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Abstract

This study investigates whether the changes in macroeconomic variables can significantly impact the performance of stock markets in Norway and Denmark for the period 2010 – 2020 while using monthly time series data. Six macroeconomic variables which include Oil prices, Inflation, interest rates, unemployment, exchange rates and GDP have been used in this study and the Vector Autoregression approach in addition to the Granger causality test have been used to establish a relationship between the variables. Empirical results from this study show that macroeconomic variables impact stock markets at varying significance and magnitudes. Oil prices are found to be the most significant factor while the exchange rates impose no effect on the stock markets.

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1 INTRODUCTION

1.1 BACKGROUND

A stock market is one that deals with the exchange of securities issued by publicly quoted companies and the government in order to obtain finance for the development and expansion of an investment (Nwaolisa et al., 2016). It is a crucial institution in an economy since it greatly determines and indicates the performance of a country's economy, that is, an increasing share price index overtime indicates stability of the economy while a falling share price index indicates an unstable economy. Thus, the nature and the state of a stock market is of great concern to the government, investors and generally all the stake holders. As an economic institution, the stock market plays a major role of enhancing the efficiency of capital formation and allocation (Kirui et al., 2014). In other words, the transactions being carried out in the stock market help to rise new funding for a corporation and allow increased investment in productive capital and economic growth (Nwaolisa et al., 2016). This implies that the overall development of the economy is a function of how well the stock market performs (Kirui et al., 2014).

Similarly, macroeconomic indicators also play an important role in the performance of the share markets. Investors and policy makers make use of these macroeconomic indicators to gather information of the current and upcoming investment priorities. However, the presence of volatility in the macroeconomic factors gives a signal to stock market participants to anticipate a higher or lower return when investing in a stock. Such influences of macroeconomic variables on stock market arouses the interest of both economists and investors and then in turn draws the attention of policy makers who help to forecast the overall effects of these economic indicators and incorporate them in their policies. This benefits investors and other stake holders as they are able to make informed decisions (Omodero & Mlanga, 2019).

The need to conduct an analysis on the link between macroeconomic variables and stock markets is very important especially if one wants to know the dynamics of the stock markets in a given country. Many studies have been conducted and they point out that there exists a relationship between macroeconomic variables and stock returns. However, while some studies show that all macroeconomic variables used in the model can significantly explain stock returns, others claim that only a part of the variables can significantly impact stock returns. This study focuses on the Oslo Stock Exchange Benchmark Index (OSEBX) which is the main index and constitutes 69 companies listed on the Oslo Stock Exchange (Oslo Børs) and the OMX Copenhagen 20 index

(OMXC20) which is the leading index on the Copenhagen stock exchange made up of the 20 most actively traded shares on the Copenhagen Stock Exchange (Nasdaq, 2022).

It is important to note that the data used and the sample period are from a time when many political, economic and health related events happened. For example, between mid-2014 and early 2016, the global economy faced one of the largest oil-price shocks in modern history. The 70 percent price drop over that period was one of the three largest declines since World War II, and the most persistent since the supply-driven collapse of 1986. These oil price drops were caused by supply factors, including booming U.S. oil production, receding geopolitical concerns, and shifting OPEC policies while at the same time, demand was also deteriorating (World Bank, 2018). Secondly, in the last two years of this study's sample period that is, in late 2019 and through out to 2020 and the subsequent years outside this study, the world has been hit by a global pandemic, COVID 19 which has brought most economic activities to a standstill and most businesses have been affected severely. Lastly, within the region in 2014, Russia which consumes nearly 7 percent of the global salmon production, banned all Norwegian seafood, along with a wide range of agricultural products from countries which imposed sanctions against it over its role in the Ukrainian conflict (Skonnord, 2014).

Given the occurrence of such events, it would be intriguing to scrutinize how they impact the macroeconomic factors and in turn the OSEBX and OMXC20 stock markets.

1.2 PROBLEM STATEMENT

Stock markets in the world of finance are important arrangements where various securities are traded. On one hand, companies and governments via stock markets source for cheap funding directly from investors to finance investment projects or increase the size of institutions thereby stimulating the economic conditions of the country. On the other hand, people and institutions as investors, via the same financial markets engage in investment of various securities for different reasons, with the most prominent one being to earn a return on investment. However, much as the major interest is return, investors are normally risk averse. Financial markets have for long been volatile, characterized by fluctuating returns attributed to various factors especially at a macro level, concerning the whole industry or market.

In this case, questions concerning how macroeconomic factors affect firms' returns in the market have been left unanswered, especially to among various stakeholders who engage in the OSEBX and OMXC20 stock markets and this has further created a need for knowledge about risk especially among the investors which would aid them in making safe investment decisions while minimizing potential losses.

This leads to the problem statement below;

Is there any causal relationship between macroeconomic variables and stock markets?

This study further wants to investigate, how these macroeconomic factors interact with the stock returns in order to understand the level of significance and direction in their relationship (positive, negative or no link at all?). By doing this, this study while based on the most recent data wishes to add an effort to the previous work of Flannery & Protopapadakis (2002) who have contributed to literature through their study that establishes a link between real macroeconomic variables and aggregate equity returns. At the same time, the Vector Autoregression (VAR), is used as a tool to scrutinize this relationship between the variables under study as a way to approach the problem statement above.

1.3 HYPOTHESIS

H1: Inflation has a positive relationship with the stock market returns.

The reasoning behind this hypothesis is based on the Fisherian theory of interest which suggests that the nominal expected return on any asset is composed of the expected real interest rate and the expected inflation rate (Li et al., 2010). In addition, it is the efficient market hypothesis (EMH) which states that stock markets gradually integrate into the world market, and prices react to world information like inflation. Hence with markets being efficient, inflation will influence stock indices in a way that when the inflation rate is higher than expected, stock returns will also be affected (Hussein, 2017).

The extended Fisher hypothesis perceives actual nominal returns to be a function of expected nominal returns and unexpected nominal returns, and both expected and unexpected inflation rates. A positive relationship between stock returns and inflation is rooted from the idea that equities are hedges against inflation because they represent claims on real assets hence return on common equity should keep pace with the inflation rate (Li et al., 2010). In otherwards Inflation is a major concern to investors because they expect to be compensated in terms of higher stock market returns to maintain their real returns. The Fisher Effect, in its strict interpretation, suggests that if the stock market is efficient, then investors expect nominal stock market returns to change proportionately with expected inflation rate (Otieno et al., 2019).

H2: Interest rates and stock markets are negatively related.

The financial theory states that movements in interest rates affect both the firm's expectations about future corporate cash flows and the discount rate employed to value these cash flows and hence in turn affecting the value of the firm, proxied by the firm's stock returns.

Interest rate fluctuations in the form of rising interest rates increase the borrowing expenses of highly leveraged companies. This causes a reduction in the cash flows available for future dividends which consequently negatively impacts the share prices.

Additionally, such movements in interest rates also affect the opportunity cost of equity investments. Higher interest rates make bonds more attractive given their risk-return characteristics, which motivates investors to adjust their portfolios by buying bonds and selling stocks, thus depressing stock prices even more. Finally, changes in interest rates may impact upon the level of real activity in the economy in the short to medium term in the form of reduced investment, and this also affects equity prices by altering the expectations of future cash flows (Martínez-Moya et al., 2013).

H3: Exchange rate has a negative relationship with the stock market returns.

One major issue facing international investors is identifying co-movements of stock prices and exchange rates over time and their frequency-varying properties. This is because of the adoption of free-floating exchange rates by many countries, which restructured the global financial system and this increased capital inflows and outflows, international economic integration, and diversification efforts.

