 2008, Solheim, 2008). The data has been obtained from the Statistics Norway, the Norwegian statistics bureau which has the overall responsibility for providing statistical information on the Norwegian society. All the main variables of interest are represented in the graphs in table 5.2, whereas the summary statistics may be inspected in the table 5.1 below. A correlation table is provided in Appendix C.

*Table 5.1*: Summary statistics

| **Variable** | **Observations** | **Mean** | **Standard Deviation** | **Min.** | **Max.** |
|---|---|---|---|---|---|
| **Real wages** | 46 | 144.18 | 31.28 | 100 | 207.59 |
| **Real crude oil prices** | | 55.06 | 30.26 | 16.75 | 141.99 |
| **GDP mainland** | | 144.18 | 58.24 | 71.77 | 267.46 |
| **GDP oil** | | 144.18 | 101.85 | 25.8 | 366.14 |
| **Household consumption** | | 144.18 | 52.81 | 73.85 | 253.6 |
| **CPI deflator** | | 4.94 | 2.41 | 1 | 8.6 |
| **Net immigration** | | 14651.09 | 14148.57 | -1453 | 47343 |
| **Population** | | 4382012 | 365030 | 3866468 | 5213985 |
| **Unemployment** | | 3.12 | 1.54 | 0.6 | 5.95 |

Source: Statistics Norway

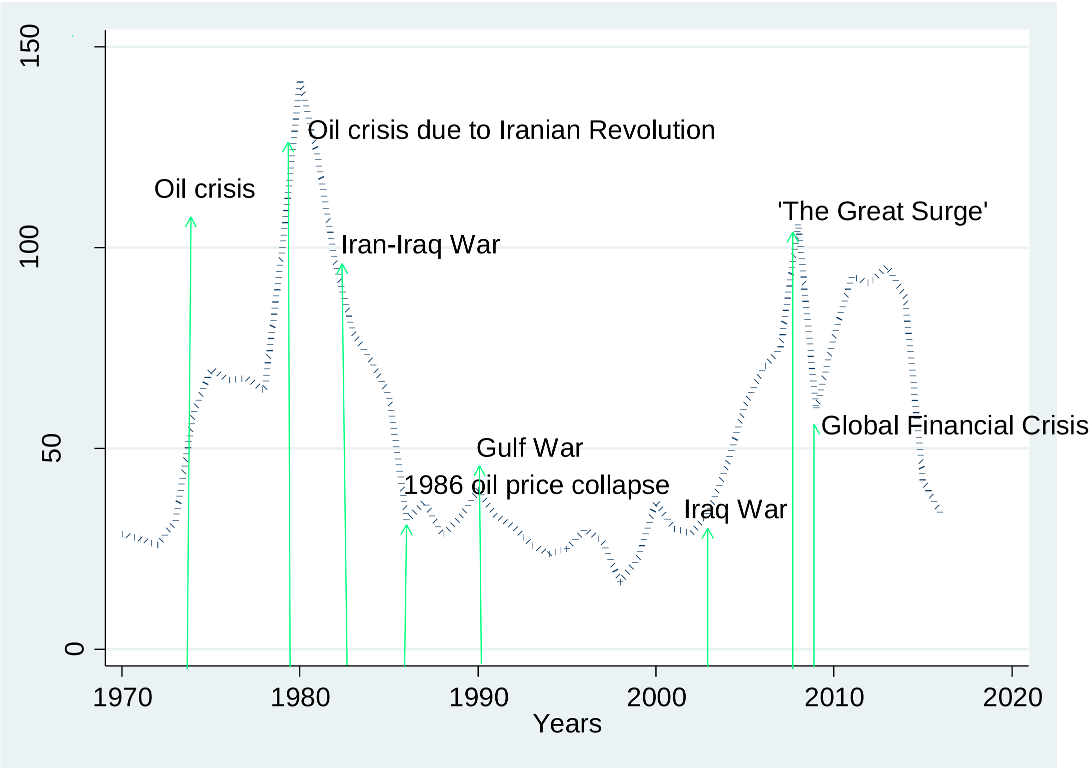
*Figure 5.2*: Main variables of interest.




***Notes****: The graphs from upper left, clockwise (all currency variables in NOK): yearly real wages, crude oil prices (yearly average), mainland GDP. Second row: GDP from petroleum activities and ocean transport, household consumption, Consumer Price Index. Third row: net immigration, population and real interest rate. At the bottom: unemployment rate.*

Source: Statistics Norway.

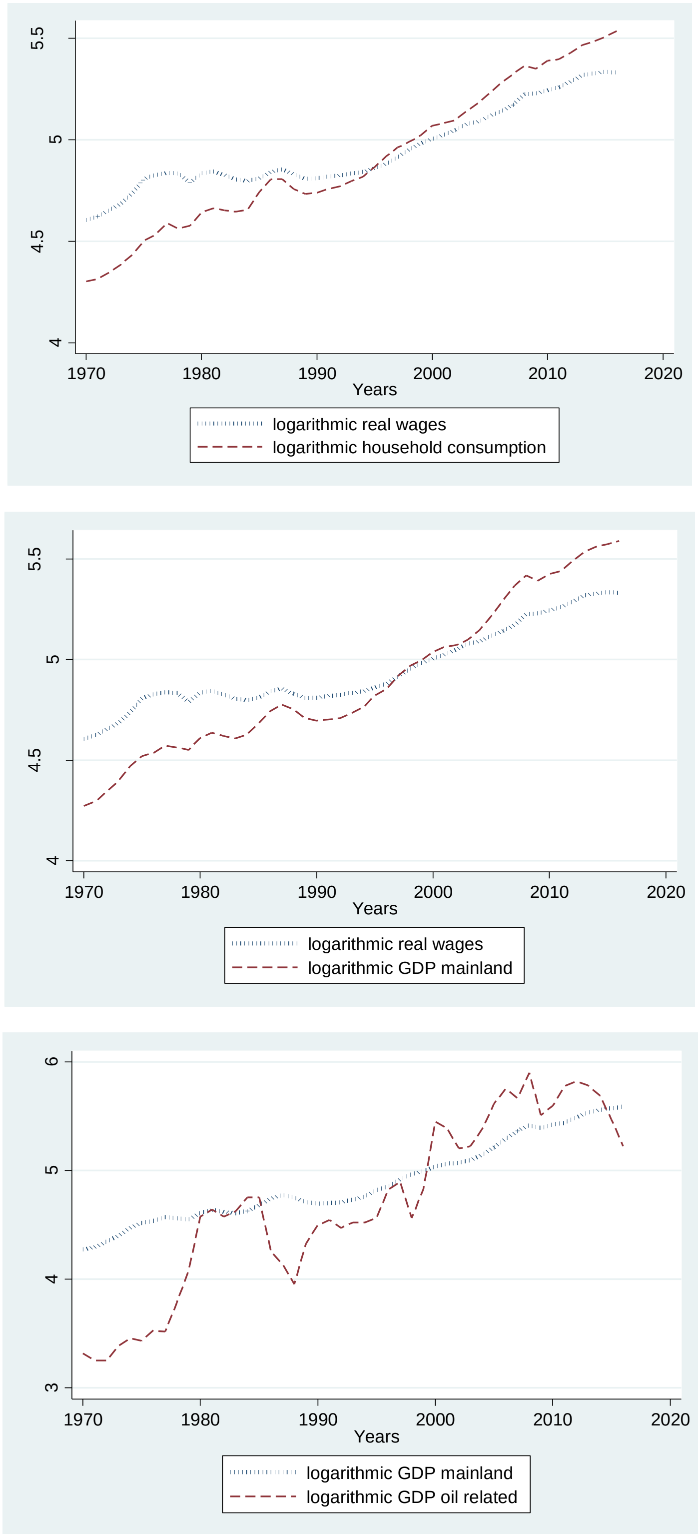
*Figure 5.3*: Oil price and major incidents affecting it in the years 1970-2016 globally.




Source: Baumeister and Kilian, 2015

In the figure 5.3 above the real oil price (price in Norwegian kroner per barrel of Brent crude oil) has been plotted, starting with 1970 until 2016. The figure presents considerable fluctuations in the price of the commodity without any obvious long-run trend. The episodes of lasting high prices are observed between 1979 and 1986 where the oil prices collapsed, then in an 11-year period stretching between 2003 and 2014. This period was interrupted shortly by a period of downturn following the financial crisis.

*Figure 5.4*: Development of the logarithm of the long-term variables: real wages, household consumption, mainland GDP and oil-related GDP.




*Source*: Statistics Norway

## 5.1 The Variables

### 5.1.1 Real Wages

The time series collected for the paper reflects the average yearly wage levels for all employees, across every sector and genders. According to other research, a surge in oil price will lead to various effects for oil-exporting and oil-importing countries. Norway's example may lead to think that an increase in oil prices will indirectly affect the wage levels, and, as a second-round effect, also the price levels (Schneider, 2004).

Norway is in a privileged and special position considering wage levels. The government employs the practice of an economy-wide bargaining system (OECD, 2016). Even though there is no minimum wage policy, all forms of confederations, worker unions, central employer associations and public agencies cooperate in order to take into account the overall macroeconomic marks. According to the OECD reports (ibid) high unionization accounts for relatively meager differences in wages between sectors and industries. It seemed thus reasonable to account for wage levels without further differentiating.

### 5.1.2. Crude Oil Price

As mentioned above, vast research is available concerning the oil price changes and their effect on the economic output. Crude oil, as any other commodity, as a good investment strategy for many, but also a factor that influences various macroeconomic variables. The change in crude oil prices, measured in NOK, is plotted in the second graph in figure 3.1.

Figure 3.2 shows changes in oil price due to major geopolitical incidents influencing the oil price. It may be observed that both the volatility of the oil price, as well as its responsiveness to various global events is noticeable. One may obtain both daily, weekly and monthly oil prices. However, responsiveness of other variables is not as perceptible, thus annual average, calculated from the monthly price, has been used in the paper.

### 5.1.3 Economic Activity

In order to reflect the development in economic activity, GDP for years 1970-2016 has been used. The previously reviewed literature suggests that net oil-exporters would be affected negatively be a negative demand shock in the oil price. The effects of the change in the price of the commodity may be direct, or through transmission channels, discussed above in section 2.2.

For this paper's needs, mainland GDP has been separated from the GDP that originated from the petroleum activity and ocean transportation (oil GDP). This is because those two measurements have widely different volatilities, in addition to the fact that the oil GDP constitutes a substantial part of the total GDP. Separating between those two measurements of economic activity is customary for resource-rich countries. Mainland GDP and oil GDP constitutes the total GDP together.

### 5.1.4 Household Consumption

Various research reports to the household consumption levels as a measurement of economic activity. In a market which is driven by demand and supply, and most of the goods and services may be purchased, real wage levels would be an important dimension defying the nation's living conditions. It is thus crucial to include this variable in the model.

The research reports that there is a cointegration between consumption and income (Slalacek, 2004). The development of household consumption is plotted in the sixth graph in the figure 3.1 above. In the graph displays what seems to be a long-run trend in the sample period. Household (or private) consumption is one of the components of a country's GDP, along public consumption, net exports and investments.