Exchange rate fluctuations are recognized to have effects on stock prices in either a positive or negative direction, depending on which country takes the position of an exporter or an importer. Many previous events such as the US subprime crisis in 2007, the global financial crisis in 2008, and the European debt crisis in 2010, which affected the exchange rates had an adverse impact on financial markets. Financial markets in most developed countries suffered substantial losses during those periods, which led to bankruptcies at several financial institutions after bank lending and liquidity collapsed. From a theoretical perspective, export-oriented firms as well as countries benefit from currency depreciation because weak currency values allow them to export more goods or services and ultimately raise their stock prices. At the same time, stock prices of importers may decline as their profits fall, which means that currency depreciation has an adverse impact on firms' stock prices ((Dahir et al., 2018).

H4: Oil prices have a positive effect on stock prices of Oil exporting countries

Theoretically, oil prices can affect stock prices in oil-exporting countries in several ways. Stock markets are considered to be efficient in that they absorb all publicly and privately available information and incorporate such information into the stock prices. Oil price shocks can affect stock prices directly by affecting current and future cash flows or indirectly by affecting interest rates that are used to discount the future cash flows. Unless there is a complete substitution between factors of production, rising oil prices generally increase the cost of doing business when oil is used as an input in the production of goods and services. For non-oil related companies, a positive unexpected increase in oil prices will usually reduce cash flows and stock prices and hence lead to a reduction of realized stock returns. For oil related companies involved in the production of oil, this generally increases cash flows and stock prices, along with realized stock returns. Furthermore, oil royalties for governments in oil-producing countries may increase as well when oil prices go up, depending on the elasticities of oil demand and on how royalties are levied. Such royalties may be used for additional domestic government spending, say to increase transfer payments to households or to build up the domestic infrastructure, and thus lead to further economic stimulus (Basher et al., 2018).

H5: Unemployment has a negative relationship with stock returns

The relationship between the labour and stock markets was well highlighted by recent events like the financial crisis in 2007-2008 and in addition, several studies conducted show that the stock market can affect the real-life economy, most notably unemployment. The stock market can be an indicator of how economic activity will act in the future, in that increased stock market returns can result into a future drop in the unemployment rate. The contention that active stock markets have a negative relationship with unemployment could be based on several transmission channels, of which Feldmann, (2011) presents four. First, stock markets foster investment in long term projects which stimulates both saving and investment, thus leading to economies of scale and scope. As a result, there's efficient resource allocation, including the allocation of labour. Second, stock markets provide funds for business creation either directly through initial public offerings, or indirectly, through spurring the growth of venture capital which motivates job creation in all sectors. Third, through stock markets, promising investment opportunities are easily identified and then facilitated financially. This brings about augmentation in both resource allocation and economic development, thereby reducing unemployment. Fourth, liquid stock markets provide a way of monitoring companies after providing finance, and supply relevant information. As a result, labour is efficiently allocated and savings are more likely to be redirected towards investment and innovation (Fromentin, 2021).

H6: Gross Domestic Product and Stock market have a positive relationship.

The relationship between stock markets and GDP in form of economic growth is assumed to be positive according to the various studies in the economics literature. A well organized and managed stock market arouses investment opportunities in the country by recognizing and financing productive projects that ultimately lead to growth in economic activity, efficient allocation of capital, mobilization of domestic savings, help in diversifying risks and facilitate the exchange of goods and services.

Stock markets improve the market efficiency by providing timely and accurate information about the firms to the investors, which provides investors with various opportunities to make diversified investments thus reducing their unique risk while at the same time increasing their risk adjusted returns. With this, domestic savings are also mobilized and increased investment is encouraged thus promoting economic growth. Moreover, it has also been reported that the stock exchange may lower the cost of transferring the ownership, which draws the investor's attention to invest in equity markets and thus bringing about an increase economic growth.

In addition, stock markets play a vital role in allocating funds to the corporate sector, something which has a real effect on the economic growth. Debt financing tends to be unavailable in many countries, mostly especially in developing countries, where banks give loans to a selected group of companies or individual investors. This limited loan facility can also expose constraints in credit markets, due to the possibility that the banker's profit (interest) from lending to a specific group of borrowers (individual or companies) does not increase as the margin rate of charge to borrowers increases. Thus, stock markets play a vital role in facilitating capital allocation, investment and growth (Nazir et al., 2010).

1.4 BACKGROUND FOR STOCK MARKETS

OMX Copenhagen 20 Index (OMXC20)

The OMX Copenhagen 20 is the Copenhagen Stock Exchange's leading share index which consists of the 20 most actively traded shares on the Copenhagen Stock Exchange. The limited number of constituents guarantees that all the underlying shares of the index have excellent liquidity. The OMXC20 is a market weighted price index and was established on July 3, 1989 with a base value 100.00 (Nasdaq, 2022).

The main selection criteria are free float adjusted market capitalization and aggregated turnover in terms of market value, that is, the most frequently traded shares on NASDAQ OMX Nordic's automated trading system, during the preceding 6-month period. The two reference periods run from 1 December to 31 May and 1 June to 30 November. The semi-annual review of the OMXC20 portfolio normally occurs immediately after the December and June expiration dates of the OMXC20 futures contract. The old OMXC20 portfolio becomes effective up to and including the 3rd Friday in December and the 3rd Friday in June. A revised and thus new OMXC20 portfolio becomes effective on the first trading day after the expiration of the December and June future contracts. The names of the constituent shares are usually announced approximately three weeks prior to the effective date of the new portfolio. The effective number of shares for the constituents in the index tend to be announced one week prior to the effective date of the new portfolio.

The OMXC20 Index is calculated in Danish Krone (DKK), and constituents that are traded in other currencies are currently translated into DKK. All shares listed on NASDAQ OMX Copenhagen are ranked according to free float adjusted market capitalization. The top 25 shares constitute the OMXC20 basic portfolio. The 20 shares with highest turnover in the OMXC20 basic portfolio will be included in the new OMXC20 portfolio. This portfolio is also called the OMXC20 active portfolio.

The index constituents are included with the free floated number of shares listed on the Exchange, except for share classes issued by foreign companies. The number of foreign shares is reviewed in connection with the review of the OMXC20. The number of foreign shares which will be included in the indices is determined on the basis of the number of shares registered with the Danish Securities Centre on the 20th day of the month prior to the entry into effect that is, in May and November, respectively. If the 20th day is not a trading day, the count will be made on the first succeeding trading day.

In exceptional cases, the Exchange reserves the right to remove a share from the selection. This rule may for instance apply if a share in the reference period has experienced an unusual trading pattern (Nasdaq OMX, 2011).

Figure 1: Historical development of stock prices in the OMXC20 Index

Source: nasdaqomxnordic.com

Figure 1, shows the performance of the OMXC20 index from 2010 to 2020. We can see that stock prices have been steadily increasing over time in the market. At the start of the year 2020, the market experienced a short-lived slump which lasted for approximately three months, ending in March with a price of 939.8 DKK.

Oslo Stock Exchange Benchmark Index (OSEBX)

Oslo Stock Exchange Benchmark Index is a total return index that functions as an indicator of the overall performance of the Oslo Stock Exchange. The Index was introduced on May 23, 2001 with a base date of December 31, 1995 and a base value of 100 (Bloomberg, 2022). The main index shall be an investable index that contains a representative sample of all listed shares on the Oslo Stock Exchange. OSEBX is revised on a semi-annual basis and the changes are implemented on 1 December and 1 June. The securities in OSEBX are free-flow adjusted. In the period between the revision dates, the number of shares for each index member is kept fixed, with the exception of capital adjustments with dilution for existing shareholders. OSEBX is adjusted for dividend payments (Oslo Børs, 2020). The OSEBX index is calculated and quoted in Norwegian Kroner (NOK). To calculate the index in any other currency than the quote currency, the index levels may be multiplied by the exchange rate of the new currency to the index quote currency.
All stocks listed on Oslo Børs or Oslo Axess are normally eligible for inclusion in the OSEBX index but however, certain criteria such as liquidity may make a security ineligible for index purposes. Oslo Børs distinguishes between primary or secondary listing. For secondary listings, only the part of the outstanding shares which is registered in the Norwegian Central Securities Depository is eligible for inclusion. Treasury shares are not included in the index determination process or index calculation. If a company has listed multiple share classes, each of which is priced and traded separately, all share classes are eligible for inclusion and are treated as separate securities. Index inclusion is based on the objective criteria such as free float methodology, sector representation and share liquidity. Security types not included in the index are closed-end funds, exchange traded funds, mutual funds, unit investment trusts, convertible debentures, preferred shares, restricted shares, rights, equity certificates, warrants, and other derivative securities.

The rebalance is conducted based on closing data on the last trading day of October and April. A security transferred to Oslo Børs from another relevant market operated by Oslo Børs will be eligible for inclusion in the upcoming index rebalancing if the transfer is conducted on or before the last trading day of October or April. Implementation of the rebalanced index will take effect from the first trading day of December and June, respectively. Rebalancing is normally undertaken using closing prices the day prior to implementation (Oslo Børs, 2020).

Figure 2: Historical development of stock prices for OSEBX index

Source: live.euronext.com

From the illustration above, it can be noted that the pattern of increase in prices has not been very continuous over the years as some notable stock price falls can be noticed towards the end of 2011, at the start of 2016 and at the start of 2020 where a big price fall was recorded, dropping from 934.9 NOK in February to 639.05 in March the same year.

In a nutshell, it is interesting to find that these two market indices experienced their biggest price falls during the same period. The most probable explanation to this behavior is the occurrence of the global pandemic which affected economic activities all over the world due to the frequent closing of businesses.

2 LITERATURE REVIEW

The literature review in this study consists of three main parts that is; theoretical framework, conceptual framework and the empirical studies.

2.1 THEORETICAL FRAMEWORK

2.1.1 EFFICIENT MARKET HYPOTHESIS

The efficient market hypothesis (EMH) states that a capital market is considered to be efficient where security prices react rapidly to any new arising information. In this way, the existing prices for securities within the market should reflect this information (Singh et al., 2011). This implies that it is impossible for one to continuously achieve returns which are over and above the average market returns on a risk-adjusted basis, given the information available at the time of making an investment. Singh et al. (2011) state that this has important implications towards the stock-broking industry and the policy makers, especially where policy makers must conduct macroeconomic policies without manipulating the stock trading processes and capital formation. The EMH has three main versions; the weak EMH which claims that security prices such as, stocks, bonds, or property tend to reflect all past publicly available information. The semi-strong EMH states that current prices are always inherent of publicly available information and hence will only change where there is emergence of any new public information. The strong EMH explains that security prices further reflect even hidden or "insider" information. However, due to extensive research, it has been revealed that financial markets are not always efficient as the Efficient Market Hypothesis contends and hence, this weakness explains the occurrence of the late-2000s global financial crisis according to the critics of this theory. However, proponents of the hypothesis respond by arguing that uncertainty about the future will continue to exist even in the presence of market efficiency hence it should rather be noted that market efficiency is only a simplification of the world which may not always be perfect, and that the market is practically efficient for investment purposes for most individuals (Omisore, 2012).

2.1.2 RISK AND RETURN.

The most commonly held notion in investment is that, there is a positive relationship between risk and return in that taking higher levels of risk in investment results into high returns yield. Hence with this intuition, any rational investor would demand for a higher expected return in exchange for accepting to take on a greater risk. This can further be expressed in the example where we have an investment that is expected to generate $1 million every year in perpetuity. In this case, how much an investor is likely to pay for such an asset will depend on the uncertainty or riskiness associated with the cash flows. Where the investor is perfectly certain about the amount of cashflows they should expect to obtain at the end of each year, they would discount the asset at the risk-free rate.

However, as the degree of uncertainty increases, the return required to justify the risk will also be much higher, thus resulting in a much lower price an investor would be willing to pay, simply because of the higher required discount rate (Womack & Zhang, 2003). Several empirical studies concerning different classes of securities have been conducted and they prove the general relationship between risk and return. The most thorough recent study has been done by Ibbotson and Sinquefield in 1979. Their data covered the period 1926 through 1978 and their results justify that common stocks have on average, over long periods of time yielded relatively very high rates of return. These returns in form of dividends and capital gains, have always been over and above the returns from long-term corporate bonds and U.S. Treasury bills by a huge margin. These stock returns have also been less affected by inflation as measured by the annual rate of increase in consumer prices. However, studies provide justification that common stock returns are highly variable hence associated with high levels of risk (Malkiel, 1981).

2.1.2.1 RETURN

A Return is considered to be the basic motivating factor and the principal reward in any investment process. Returns can take the form of realized return that is, the return which is actually earned and expected return which is the return an investor hopes to earn over some future period of time. The expected return on one hand is a predicted or estimated return and is likely or not to occur (Omisore, 2012). For example, where an investment has been made by an individual investor, expectation of what the rate of return from that investment will be are made. In the case of a bank account, an individual will anticipate to earn an income in form of interest rate quoted by the bank. While in the case of a stock investment, the return one expects to receive depends on the dividends the company will pay and what an investor thinks the future price of the stock will be. Hence this anticipated return is simply called the expected return. It’s mostly based on whatever information that is available to the investor concerning the nature of the security at the time he or she buys it. According to Omisore, (2012), the realized return on the other hand is the cash inflow in terms of dividends, interest, bonus, capital gains, etc., available to the holder of the investment. The return can either be measured as the total gain or loss to the holder over a given period of time and may be defined as a percentage return on the initial amount invested. If we are to consider an investment in stocks, the return will consist of dividends and the capital gains or losses at the time of sale of these stocks. It is given by the formular;

$$Ri = \frac{Pt + Ct - Pt-1}{Pt-1} \quad (1)$$

Where; R_i is the return on stock i

P_t is the current price of stock i

C_t is the cashflow paid on stock i in the current period

P_{t-1} is the price of stock i in the previous period

2.1.2.2 RISK

According to Malkiel (1981), risk is described as the chance that expected security returns will not materialize and, in particular, that the securities one holds will fall in price. In other words, risk is the possibility of suffering loss. A measure of risk can also be considered as the extent to which the future portfolio values are likely to deviate from the expected or predicted value. More specifically, most investors take risk to be related to the probability that future portfolio values will fall below the expected (Modigliani & Pogue, 1973). For example, if individual A buys one-year Treasury bills to yield, say, 10 percent and hold them until their maturity, this individual faces no uncertainty about the monetary outcome as the value of the portfolio at maturity for the treasury bills will be identical with the predicted value hence, he will earn a 10 percent monetary return before income taxes. The possibility of loss is so small and if not, it can be considered nonexistent thus the investor has borne no risk. However, in situations where the same individual A holds a portfolio of common stock in a local firm for one year on the basis of an anticipated 12.5 percent dividend return, the possibility of loss increases. The dividend of the company might be cut and, more important, the market price at the end of the year could be much lower, in that this individual might suffer a serious net loss. With this, it can become very hard for this investor to perfectly predict the value of the portfolio as of any future date (Malkiel, 1981).

2.2 CONCEPTUAL FRAMEWORK

The conceptual framework shows how each macroeconomic variable interacts with and impacts the stock markets.

2.2.1 UNEMPLOYMENT RATE

Unemployment rate refers to the ratio of individuals who are unable to secure employment to the total number of individuals in the labor force. It should be noted that the labor force constitutes only those individuals who are actively looking for jobs and are willing and able to work. Any changes in the unemployment rates are highly attributable to changes in the supply or demand for labor. On the other hand, other changes in form of technology, aggregate demand and interest rate can affect the demand for labor and thus later the unemployment rate (Farsio & Fazel, 2013).