### 5.1.5 Consumer Price Index

The Consumer Price Index is a measurement that shows change in the price of a predetermined package of goods and services that is typical for a household to purchase. It is used as a measurement for inflation in the sense that one considers the degree to which the CPI has increased in percentage terms in comparison with the previous time slot. Thus, since the rate of inflation is often based on the CPI, it has been decided not to include inflation in the model. All economic variables are deflated by the CPI.

It is often practiced presenting the monthly changes in the CPI. For the needs of this paper, it is sufficient to use a yearly average, ranging from the 1970 until 2016. It is important to point out that CPI is a complex measure, taking into account factors as varied as changes in interest rate, taxes and duties and other short-term disturbances. Moreover, the index faces a certain difficulty due to the fact that establishing which price movements are permanent and which are just temporary, is problematic. However, seeing that there are no precise measurements of all inflationary movements, the CPI is still probably the main index for measuring inflation.

### 5.1.6 Net Migration

The migration figures are obtained from the Statistics Norway. Net migration is defined as the difference between the in-migration and out-migration, which attempts at presenting the extent of immigration and emigration from Norway. As of February, 1st 1980, a person is regarded a Norwegian resident with regard to a 6-months rule: if the person has lived or intends to live in Norway for the next six months, then the individual is regarded a resident of Norway.

Additionally, the changes in net migration, as shown in figure 3.1, have been dramatic over the years. 2016 for instance has had a particularly sharp decrease of net migration (roughly by 3800) due to the high levels of emigration. The composition of arriving population has also changed; however, this is not the focus of the task.

### 5.1.7 Population

Norway is a scarcely populated country, specifically in the northern municipalities. The data collected for the paper shows growth in number of people living in Norway from 1970, which is characterized by a steady growth every year. Since the start of the series, the population has almost doubled in size and has only recently (2012) turned the five-million benchmark.

### 5.1.8 Real Interest Rate

The definition of the real interest rate is interest rate on loans minus the increase in prices, whereas an increase in prices is the percentage change in the CPI from the year before. In addition, it is a major financial policy tool, regulated regarding the economic outlook of the country of interest.

As of 2016, when the unemployment rates have been plunging, the key fiscal policy instrument was low interest rate. As a result, the mortgage rates drop. Together with fall in oil price, the weakening interest rates have contributed to weaker Norwegian currency. In a long-term perspective, lower interest rates, alongside weak NOK and global growth, cause the Norwegian economy to recover, and stimulate mainland economic activity. It is assumed that the fiscal policy will keep the expansionary trend at least until 2018, so as to improve the economic outlook of Norway.

#### 5.1.9 Unemployment Rate

Unemployment rate is defined as the number of unemployed people as percentage of the labour force (OECD, 2016). The labour force includes the unemployed and those in paid positions or self-employed. There are various sources for unemployment rates, however, the Statistic Norway’s data seems the most reliable.

High unemployment rate entails normally pressure on the wage level, so that it becomes more contracted across industries and sectors. In the period of interest, Norway has had small changes in unemployment rate, and for the last 46 years (the duration of the sample period), it has been always below the average of the European Union. Since 2008 the unemployment rate has had higher levels than previously.

# RESULTS

The main objective in the research is, as mentioned before, to investigate whether the oil price changes influence the wage formation in Norway based on time series analysis. To make that possible, it is necessary to allow other variables to affect the explanatory variable (wage levels). After including other possible explanatory variables in the model, it is possible to determine oil prices' impact alone on the wage levels. Hence, in this section, we provide evidence for the presence of long-term relationship between those two variables. First, the augmented Dickey-Fuller test has been applied in order determine unit root presence in each variable. Next, the Johansen test has been used to test for a number of cointegration vectors. The Johansen test provides a set of dynamic terms for our model, which is derived from the cointegrating vectors. Those steps are being undertaken in order to check whether the model is congruent with the data and if it is well specified. Last, an ECM is estimated.

## 6.1 Unit Root Testing

Dickey-Fuller unit root tests are performed in order to quantify the order of integration ($I(d)$). All variables will be stationary when they are differentiated with the number of unit roots. As one can read from the Table 6.1, all variables have been tested for unit roots using α=5%. The test statistics for ln(wage), ln(oil price), ln (GDP mainland), ln(GDP oil), ln(households consumption), CPI deflator, net immigration, population, real interest rates and unemployment rate have been checked against the critical value of -2.941. The $H_0$, that unit roots exist, is accepted at 5% significance level. Since all variables apart from population have test statistics below the critical value, we may infer that they are integrated of order 1, meaning that they have one unit root. Population proves to be an exception, as it has two unit roots.

What one wishes to establish, is whether the model is stationary, and the test may be defined as follows:

$$\Delta\varepsilon_t = \beta\varepsilon_{t-1} + \sum_{t=1}^{N} \alpha_i \, \Delta\varepsilon_{t-i} + u_t$$

The null hypothesis includes the assumption that the error terms are non-stationary, whereas accepting the alternative hypothesis would entail presence of stationarity:

$H_0=S_t \sim I(1), \beta = 0$ – one or more unit roots are present

$H_1=S_t \sim I(0), \beta < 0$.