Unemployment is traditionally known as a measure of the health of an economy and of recent has been viewed as a highly efficient predictor of stock market behaviour. There are two viewpoints to this debate. On one hand, unemployment can be found to impact stock market returns. Such evidence would imply that investors can base their future investment decisions on actual or expected unemployment data. On the other hand, if stock market returns are found to lead unemployment, stock market development can be thought of as a driving force towards eradicating unemployment and poverty in the country (Tapa et al., 2016).

In situations where more active stock markets reduce unemployment, there are two channels through which this effect is likely to occur. First, the stock markets can improve the efficiency of resource allocation by allowing a large number of savers to invest in a large number firms which facilitates long term economic growth. This allocative efficiency also applies to the labour market, thereby reducing unemployment. Second, through initial public offerings, stock markets improve business formation which is also likely to reduce unemployment ((Sibande et al., 2019).

On the other hand, the unemployment rate is one of the important indicators used by the central banks to determine the health of the economy. With monetary policy measures, there are two possible channels through which the unemployment rate can impact stock prices. First, the unemployment rate affects the Federal funds rate or the policy rate which in turn affects stock market prices. Using the existing economic theory, the policy rate reacts negatively to unemployment rate, in that a decrease (increase) in unemployment rate is followed by an increase (decrease) in policy rate which in turn leads to a decrease (increase) in stock market price (return).

The second channel is through money supply. Here, we find that anticipated unemployment rate affects money supply growth, which also immediately affects Federal funds rate, which in turn affects stock market returns (Taamouti & Gonzalo, 2012).

Additionally, financial analysts also assert that unemployment rate is a strong predictor of stock prices. They refer to certain short-term periods and posit a negative causal relation from unemployment rate to stock prices. They argue that declining (rising) unemployment would display an upturn (a downturn) in the economy, an increase (a decrease) in demand for goods and services, and would therefore lead to higher (lower) profits and stock prices (Farsio & Fazel, 2013).

2.2.2 INFLATION

Stock market returns are systematically influenced by various types of information which arrives randomly to the stock market. A key type of such influential information is news regarding the evolution of inflation rate. Thus, where financial markets are efficient, they can easily react to any new inflation information and this can have implications on the investors decision making. In addition, disrupts economic growth in the long run, a thing which affects investors through reducing their returns on financial assets. This can in turn result into a rise in prevailing interest rates and depress the performance of the overall economy (Otieno et al., 2019).

Based on the economic theory, there exists a relationship between stock market returns and inflation, yet from the several studies which have been conducted to examine this link, they reach no consensus on whether the relationship is positive or negative, whether there is a causal link between the two variables, and still whether the causality runs from stock market returns to inflation or from inflation to stock market returns, or whether the causality is bi-directional (Eita, 2012).

Two schools of thought from the economic theory have been put forward to explain the link between inflation and stock market returns. First, is the hypothesis Fisher (1930), where he contends that the two variables have a positive causal relationship, thus termed as the Fisher Effect. Here, both the expected inflation rate and the expected real interest rates make up the nominal interest rates which are the expected return on a financial asset. The expected real rate of interest is constant, being only dependent on the rate of return on capital while the nominal rate of interest reflects all available information on the future levels of inflation rate. In this way, the theory asserts that nominal interest rate will only react to changes that occur in inflation rate thus bringing about a positive relationship.

When generalized to real assets, the theory suggests that common stock returns should consist of real stock returns and expected inflation rate. With the real stock returns being constant, an increase in expected inflation rate should cause common stock returns to increase by the same amount thus returns from stocks should compensate investors for increases in expected as well as in unexpected inflation rate (Otieno et al., 2019). On the contrary, the Proxy Effect hypothesis by Fama (1981) suggests the existence of a negative correlation, which is not causal between stock market returns and inflation rate. The theory provides two propositions for this negative relationship. First, there is a negative relationship between inflation and real output and secondly, the relationship between real output and the stock market returns is positive. The negative relation between stock market returns and inflation arises where rising inflation rate is expected to depress real economic activity and in turn negatively affect future corporate cash flows (Eita, 2012).

2.2.3 EXCHANGE RATES

Exchange rates are considered to be the price of one currency in terms of another. The relationship between exchange rates and stock prices has significant implications, especially from the viewpoint of recent large cross-border movement of funds and investments. (Lee & Zhao, 2014). Establishing a relationship between stock prices and exchange rates is important for a few reasons. First, it may affect decisions about monetary and fiscal policy. For example, in situations where the stock market is experiencing a boom, aggregate demand tends to be affected positively. And hence, the expansionary monetary or contractionary fiscal policies that target the interest rate and the real exchange rate will be neutralized. Sometimes policy-makers may choose to promote their countries' exports by advocating for currency devaluation but at the same time should be mindful of the consequences which come with this policy such as, depressing the stock market. Second, currency is more often being included as an asset in investment funds' portfolios. Knowledge about the link between currency rates and other assets in a portfolio is vital for the performance of the fund. The Mean-Variance approach to portfolio analysis suggests that the expected return is implied by the variance of the portfolio. Therefore, an accurate estimate of the variability of a given portfolio is needed. This requires an estimate of the correlation between stock prices and exchange rates (Dimitrova, 2005). Last, the understanding of the stock price-exchange rate relationship may prove helpful to foresee a crisis. For example, the 1997 Asian financial crisis is attributed to this link between the stock and currency markets. This leads to the sudden dislocation of asset demands because of the herding behavior of investors or the loss of confidence in economic and political stability. This dislocation usually results in the shift of portfolio preference from domestic assets to assets denominated in other currencies (for example, the U.S. dollar), implying a decrease in the demand of money. This will lead to a decrease in the domestic interest rate and in turn lead to capital outflows. As a result, the currency will depreciate ((Pan et al., 2007). Awareness about such a relationship between the two markets would trigger preventive action before the spread of a crisis (Dimitrova, 2005).

In retrospect of the literature, a number of hypotheses also suggest a causal relation between stock prices and exchange rates. For instance, the goods market hypothesis suggests that changes in exchange rates affect the competitiveness of multinational firms and hence their earnings and stock prices. A depreciation of the local currency makes exporting goods cheaper and may lead to an increase in foreign demand and sales. Consequently, the value of an exporting firm would benefit from a depreciation of its local currency. However, depreciation of domestic currency increases the cost of input, thus lower firms' profit and lead to decline in stock prices (Habibi & Lee, 2019). On the other hand, because of the decrease in foreign demand of an exporting firm's products when the local currency appreciates, the firm's profit will decline and so does its stock price. In contrast, for importing firms, the sensitivity of firm value to exchange rate changes is just the opposite. An appreciation (depreciation) of the local currency leads to an increase (decrease) in the firm value of importing firms. Additionally, variations in exchange rates affect a firm's transaction exposure. That is, exchange rate movements affect a firm's future payables (or receivables) denominated in foreign currency. For an exporter, an appreciation of the local currency reduces profits, while a depreciation of the local currency increases profits (Pan et al., 2007).

Conversely, stock price fluctuations can influence exchange rate movements. For instance, according to the portfolio balance approach, exchange rates, like all commodities, are determined by market mechanism. A blooming stock market would attract capital flows from foreign investors and hence causes an increase in the demand of a country's currency and vice versa. As a result, rising (declining) stock prices are related to an appreciation (depreciation) in exchange rates. (Pan et al., 2007).

Finally, a weak or no association between stock prices and exchange rates is suggested by the asset market models. These models treat exchange rate to be the price of an asset, the fundamental characteristic of which is that its present value is largely influenced by its expected rate of return. Since developments of stock prices and exchange rates may be driven by different factors, the asset market approach advocates the absence of any linkage between stock prices and exchange rates (Kollias et al., 2012).

2.2.4 INTEREST RATES

As one of the main parameters in the economy, interest rates reflect the time value of money and affect other parameters in money and capital markets. Investment decision makers in capital markets are influenced by the interest rates because of both their use in the valuation of the stock prices and the fact that their volatility directly influences shifts in capital between short-term money market and long-term capital market (Çifter & Özun, 2007).