*Table 6.1:* Stationarity test's results

| | **MacKinnon p-values (H0=unit root exists, α=5%)** | | |
|---|---|---|---|
| **Variable** | **Level**<br>**Test stat.** | **First Difference**<br>**Test stat.** | **Second Difference**<br>**Test stat.** |
| ln(wage) | 0.123 | -4.213 | |
| ln(oil price) | -2.419 | -5.674 | |
| ln(GDP mainland) | 0.356 | -3.824 | |
| ln(GDP oil) | -1.609 | -5.481 | |
| ln(household consumption) | -0.030 | -4.785 | |
| CPI deflator | -9.514 | | |
| net immigration | -2.115 | -7.616 | |
| Population | 7.708 | -1.025 | -5.227 |
| real interest rates | -6.172 | | |
| unemployment rate | -1.757 | -5.297 | |
| **Critical value** | **-2.941** | **-2.941** | **-2.947** |

*Source:* Stata

6.2 Johansen Test

After determining number of unit roots, the next natural step is to check whether some of the variables are cointegrated. We test whether the following variables are cointegrated:

1. Wage – household consumption
2. Wage – GDP mainland
3. GDP mainland – GDP oil related industry

In the table 6.2 below the cointegration tests are shown. As can be seen, all the tested relationships are highly significant. This translates into the fact that all relationship we have tested for here, such as relationship between wages and household consumption, wages and mainland GDP, as well as mainland GDP and oil GDP are connected in the long-term. Moreover, the reported test statistics mean is 12.53 in all relationships, which suggests that there are close links between the variables.

*Table 6.2:* Johansen-Juselius cointegration rank test

| Description | lnW & lnHC | lnW & lnGDP_main | lnGDP_main & lnGDP_oil |
|---|---|---|---|
| r>=0 | 235.38222 | 212.45312 | 178.45292 |
| r>=1 | 235.38222 | 0.00936467 | 0.08621061 |
| Test statistic | 12.53 | 12.53 | 12.53 |
| Osterwald-Lenum Critical values (95% interval) | | | |

*Source*: Statistics Norway

Thus, as expected, there is a long-term relationship between those variables. Johansen cointegration tests show that whether these three relationships are cointegrated. The normalized cointegration vectors are:

1) gen ecm_WHC=lnW-0.8162915*lnHC

2) gen ecm_WGDPM=lnW-.7024066*lnGDP_main

3) gen ecm_GDPMO=lnGDP_main-.8371399*lnGDP_oil

As the mean of the long-term variables is the same, we test whether the cointegration vector should be [1 -1]. All z-values are above 2 (see Table 6.3 below). Hence these estimates are significant different from zero and those relationships are used in order to test which variables that effect the wage changes.

*Table 6.3:* The z-test of the normalized cointegration vectors

| Description | $H_0$=-1 | β | Difference | S.E. | z-value |
|---|---|---|---|---|---|
| lnW lnHC | -1 | -0.82 | $[1-(-0.82)]$ | 0.05 | 3.70 |
| lnW lnGDP_main | -1 | -0.70 | $[1-(-0.70)]$ | 0.11 | 2.83 |
| lnGDP_main lnGDP_oil | -1 | -0.84 | $[1-(-0.84)]$ | 0.07 | 2.20 |

*Source*: Statistics Norway

6.3 Error Correction Model Estimation

The fundamental requirements for ECM is determining co-integration and non-spurious regression. The results of ADF test provide enough evidence of stationarity (Table 6.1). The results of the Johansen co-integration test (Table 6.2) provide enough evidence on the long run relationship between the variables under consideration. These two conditions are satisfied, forming a base for an ECM estimation. In the section above, three cointegration vectors have been identified using the Johansen test. The next step entails checking whether those vectors are helpful in predicting wage changes. With the assumptions described above, we are provided with the following model:

$$d.lnW_t = \beta_0 + \beta_1^* WHC_{(t-1)} + \beta_2^* WGDPM_{(t-1)} + \beta_3^* GDPMO_{(t-1)} + \beta_4^* net_{immigration_{(t-1)}} + \beta_5^* UnEm_{(t-1)} + \beta_6^* Pop_{(t-1)} + \beta_7^* real_{interest\ rates_{(t-1)}} + \beta_8^* Oil\ \text{Price}_{(t-1)} + e_t$$

Here, $d.lnW_t$ implies the logarithmic development of wage levels in a certain period. Next, $\beta_0, \beta_1^*, \beta_2^*, \beta_3^*, \beta_4^*, \beta_5^*, \beta_6^*, \beta_7^*\ and\ \beta_8^*$ are all parameters to be estimated, whereas $WHC_{(t-1)}$, $WGDPM_{(t-1)}$, $GDPMO_{(t-1)}$, net $immigration_{(t-1)}$, $UnEm_{(t-1)}$, $Pop_{(t-1)}$, real interest $rates_{(t-1)}$ and Oil $price_{(t-1)}$ are first (except population, which is second) differences of the variables used in the model. All the explanatory variables, except for the shock term, are presented with one lag.

Different specifications of the above equations are estimated and shown in the table 6.4. In order to not subjectively choose a model, we have used the method of deleting the last significant variable such that we end up with the final model. However, we have also re-jected some of the previously excluded variables back into the model to test whether they should be included after all. As we can see from the table, the long-term relationship between wage and household consumption and the long-term relationship between the wage levels and GDP from mainland activities are marginally significant (under 10% in p-value). Due to the strong evidence in the literature ((Zaytsev, 2010, Sigurdson, 2016, Lescaroux et. al., 2008, Solheim, 2008), it is reasonable to keep those variables in the model. Change in unemployment is significant and affects the wage change in the next period negatively.

In addition, lags of the change in wage, consumption and GDP has been tried without being nearly significant and hence left out. In model 6, it is tested whether it is the positive change in oil price that affects the wage changes. A dummy variable is created, and it is one if the last period has had a positive change (an increase), but lagged once. Moreover, an interaction variable is created between the oil price and the dummy variable. The test indicates that it is the positive changes in oil prices that affect the wage changes. This positive effect could be related to other macroeconomic effects.