In the valuation of stocks, according to the cashflow discount model, the present values of stocks are calculated by discounting the future cashflows at a discount rate, which is a risk adjusted required rate of return and equal to the level of interest rates in the economy. Therefore, if the discount rate increases due to an increase in the interest rates, then the present value of stocks declines and vice versa (Panda, 2008).

Alternatively, the interest rate in the form of a risk-free rate, plays a significant role in the investment practice whereby it is considered as a rate of return on an investment which has an assured or nearly assured payoff. Consequently, investors use the risk free-rate such as the Treasury Bills rate as a reference rate when making investment decisions on the valuation of stocks. Furthermore, since the required rate of return comprises a risk- free rate and a risk premium, an increase in the Treasury Bills rate should translate into a corresponding increase in the required rate of return and, by extension, to a rise in stock market returns (Otieno et al., 2017).

Due to the investors' behavior of comparing high-risk investments with low-risk interest-bearing securities, an investor might not make an investment in a high-risk stock market if there is an increase in the interest rates. As a result, there tends to be a change in the asset allocation in favour of bonds rather than stocks. On the other hand, a decrease in the interest rates, stock returns become more attractive, and the investors shift from fixed-income instruments to stock market (Teker & Alp, 2014).

Furthermore, firms listed at a stock market have an option of obtaining long term financing by issuing additional shares through equity financing or taking loans from commercial banks through debt financing. However, firms often seek to minimize the cost of funds and maximize existing shareholders' wealth. Therefore, lower lending rates could induce firms to use more loans from banks and issue fewer additional shares with a view to reducing the cost of capital while minimizing the chances of diluting existing shares. Thus, lower lending rates are expected to translate into rising stock market returns. On the other hand, high lending rates might force firms to issue more shares in order to raise investment finances. This could in turn drive down share prices and lead to a decline in stock market returns. Rising lending rates could also increase interest expenses and reduce cash flows and stock market returns. (Otieno et al., 2017).

2.2.5 OIL PRICES

Oil is considered to be the lifeblood for all economies of the world because as soon as countries modernize and urbanize, their need for oil also increases significantly. Oil prices play a prestigious part in the development of any economy (Khan et al., 2021).

An economy that is largely oil dependent, becomes highly sensitive to movements in global crude oil prices. Oil price volatility matters for the investment decisions of prospective investors in oil and gas sector, most especially. This in turn affects the profitability of firms (Adekunle et al., 2020). Meanwhile, it is argued that Oil prices not only affect the economies of countries but also, they affect financial markets and the prices of shares traded in these markets. The differential effects of oil prices depend on the characteristic of the country, that is, whether it is an oil exporter or an importer (Cevik et al., 2020). For an oil exporting country, an increase in oil prices improves the trade balance, leading to a higher current account surplus and an improving net foreign asset position. At the same time, a rise in oil prices tends to increase private disposable income in oil exporting countries. This in turn enhances corporate profitability, boosts domestic demand and pushes up stock prices, thereby causing the exchange rate to appreciate. In oil importing countries, the process works broadly in reverse: trade deficits are offset by weaker growth and, overtime, real exchange rate depreciates and stock prices decline (Adekunle et al., 2020).

According to Jouini (2013), the extent to which stock prices are influenced by world oil price changes can be explained based on the theory of equity valuation, defining the stock price as the sum of discounted values of expected future cash flows at different investment horizons. Consequently, oil prices affect stock prices directly by impacting future cash flows or indirectly through an impact on the interest rate used to discount the future cash flows. In the absence of complete substitution effects between the factors of production, rising oil prices, for example, increase the cost of doing business, and for non-oil related companies, they reduce profits. Rising oil prices can also be passed on to consumers in form of higher prices, but this will reduce the demand for final goods and services and depress profits. In addition, rising oil prices are often seen as inflationary by policy makers, and central banks respond to inflationary pressures by reviewing interest rates upwards, which in turn affects the discount rate used in the stock pricing formula. Faced with initial oil price increases, investors and analysts would predict further oil price increases and estimate lower expected future cash flows, resulting in a lower stock value. But the fact that these expected future cash flows respond differently to positive and negative oil price changes implies that the effect of an oil price shock on stock prices should also depend on the nature of asymmetry of the shock both in terms of the size and sign of the shock (Adekunle et al., 2020).

2.2.6 GROSS DOMESTIC PRODUCT (GDP)

It has theoretically been shown that GDP in the form of industrial production tends to increase during periods of economic expansion and decreases during a recession, and thus any change in industrial production would result into a change in economy. The productive capacity of an economy indeed rises during economic growth, which in turn contributes to the ability of firms to generate cash flows. That is why the industrial production would be expected to act beneficially on expected future cash flows, hence a positive relationship between real economy and stock prices exists. Furthermore, the volatility of stock returns increases during economic contractions and decreases during recoveries. This indicates that the growth rate of industrial production had a strong contemporaneous relation with stock returns (Nwaolisa et al., 2016).

The main argument for a relationship between stock returns and future growth rates of real activity comes from standard valuation models where the price of a firm's stock equals the expected present value of the firm's future payouts (dividends). For as long as these expectations reflect the underlying fundamental factors, they must ultimately also reflect real economic activity as measured by industrial production or GDP. Under these circumstances, the stock market is a passive informant of future real activity as stock prices react immediately to new information about future real activity well before it occurs (Binswanger, 2000).

There are two complementary approaches that can be applied to explain the relationship between industrial production and stock market. There are the neo-classical growth theory and the endogenous economic growth theory. Under the traditional neo-classical growth model, economic growth is mainly achieved via a combination of three driving forces, that is, labour, capital and technology as an external factor. Economic growth is achieved depending on the relationship between capital and labour and finally, the usage of technology is meant to augment labour productivity and then output. On the other hand, the endogenous economic growth theory has an internal mechanism as its source of growth unlike the neo-classical growth theory. It advocates for the enhancement of human capital and innovation to stimulate economic growth (Nwaolisa et al., 2016).

However, in most stock market literature, the main channels to economic growth are seen in the efficiency of capital allocation, savings mobilization and capital accumulation. Stock markets avail long-term capital to the listed firms by pooling funds from different investors and allowing them to expand in business and also offer investors alternative investment avenues to put their surplus funds in. Stock markets attract domestic and foreign capitals which contribute in achieving economic growth. Similarly, high industrial production raises corporate sales and profits, which directly results into an upsurge in the trading activities in the stock market reflected by the market index (Nwaolisa et al., 2016).

2.3 EMPIRICAL STUDIES

The empirical review is made up of studies from different countries and regions in the world where varying time periods, statistical tools and macroeconomic indicators were applied to assess the impact of macroeconomic factors on stock market performance. Therefore, the findings differ depending on the economic environment studied, macroeconomic factors used and the time periods covered.

Bhuiyan & Chowdhury (2020) examined how certain macroeconomic variables influence different sectors of the stock market differently in the US and Canada. Using monthly data over the 2000–2018 period, a cointegration analysis was applied to model the relationship between industrial production, money supply, long-term interest rate, and different sector indices. Sectors examined under the study included energy, financials, real estate, industrial, healthcare, consumer discretionary, and consumer staples. Results suggested that there is a stable long-term relationship between the macroeconomic variables used in the study and different sector indices for the US but not for Canada.

Camilleri et al (2019) examined the connections between stock prices and key macroeconomic indicators: inflation, industrial production, interest rates, money supply and select interactions between the latter group of variables. Such links were evaluated through vector-autoregressions (VARs) on monthly data spanning over the period 1999–2017, for Belgium, France, Germany, Netherlands and Portugal. The VAR models indicated that stock prices significantly lead inflation across all countries during the sample period and in most cases this relationship was positive. In addition, stock prices significantly lead industrial production in four of the sampled countries and these relationships were positive as well. Contrary to long-established finance theories, no significant links were found between interest rates and stock indices.

Omodero & Mlanga (2019) conducted a study which investigated the role of macroeconomic variables in determining the stock market performance in Nigeria using annual time series data covering a period from 2009 to 2018. The results from the regression analysis indicated that exchange rate and interest rate do not have significant impact on share price index while inflation rate exerts a significant negative influence on share price index. On the contrary and in line with the concept of GDP and stock market performance, GDP significantly and positively impacted on share price index.

Gay (2016) investigated the time-series relationship between stock market index prices and the macroeconomic variables of exchange rate and oil price for Brazil, Russia, India, and China (BRIC) using the Box-Jenkins ARIMA model. Under the study conducted, no significant relationship was found between respective exchange rate and oil price on the stock market index prices of any of the BRIC countries thus suggesting that the markets of Brazil, Russia, India, and China exhibited a weak-form of market efficiency.

Ouma & Muriu (2014) in their study investigated the impact of the macroeconomic variables on stock returns in Kenya during the period 2003- 2013, using the Arbitrage Pricing Theory (APT) and Capital Asset Pricing Model (CAPM) framework for monthly data. According to the findings of their study, Money Supply, exchange rates and inflation affect the stock market returns in Kenya. Money supply and inflation are found to be significant determinants of the returns at Nairobi Stock Exchange (NSE). Exchange rates were however, found to have a negative impact on stock returns, while interest rates were not important in determining long rung run returns in the NSE.

3 DATA AND METHODOLOGY

3.1 DATA

All the time series data used in this study has a monthly frequency and ranges from January 2010 to December 2020. This data is further broken down into three subdivisions basing on the occurrence of the 2014 oil crisis, where the first part covers the period from Jan-2010 to June-2014, termed as the pre-oil crisis period. The Second segment runs from Jan-2016 to Dec-2020 and this is the post-oil crisis period. The last part covers the entire study period from Jan-2010 to Dec-2020 hence called the Overall full period. This data segmentation is aimed at ascertaining whether the oil prices in conjunction with other macroeconomic variables have an impact on the selected market indices during the different periods.

Various variables have different data sources some of which are country specific while others are international. International data sources include; Yahoo finance were data concerning stock prices was collected for the case of the OSEBX stock market while investing.com was used to gather stock prices for the case of OMXC20 stock market. Brent crude oil index was used for gathering oil prices data and lastly, the Organization for Economic Co-operation and Development (OECD) was used to get Denmark's unemployment rates and interest rates information.

Country specific sources include Norges bank were data collected includes; interest rates, exchange rates and inflation, Statistics Norway was used to gather data for Gross Domestic Product and lastly, the Norwegian Labour and Welfare Administration (NAV) was used to provide data for the unemployment rate for the case of Norway. For Denmark, Statistics Denmark was used as a domestic source to collect data for exchange rates, inflation, and Gross domestic Product. Here, variables like interest rates were used as a proxy of the three months treasury bills for Norway's case while Inflation represented the Consumer Price Index for both Norway and Denmark.

Adjustments have also been done on the data in order to improve it and make its usage easy in the models for example through a log transformation, Oil prices and GDP had large values initially but their log values have been generated and used instead for the purposes of reducing variation i.e., the large difference between very high and very low values of data in the time series. This logged data becomes more stable with less variance and standard deviation, and this gives more robust results which are good for estimation. In addition, the Danish exchange rates quotation has also been changed from units of Danish kroner (DKK) per 100 units of foreign currency to units of DKK per 1 unit of foreign currency (Dollars). GDP data was originally generated with a quarterly frequency but was converted to a monthly frequency with the help of the EViews application. Table 1 below throws more light on various variables and their sources with a monthly frequency;

Table 1: Variables and their data sources

Variable	Source of data	
	Norway	***Denmark***
Stock prices	Yahoo Finance	Investing.com
Unemployment rates	NAV	OECD
Exchange rates	Norges Bank	Statistics Denmark
Interest rates	Norges Bank	OECD
Inflation	Norges Bank	Statistics Denmark
Oil prices	Brent Crude Oil index	Brent Crude Oil index
Gross Domestic Product	Statistics Norway	Statistics Denmark

3.2 DESCRIPTIVE STATISTICS

Table 2 below shows the descriptive statistics for the monthly returns' series of the two markets in the study. The two markets have a low monthly returns range, with that of OSEBX being at 0.2943 while that of OMXC20 being at 0.2571. The standard deviation in both markets is closely similar with that of OSEBX reported at 0.0434 and OMXC20 having its own at 0.0419. However, the OSEBX market happens to have a higher standard deviation in relation to its mean of 0.0083, if compared to the OMXC20 which has a lower value in terms of the difference between its standard deviation in relation to the 0.0121 mean. This also in turn indicates that the OSEBX market is characterized by higher volatility in its returns than the OMXC20 market. These differences in volatility in the two markets suggest differing risk levels and risk premia thus reflecting differing characteristics prevailing in each country. When it comes to skewness which is the measure of symmetry of a distribution, both markets have returns distributions that are negatively skewed. That is, the values in both markets are less than -0.5 hence giving rise to a moderate negative skewness. This also implies that most of the values of the market returns in both indices are below their respective sample mean values. In general, the skewness statistic indicates a lack of normality in the distribution of the returns' series. In addition, the values of the kurtosis statistic suggest that the returns of both market indices are platykurtic if compared to the normal distribution That is, they have a kurtosis that is less than 3 (K=3), which makes them flatter than the normal distribution. This also implies that most return values are spread away from the mean leading to a high variance and standard deviation around the mean.

Table 2: Descriptive statistics

Statistics	**Market**	
	OSEBX Returns	***OMXC20 Returns***
Mean	0.0083	0.0121
Median	0.0110	0.0106
Standard Deviation	0.0434	0.0419
Variance	0.0019	0.0018
Kurtosis	1.7252	0.7232
Skewness	-0.3357	-0.2006
Range	0.2943	0.2571
Minimum	-0.1483	-0.1454
Maximum	0.1460	0.1117
Sum	1.0913	1.5932
Observations	132	132

3.3 ECONOMETRIC METHODOLOGY

3.3.1 STATIONARITY & UNIT ROOT TEST

Most time-series methods are only valid if the underlying time-series is stationary. The more stationary a time series is, the more predictable it becomes. More specifically, stationarity in a time-series occurs where its mean, variance, and autocovariance do not rely on the particular time period.

Furthermore, testing for stationarity in time series data helps to overcome the problem of spurious regression which occurs if we regress two completely unrelated integrated processes on each other. For example, if variables X and Y are both trending, regressing variable Y on X is likely to indicate a strong relationship between them, even when there is no real connection (Levendis, 2018).

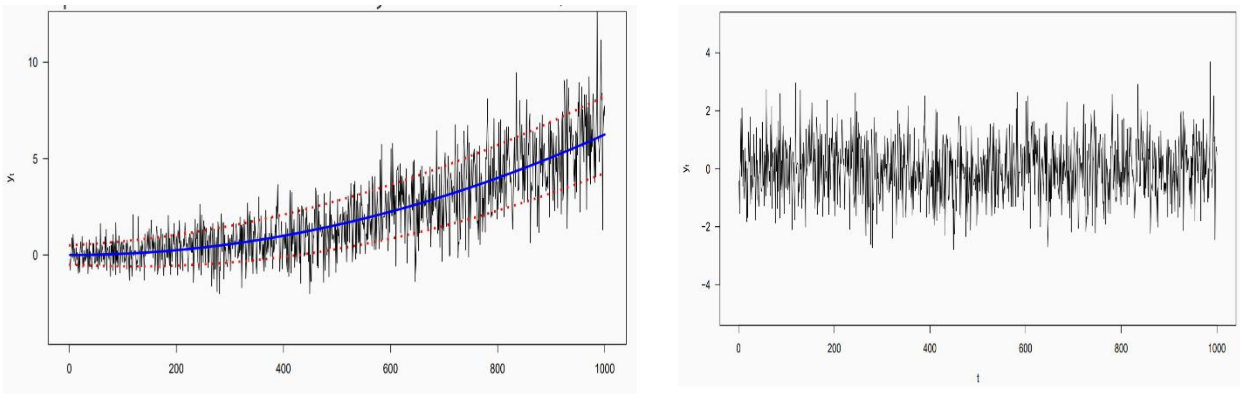

Figure 3: Stationary and non-stationary time series plots

The two illustrations in figure 3 show stationarity and non-stationarity in the time series data. We can see that the plot on the left has a constant upward trend. This kind of behavior in data is an expression that the mean and variance are increasing constantly. On the other hand, the illustration on the right shows that the data is stationary and hence the time series is regarded as white noise.