As for the normality and autocorrelation, Jarque Bera joint test and Durbin Watson tests have been performed. The Durbin Watson test is inclusive for all specifications except in the final, 7th model. In that particular model, two dummy variables have been created in order to account for the two outliers in our sample. As for the normality, most of the models breach when it comes to the Jarque Bera tests, but when controlling for the outliers, the residuals in the last model are normally distributed. We can also notice that the coefficients change very little with different specifications of the model. Hence, neither the normality not the autocorrelation seems to be a problem in our model.

In a model such us ours, with many insignificant variables, interpreting the output may be deceitful. Even though we originally apply many variables to the model, the R-squared value is 42.00%. This means that less than 50% of the changes in wage levels may be explained by the variables included in the model. Further down along other specifications, that value lessens even more, until we arrive at a model with an R-squared value of 34%. This may be because important explanatory variables have been omitted. Alternatively, a measurement error may be present in the model.

Not surprisingly, the R-squared measurement increases dramatically when we reach the last model, and ranges 65%. This owes to the fact that in the last model, two dummy variables have been included. The results from the Durbin Watson suggests no further evidence for positive autocorrelation. However, the Durbin Watson statistics is kept under the R-squared value, which is a positive sign: otherwise, we would be dealing with spurious regression.

The main finding from the model is that the largest effects on the wage levels are imposed by the changes in the oil prices, household consumption, mainland GDP and unemployment, in descending order. Net immigration, GDP related to petroleum activities and ocean transport, population and real interest rates do not seem to have significant impact on the wage levels. Individual coefficients in the last model are statistically significant at 5%-level.

The model suggests that an oil price increase in the previous period, then the wage level would increase. This is indicated by the coefficient $\beta_8^*$, which is positive, suggesting that there is a positive long run relationship between the oil price and wage level. More specifically, the estimated value of the coefficient is 0.03. It is statistically significant at 5% level (see Table 6.4 below). The coefficient represents the rate at which the previous period's disequilibrium of the system is being corrected, which is at a speed of 3.00% between the wage level and the oil price.

*Table 6.4:* Regression output.

| Model | Descrip-tion | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| l.ecm_WHC | Coef. | 0.18 | 0.18 | 0.20 | 0.22 | | | 0.22 |
| | t-value | 1.16 | 1.20 | 1.62 | 1.70 | | | 1.90 |
| l.ecm_WGDPM | Coef. | -0.32 | -0.32 | -0.34 | -0.34 | | | -0.32 |
| | t-value | -1.63 | -1.68 | -1.90 | -1.92 | | | -1.89 |
| l.ecm_GDPMO | Coef. | 0.00 | 0.00 | | | | | |
| | t-value | 0.27 | 0.27 | | | | | |
| l.d_net_ | Coef. | 0.00 | 0.00 | 0.00 | | | | |
| immigration | t-value | -0.28 | -0.27 | -0.29 | | | | |
| l.dUnEm | Coef. | -0.02 | -0.19 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 |
| | t-value | -3.11 | -3.16 | -3.23 | -5.33 | -3.74 | -4.78 | -5.25 |
| l.d2lnPop | Coef. | -2.24 | -2.27 | -2.25 | | | | |
| | t-value | -0.82 | -0.85 | -0.86 | | | | |
| l.d_real_ | Coef. | 0.01 | | | | | | |
| interestrates | t-value | 0.06 | | | | | | |
| l.d_lnOilPrice | Coef. | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.00 | 0.03 |
| | t-value | 2.51 | 2.62 | 2.67 | 2.76 | 2.69 | 0.10 | 3.00 |
| Dummy =1 if oil price incr. | Coef. | | | | | | -0.01 | |
| | t-value | | | | | | -0.67 | |
| Dummy*l.d_lnOil-Price | Coef. | | | | | | 0.07 | |
| | t-value | | | | | | 2.16 | |
| Constant | Coef. | 0.32 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 |
| | t-value | 1.98 | 2.03 | 2.16 | 2.11 | 2.18 | 2.18 | 2.18 |
| Dummy if year = 1979 | Coef. | | | | | | | -0.06 |
| | t-value | | | | | | | -11.85 |
| Dummy if year = 1988 | Coef. | | | | | | | -0.05 |
| | t-value | | | | | | | -17.14 |
| R^2 | | 42 % | 42 % | 42 % | 41 % | 34 % | 41 % | 65 % |
| Obs | | 44 | 44 | 44 | 45 | 45 | 45 | 45 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Jarque Bera joint test** | **Prob>chi2** | **0.02** | **0.02** | **0.01** | **0.01** | **0.02** | **0.03** | **0.99** |
| **Durbin Watson** | **d-statistic** | **1.92** | **1.93** | **1.91** | **1.90** | **1.74** | **0.03** | **1.86** |
| | **dU** | **1.83** | **1.77** | **1.70** | **1.58** | **1.47** | **1.58** | **1.70** |
| | **dL** | **0.93** | **0.97** | **1.02** | **1.11** | **1.20** | **1.11** | **1.02** |

*Source*: Statistics Norway

This thesis' findings confirm the conclusions drawn in similar available research. Lescaroux et. al. (2008) reports long-term relationships between oil price and macroeconomic aggregates for oil-exporting countries outside for the non-OPEC producers. Three variables are related most closely: GDP, CPI and unemployment rate. Wage levels are indirectly affected through the links between the variables and the overall economic activity. The analysis is extended to include share prices, which also seem to be affected by the movements in the oil prices.

The necessity to underline the lagged effects of the oil prices' impact on the economy also becomes visible in available research. Zaytsev (2010) completes the discussion with focus on the fact the increase in oil price has no negative simultaneous effect on GDP of an oil-importing country. Negative effect may be observed first a month after the sharp oil price increase. Even though the research is not directly comparable, both may agree on the lagged nature of the effect of oil price change on GDP.