Autoregressive unit root tests are based on testing the null hypothesis that given the timeseries data at hand, there exists a unit root in it, that is to say, it is non-stationary against the alternative hypothesis asserting existence of stationarity in the time series (Chris, 2019). Using a simple AR (1) model, important statistical issues associated with autoregressive unit root tests can be expressed below.

$$Y_t = \varphi Y_{t-1} + \varepsilon_t, \quad (2)$$

We can test whether $\varphi = 1$ or non-stationary.

$$Y_t - Y_{t-1} = \varphi Y_{t-1} - Y_{t-1} + \varepsilon_t \quad (3)$$

$$\Delta Y_t = (\varphi - 1) Y_{t-1} + \varepsilon_t \quad (4)$$

$$\Delta Yt = \rho Y_{t-1} + \varepsilon_t \quad (5)$$

From equation 5, when $\rho = 0$, then $\varphi = 1$. This shows that initially the model was a random walk but after first differencing, the model now turns out to be stationary (Levendis, 2018).

3.3.1.1 AUGMENTED DICKEY-FULLER UNIT ROOT TESTS (ADF TEST).

The unit root tests described above are valid if the time series Y_t is well characterized by an AR (1) with white noise errors. Many financial time series, however, have a more complicated dynamic structure than what is captured by a simple AR (1) model. To Said and Dickey, they augmented the basic autoregressive unit root test to accommodate general Autoregressive models with unknown or more lag orders and their test came to be known as the Augmented Dickey-Fuller (ADF) test. The ADF test tests the null hypothesis that a time series Yt is non stationary, that is, I (1) (being integrated of order one) against the alternative that it is stationary, that is to say, I (0) (integrated of order 0), assuming that the dynamics in the data have an ARMA structure (Levendis, 2018).

Table 3: Augmented Dicky Fuller test for stationarity

	ADF test results for Model 1				ADF test results for Model 2			
	H0: Non stationary time series							
	Levels		Differenced		Levels		Differenced	
Variable	P-value	Outcome	P-value	Outcome	P-value	Outcome	P-value	Outcome
Index returns	0.0000	Reject	0.0000	Reject	0.0000	Reject	0.0000	Reject
Oil prices	0.6811	Not rejected	0.0000	Reject	0.6811	Not rejected	0.0000	Reject
Interest rates	0.6227	Not rejected	0.0001	Reject	0.438	Not rejected	0.0002	Reject
inflation	0.1209	Not rejected	0.0002	Reject	0.6102	Not rejected	0.0000	Reject
Unemployment rate	0.0047	Reject	0.0000	Reject	0.7373	Not rejected	0.0000	Reject
Exchange rates	0.8652	Not rejected	0.0000	Reject	0.4886	Not rejected	0.0000	Reject
GDP	0.5865	Not rejected	0.0000	Reject	0.9266	Not rejected	0.0000	Reject

p-value < 5% denotes significance level

Before we run the vector autoregression, we conduct an ADF test to ensure stationarity in the timeseries data. The results in table 3 show that OSEBX index returns and unemployment rate are the only variables that are stationary at levels under model 1 while on the other hand, the OMXC20 returns is the only stationary variable under model 2 at levels. The rest of the variables gain stationarity after first differencing.

3.3.1.2 PHILLIPS-PERRON UNIT ROOT TESTS (PP TEST).

The Phillips-Perron (PP) unit root tests differ from the ADF tests mainly when it comes to the analysis of the financial time series and how they deal with serial correlation and heteroskedasticity in the error terms. In particular, where the ADF tests use a parametric autoregression to approximate the ARMA structure of the errors in the test regression, the PP tests ignore any serial correlation in the test regression. The test regression for the PP tests is given by:

$$Y_t = \beta_0 + \pi Y_{t-1} + \beta^1 D_t + u_t \qquad (6)$$

where u_t is stationary with I(0) and may be heteroskedastic. The PP tests correct for any serial correlation and heteroskedasticity in the errors u_t of the test regression by directly modifying the test statistics. Under the null hypothesis that $\pi = 0$, the PP statistics have the same asymptotic distributions as the ADF t-statistic and normalized bias statistics. It assumes non stationarity in a time series data just like the ADF test. One advantage of the PP tests over the ADF tests is that the PP tests are robust to general forms of heteroskedasticity in the error term u_t. Another advantage is that the user does not have to specify a lag length for the test regression (Zivot & Wang, 2001).

Table 4: Phillip-Perron test for stationarity

	PP test results for Model 1				PP test results for Model 2			
	H0: Non stationary time series							
	Levels		Differenced		Levels		Differenced	
Variable	P-value	Outcome	P-value	Outcome	P-value	Outcome	P-value	Outcome
Index returns	0.0000	Reject	0.0000	Reject	0.0000	Reject	0.0000	Reject
Oil prices	0.4719	Not rejected	0.0000	Reject	0.4719	Not rejected	0.0000	Reject
Interest rates	0.7752	Not rejected	0.0000	Reject	0.3124	Not rejected	0.0000	Reject
inflation	0.1173	Not rejected	0.0000	Reject	0.5373	Not rejected	0.0000	Reject
Unemployment rate	0.0001	Reject	0.0000	Reject	0.6331	Not rejected	0.0000	Reject
Exchange rates	0.7578	Not rejected	0.0000	Reject	0.2768	Not rejected	0.0000	Reject
GDP	0.7117	Not rejected	0.0000	Reject	0.8647	Not rejected	0.0000	Reject

p-value < 5% denotes significance level

The Phillip Perron test in table 4 produces similar results as the ADF test since we can notice that the same variables, that is, Oil prices and Unemployment rate reject the null hypothesis of existence of non-stationarity in the times series data at levels under model 1. The same results are registered with model two where oil prices remain as the only variable to be stationary at levels while other variables in both model 1 & 2 become stationary after the first difference.

3.3.2 VECTOR AUTOREGRESSION

The VAR model is considered to be a natural generalization of univariate autoregressive models with a constitution of more than one dependent variable. VAR models can also be seen as the estimation of the reduced form of the correctly specified but unknown model of the true economic structure and they are purposely used to analyze the relationship between variables without imposing any restrictions on the structure of the system. This reduces the researcher's discretion to decide on which variables can be endogenous or exogenous. (Chris, 2019). The VAR methods can also allow the researcher to carry out an optimal lag length selection on the model something which is important because of the time delays in the production of information concerning the macroeconomic variables. In particular, the transmission and incorporation of information into stock returns is not always instantaneous. This may be the case because reporting delays may create a lag between the observation of data concerning a macroeconomic variable and the incorporation of that information into stock returns. (Abugri, 2008).

The VAR model through an equation can be expressed as follows:

$$R_t = \delta_0 + \beta_1 R_{t-i} + \alpha_1 Z_{t-i} + \varepsilon_t \qquad (7)$$

Where R_t is the stock market returns at time t, δ_0 is the intercept or slope, β_1 and α_1 represent the matrix of coefficients, Z_t can represent any of the macroeconomic variables at time t and ε_t is the error term or disturbances which are uncorrelated with past values across equations. i represents any lag length from 1 to n.