A major strengthening of our findings may be found in Jimenez and Sanchez (2005). The reported results confirm a positive effect of an oil price increase on the Norwegian economy, whereas a potential decrease in the oil price would not have statistically significant impact on the economy. Interestingly, Norwegian economy is compared to another net-oil exporter in the research, Great Britain. The main difference is displayed in the fact that a potential oil price decrease would affect the British economy significantly. As the main reason behind such development, the authors suggest that the monetary policy following the oil price shocks differs in the two countries, thus affecting the aftermath. Main differences are found in the exchange rate responses as well as adjustments in real wages and interest rates.

Another validation of our results is to be found in Peersman and Robays (2011). The research claims that there is a positive effect on the economic activity following an oil price increase for an oil-exporting country. Additional factors are being added in the paper, such as the underlying reasons for the shocks, and whether they are driven by a demand or a supply shock, which was not included in our research. A contrast to our findings, however, is Rydland's discussion (2011) on impact of the oil price changes on the Norwegian economy. The suggested impact is weak on the aggregate economic activity, compared to other small net-exporting countries.

Section 7

# CONCLUSION

This thesis examines the effect of oil price changes on the wage formation in Norway. Understanding the current development in the energy markets and the underlying reasons for changing nature of the oil demand and supply is of big importance for both the policy makers and analysts across the globe. Short- and long-run effects may differ, as well as the impact of the changes varies in its scale and span. For a small, open, oil-exporting economy, such as the Norwegian one, oil price shocks will affect the overall economy. The question as to what Norwegian employers may expect in terms of changing wages, remains crucial.

As mentioned above, the economic climate changes, the countries and industries enter different phases of business cycle, as well as the influence of oil within energy sources has changed tremendously. Hence, that literature may be used as a guide, but does not provide all the answers. A research concerning impact of oil price shocks should be country-specific, based on appropriate data set. The contribution of this analysis is thus investigation of impact of oil price shock on Norwegian economy in the years 1970-2016, allowing various other variables to explain the real wage formation.

The result this thesis provides is that the wage formation in Norway is affected by the oil price to a big extent. The effect of an oil price shock on wage levels is positive. This does comply with the previous literature on the consequences of oil price shocks for the net-exporting countries. Such result implies consequences for policy makers, discussed in the section above.

In addition to the oil price changes, also unemployment rate is a statistically significant variable in the model. According to our results, an increase in unemployment, would affect the wage levels in negative direction. Such development seems intuitive, as collective wage bargaining would be affected by the decreasing demand after working capital, thus the employers' organization could press the wage levels further down in times of high unemployment.

## 7.1 Thesis' Limitations and Further Research

As with all research that includes data input, the quality of the results depends on the quality of the input. Using the monthly data has its caveats: for instance, the price of oil, typically a volatile variable, becomes much more stable when turned into a monthly average. Ideally, one should use the daily data. However, for the needs of this analysis, it was more practical to use the monthly data. Many variables, such as the unemployment rate, wage levels and real interest rates would be meaningless in a daily representation, as they do not change as often.

Moreover, concerning the data issue, using different units could have given different results. For instance, if the market values of the petroleum sector would have been applied, instead of GDP within petroleum activities and ocean transport, perhaps they would be more significant. In result, they would have been included in the model for wage formation. Such considerations are always present while working with datasets. In this analysis, the starting point included a wide array of variables, and thus accounted for a well-specified model in the end.

Future research within the subject could involve the impact of various policies on the wage formation. As we know, change in one macroeconomic variable, such as price of the main export commodity, will be followed by a fiscal or monetary policy that has as a goal to diminish the impact of the changes. Those policies should be taken into account when measuring the impact of the oil price shocks. Only by such approach, one can determine whether the macroeconomic effects are caused by a volatile oil price or the policies that follow the commodity price. As such, the analysis has a major drawback seeing as it ignores potential policies.

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# APPENDIX

Appendix A: The dataset used in the thesis.

| Year | Real Wages | Real Oil Prices | Mainland GDP | Oil-related GDP | Household Consumption | CPI deflator | Net_ immigration | Population | Real Interest rate | Unempl. |
|---|---|---|---|---|---|---|---|---|---|---|
| **1970** | 100.0000 | 28.6906 | 71.7720 | 27.6469 | 73.8547 | 1 | -969 | 3866468 | -0.041 | 0.8 |
| **1971** | 101.8922 | 27.5229 | 73.3498 | 25.8684 | 74.8095 | 1.107 | 6615 | 3888305 | 0.006 | 0.8 |
| **1972** | 105.0198 | 25.9650 | 77.1877 | 25.7911 | 77.3431 | 1.17342 | 4423 | 3917773 | -0.005 | 0.9 |
| **1973** | 108.4052 | 31.9584 | 81.3363 | 29.5615 | 80.2721 | 1.25790624 | 3444 | 3948235 | -0.008 | 0.6 |
| **1974** | 114.1815 | 58.4643 | 87.5137 | 31.6835 | 84.3125 | 1.353507114 | 4922 | 3972990 | -0.018 | 0.9 |
| **1975** | 122.5616 | 69.7875 | 91.8520 | 31.0148 | 90.2615 | 1.480736783 | 4769 | 3997525 | -0.031 | 1.1 |
| **1976** | 124.8999 | 67.0917 | 93.4320 | 34.0814 | 93.0565 | 1.65250225 | 4889 | 4017101 | -0.003 | 0.8 |
| **1977** | 126.1321 | 67.5363 | 96.7131 | 33.6785 | 98.5654 | 1.804532457 | 5034 | 4035202 | 0.001 | 0.9 |
| **1978** | 125.8171 | 64.3265 | 95.8273 | 44.1261 | 95.9079 | 1.966940378 | 3974 | 4051208 | 0.027 | 1.1 |
| **1979** | 120.2372 | 99.8148 | 94.7185 | 59.2394 | 97.2948 | 2.128229489 | 2746 | 4066134 | 0.063 | 1.3 |
| **1980** | 125.9012 | 141.9920 | 100.5530 | 97.1585 | 103.7507 | 2.230384504 | 4071 | 4078900 | 0.015 | 1.3 |
| **1981** | 127.1391 | 122.3220 | 103.2905 | 103.7742 | 106.0029 | 2.473496415 | 5176 | 4092340 | -0.004 | 2.001 |
| **1982** | 124.7397 | 95.8709 | 101.5708 | 97.1224 | 104.9144 | 2.809891928 | 5740 | 4107063 | 0.025 | 2.606 |
| **1983** | 122.1953 | 78.6954 | 100.3864 | 102.3054 | 104.2167 | 3.127409716 | 4285 | 4122511 | 0.054 | 3.426 |
| **1984** | 121.2677 | 71.7734 | 102.2906 | 115.9342 | 105.2874 | 3.390112132 | 3761 | 4134353 | 0.072 | 3.147 |
| **1985** | 122.7919 | 63.2814 | 108.0022 | 116.2157 | 114.9634 | 3.600299084 | 6228 | 4145845 | 0.079 | 2.588 |
| **1986** | 126.6989 | 32.1139 | 114.8082 | 70.4721 | 122.2353 | 3.805516132 | 7451 | 4159187 | 0.089 | 1.962 |
| **1987** | 128.5061 | 36.8239 | 118.7527 | 62.6295 | 122.4271 | 4.079513293 | 13769 | 4175521 | 0.083 | 2.084 |
| **1988** | 125.2823 | 28.3800 | 115.9635 | 52.2192 | 116.5109 | 4.43443095 | 10143 | 4198289 | 0.101 | 3.149 |
| **1989** | 122.5390 | 32.7869 | 110.9846 | 75.9921 | 113.7287 | 4.731537823 | -1453 | 4220686 | 0.103 | 4.908 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **1990** | 122.7967 | 39.6558 | 109.5513 | 89.8615 | 114.5010 | 4.949188563 | 1710 | 4233116 | 0.106 | 5.229 |
| **1991** | 123.9074 | 33.1823 | 110.2184 | 94.1160 | 116.6708 | 5.152105294 | 8045 | 4249830 | 0.108 | 5.469 |
| **1992** | 124.5101 | 30.5820 | 110.9536 | 87.6888 | 118.1703 | 5.327276874 | 9942 | 4273634 | 0.12 | 5.915 |
| **1993** | 125.8501 | 26.0120 | 113.6883 | 92.1509 | 121.2661 | 5.449804242 | 12808 | 4299167 | 0.069 | 5.948 |
| **1994** | 126.7650 | 23.7725 | 117.0374 | 92.2507 | 123.8521 | 5.57514974 | 7436 | 4324815 | 0.07 | 5.393 |
| **1995** | 129.1840 | 25.0761 | 124.2290 | 96.0725 | 129.9025 | 5.653201836 | 6366 | 4348410 | 0.052 | 4.906 |
| **1996** | 131.7981 | 29.9124 | 128.3119 | 124.3470 | 136.9091 | 5.78887868 | 5817 | 4369957 | 0.054 | 4.833 |
| **1997** | 136.3651 | 26.9018 | 136.8024 | 134.1328 | 142.9228 | 5.864134103 | 10700 | 4392714 | 0.034 | 4.034 |
| **1998** | 141.5836 | 16.7533 | 143.6907 | 96.0711 | 146.9285 | 6.01660159 | 13823 | 4417599 | 0.075 | 3.186 |
| **1999** | 145.8401 | 22.7705 | 147.9547 | 125.4580 | 151.8590 | 6.154983427 | 18999 | 4445329 | 0.053 | 3.172 |
| **2000** | 149.0315 | 36.8154 | 154.0975 | 232.8469 | 159.2574 | 6.296548045 | 9688 | 4478497 | 0.058 | 3.426 |
| **2001** | 152.2266 | 29.9852 | 158.2039 | 219.4724 | 161.2442 | 6.491741035 | 7955 | 4503436 | 0.057 | 3.546 |
| **2002** | 155.7993 | 28.8713 | 159.5419 | 182.0888 | 163.6068 | 6.686493266 | 17174 | 4524066 | 0.074 | 3.889 |
| **2003** | 160.7094 | 34.5983 | 163.6833 | 185.6968 | 171.1867 | 6.773417678 | 11285 | 4552252 | 0.022 | 4.494 |
| **2004** | 162.2698 | 45.9080 | 171.8665 | 217.5972 | 178.1888 | 6.94275312 | 13211 | 4577457 | 0.036 | 4.471 |
| **2005** | 166.9850 | 60.7563 | 184.1274 | 274.9491 | 187.0499 | 6.970524133 | 18439 | 4606363 | 0.024 | 4.616 |
| **2006** | 171.1064 | 69.6705 | 198.8597 | 315.6874 | 196.8167 | 7.082052519 | 23723 | 4640219 | 0.024 | 3.433 |
| **2007** | 176.2754 | 74.9963 | 214.0573 | 289.8697 | 205.2973 | 7.244939727 | 39652 | 4681134 | 0.059 | 2.513 |
| **2008** | 185.8955 | 106.0158 | 225.5237 | 366.1364 | 213.8935 | 7.302899245 | 43346 | 4737171 | 0.035 | 2.595 |
| **2009** | 186.6410 | 59.7088 | 219.6544 | 247.7658 | 210.7544 | 7.580409416 | 38637 | 4799252 | 0.022 | 3.157 |
| **2010** | 189.5452 | 77.8686 | 227.1090 | 269.3116 | 219.1447 | 7.739598014 | 42346 | 4858199 | 0.021 | 3.584 |
| **2011** | 192.6042 | 92.8574 | 230.5311 | 322.8134 | 220.7889 | 7.933087964 | 47032 | 4920305 | 0.038 | 3.28 |
| **2012** | 197.9533 | 91.1449 | 242.3195 | 336.9309 | 228.0969 | 8.028285019 | 47343 | 4985870 | 0.039 | 3.221 |
| **2013** | 204.1210 | 95.3473 | 253.3206 | 325.5338 | 236.9623 | 8.0925113 | 40073 | 5051275 | 0.026 | 3.503 |
| **2014** | 206.0353 | 87.6808 | 259.8553 | 296.7147 | 241.1984 | 8.262454037 | 38155 | 5109056 | 0.024 | 3.53 |
| **2015** | 207.5886 | 42.0268 | 263.4823 | 238.3444 | 246.6559 | 8.427703118 | 29802 | 5165802 | 0.015 | 4.6 |
| **2016** | 206.8406 | 33.8249 | 267.4596 | 186.0119 | 253.5955 | 8.604684883 | 26076 | 5213985 | -0.001 | 4.4 |

Appendix B:

THE CORRELATION MATRIX

| | Wages | Household consumption | CPI deflator | real interest rates | population | net imm. | unemloyment | GDP mainland | GDP oil |
|---|---|---|---|---|---|---|---|---|---|
| **Wages** | 1 | | | | | | | | |
| **Household-consumption** | 0.9977 | 1 | | | | | | | |
| **CPI deflator** | 0.9637 | 0.9462 | 1 | | | | | | |
| **real interest rates** | 0.0733 | 0.0224 | 0.2756 | 1 | | | | | |
| **population** | 0.9937 | 0.9952 | 0.9392 | 0.0279 | 1 | | | | |
| **net imm.** | 0.8645 | 0.8741 | 0.7657 | -0.0766 | 0.8586 | 1 | | | |
| **unemloyment** | 0.5268 | 0.4846 | 0.6928 | 0.5917 | 0.4937 | 0.1866 | 1 | | |
| **GDP mainland** | 0.981 | 0.9892 | 0.8994 | -0.0529 | 0.9864 | 0.9056 | 0.3717 | 1 | |
| **GDP oil** | 0.8986 | 0.8975 | 0.8517 | 0.0006 | 0.8767 | 0.868 | 0.3555 | 0.9062 | 1 |

APPENDIX C:

STATA OUTPUT: JOHANSEN-JUSELIUS COINTEGRATION RANK TEST

## Wage and household consumption

```
Johansen-Juselius cointegration rank test                    Sample: 1 to 47
                                                           Number of obs =  46
                                             H1:
                 H0:     |   Max-lambda         Trace
 Eigenvalues  rank<=(r) |   statistics      statistics
  (lambda)        r     |  (rank<=(r+1))   (rank<=(p=2))
------------------------+--------------------------------
  .99400161       0     |    235.34818       235.38222
  .00073976       1     |    .03404142       .03404142

    Osterwald-Lenum Critical values (95% interval):

    Table/Case 0  (assumption: no intercept, no trend)
                 H0:     |   Max-lambda         Trace
    --------------------+--------------------------------
                  0     |      11.44            12.53
                  1     |       3.84             3.84

                 Johansen normalization restriction imposed
------------------------------------------------------------------------------
        beta |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
_ce1         |
         lnW |          1          .        .       .            .           .
        lnHC |  -.8162915   .0497178   -16.42   0.000    -.9137367   -.7188464
------------------------------------------------------------------------------
```

## Wage and GDP mainland

```
Johansen-Juselius cointegration rank test                    Sample: 1 to 47
                                                           Number of obs =  46
                                             H1:
                 H0:     |   Max-lambda         Trace
 Eigenvalues  rank<=(r) |   statistics      statistics
  (lambda)        r     |  (rank<=(r+1))   (rank<=(p=2))
------------------------+--------------------------------
  .99013086       0     |    212.44376       212.45312
  .00020356       1     |    .00936467       .00936467

    Osterwald-Lenum Critical values (95% interval):

    Table/Case 0  (assumption: no intercept, no trend)
                 H0:     |   Max-lambda         Trace
    --------------------+--------------------------------
                  0     |      11.44            12.53
                  1     |       3.84             3.84


                 Johansen normalization restriction imposed
------------------------------------------------------------------------------
        beta |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
_ce1         |
         lnW |          1          .        .       .            .           .
  lnGDP_main |  -.7024066   .1053052    -6.67   0.000    -.9088009   -.4960123
------------------------------------------------------------------------------
```

GDP mainland and GDP oil

```
Johansen-Juselius cointegration rank test                        Sample: 1 to 47
                                                             Number of obs =  46
                                             H1:
                 H0:     |   Max-lambda         Trace
 Eigenvalues  rank<=(r)  |   statistics       statistics
  (lambda)        r      |  (rank<=(r+1))   (rank<=(p=2))
-------------------------+--------------------------------
  .97929825       0      |    178.36671       178.45292
  .00187239       1      |    .08621061       .08621061


    Osterwald-Lenum Critical values (95% interval):

    Table/Case 0  (assumption: no intercept, no trend)
                 H0:     |   Max-lambda         Trace
    ---------------------+--------------------------------
                  0      |      11.44            12.53
                  1      |       3.84             3.84


                 Johansen normalization restriction imposed
------------------------------------------------------------------------------
        beta |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
_ce1         |
  lnGDP_main |          1          .        .       .            .           .
   lnGDP_oil |  -.8371399   .0738638   -11.33   0.000    -.9819102   -.6923696
```