Table 5: VAR models

Models	Variables
Model 1	OSEBX index, Oil prices, Inflation, Interest rates, Unemployment, Exchange rates, GDP
Model 2	OMXC20 index, Oil prices, Inflation, Interest rates, Unemployment, Exchange rates, GDP

In this study, two models have been created for the purpose of getting an in-depth understanding of how macroeconomic variables affect the returns of the respective stock indices. Both models are shown in table 5 above and each model entails stock market returns from each market index as a dependent variable while the macroeconomic factors makeup the independent variables.

3.3.3 OPTIMAL LAG LENGTH SELECTION

Here, there is a need to determine the number of lags to be included in the model and also decide on the best selection criteria and measure of fit to use (Levendis, 2018). Information criteria have been regarded to be effective in selecting a statistical model. In the time series literature, several criteria have been proposed and all criteria are likelihood based and consist of two components. The first component is concerned with the goodness of fit of the model to the data, whereas the second component penalizes more heavily complicated models (Tsay, 2013).

The standard set of lag length selection criteria includes Akaike's information criterion (AIC), Schwarz's Bayesian information criterion (SBIC), and the Hannan and Quinn information criterion (HQIC). The three models differ by how, and how much, they penalize for the number of variables (Levendis, 2018). AIC imposes a lower penalty term hence selects a bigger lag length while SBIC imposes a much bigger term hence chooses a small lag length. HQIC in this case lies in between AIC and SBIC (Chris, 2019).

However there have been situations where the different Information Criteria suggest different lag lengths something which is unfortunate but happens to be a common problem. Problems tend to arise especially where improper lag selection is done, which can seriously affect the variance decompositions. Besides, there's also a possibility of failure to include important variables in the model.

However, previous studies have been conducted and they confirm that where a VAR model contains two or three variables, then SBIC and HQIC happen to be the best information criteria to select the optimal lag order while where the model entails four or more parameters, then AIC serves to be the best tool for selecting the lag length thus AIC is by far the best metric in large dimensional models (Levendis, 2018).

In this case, the model under study has seven variables and AIC has been used as a superior information criterion in determining the optimal lag length especially where SBIC or HQIC may have deviating results from AIC's. Under appendix B, the asterisks (*) has been used to indicate which model is preferred by each selection criterion.

Table 6: Optimal lag selection by AIC

Models	**Period**		
	Pre-Oil crisis	***Post-Oil crisis***	***Overall Full period***
Model 1	2	2	2
Model 2	2	2	1

Table 6 shows the optimal lags as selected by AIC during the three periods. it can be observed that both models have a uniform maximum lag order of two for most periods except in the overall period of model 2 where only one lag is recommended for use.

3.3.4 GRANGER CAUSALITY TEST.

Chris, (2019) considers Granger causality to mean the correlation between the current value of one variable and the past values of the others and not that movements of one variable cause movements of another.

In performing the Granger causality tests, the hypothesized dependent variable is regressed on its lagged values. The lag length in the regression equation must be selected in such a way that the resulting residuals are white noise, and therefore any first order serial correlations are eliminated. Next, the lagged values of the hypothesized independent variable are added to the right side of the regression equation and the new regression is executed. Using an F test, the resulting sums of squared residuals from the two regression equations are compared. A relatively large difference between the two sums of squared residuals (a large F) would provide evidence that the hypothesized independent variable Granger causes the dependent variable (Farsio & Fazel, 2013).

As an example, one variable X is said to Granger cause another variable Y if the past and present values of variable X can help to predict the values of variable Y and vice versa. This paper applies a Granger causality test to examine the causal relationship between stock market returns and the selected macroeconomic factors in Norway and Denmark. A simple Granger causality test can be expressed in the equation below:

$$Y_t = \alpha_0 + \sum_{i=1}^{k} \delta i Y_{t-i} + \sum_{i=1}^{k} \beta i X_{t-i} + \varepsilon_t \quad (8)$$

$$X_t = \phi_0 + \sum_{i=1}^{k} \theta i Y_{t-i} + \sum_{i=1}^{k} \lambda i X_{t-i} + \mu_t \quad (9)$$

where Y_t is the stock market returns at time t and X_t can be any of the macroeconomic variables in the model at time t, while ε_t and μ_t are residuals at time t which must not be correlated. There are two null hypotheses to be tested:

H0: The selected macroeconomic variable does not granger cause stock market returns.

H1: Stock market returns do not granger cause a given macroeconomic variable.

If equation 8 above is to be tested and the first hypothesis is rejected, it suggests that variable X Granger causes stock market returns. Rejection of the second hypothesis indicates that the causality comes from variable Y to X based on equation 9. If none of the hypothesis is rejected, it suggests that X does not Granger cause Y and Y also does not Granger cause X. This means that the two variables are independent of each other. The causality is bi-directional if all hypotheses are rejected (Eita, 2012).

4 VAR MODEL DIAGNOSTICS

Here, post estimation checks are performed to ensure that the model is stable, without having any autocorrelation and that the error terms or residuals are normally distributed.

4.1 STABILITY

Stability is used to check for stationarity in a VAR model. Stability and stationarity are sometimes used interchangeably but they are not the same thing. Stability applies to the coefficients affecting the mean thus making it a subset of stationarity (Levendis, 2018). On the other hand, Chris (2019) describes stationarity to be a broader concept that in addition to constant mean, it also demands for constant autocovariances and constant error variances over time. We can get a better understanding of stability while using a univariate AR (1) model:

$$Y_t = \beta_1 Y_{t-1} + u_t \qquad (10)$$

Y_t will stable if, $| \beta_1 | < 1$

In this case, Y_t can grow without limit if β_1 is greater than one, fall without limit if β_1 is less than one and is a non-stationary random walk process if β_1 is equal to one.

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In a vector-valued case, the model becomes steady where the matrix β_1 maps or feeds vector Y_{t-1} into vector Y_t. Here, every companion matrix β_1 has at least one eigenvalue and associated eigenvector. If iterations are to be done while constantly feeding Y_t through β_1, then Y_t must not grow bigger and bigger if the model is to stay stable. In this case, the vector should instead shrink with its eigenvalues becoming less and lesser for each iteration done. Eigenvalues being complex numbers must have a length less than one when mapped on a complex plane or must lie inside the unit circle. In other words, their modulus should be less than one (Levendis, 2018).

Table 7: Model Stability

Eigenvalue stability condition

Eigenvalue	Modulus
.416582	.416582
-.3949532	.394953
-.0536762 + .2463683i	.252148
-.0536762 - .2463683i	.252148
.09511182 + .06973391i	.117937
.09511182 - .06973391i	.117937
.01636188	.016362

All the modulus is less than one.
VAR satisfies stability condition.

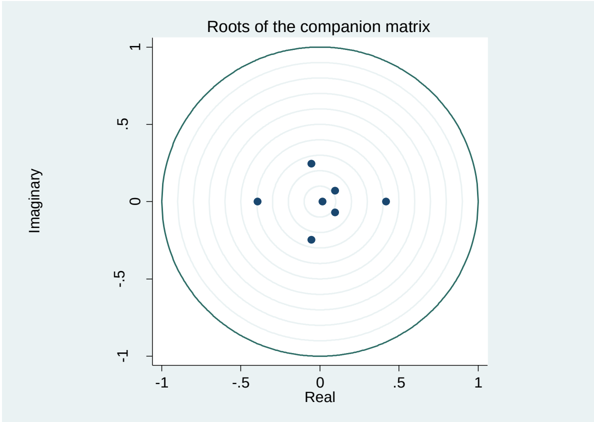

Figure 4: Plot of unit circle showing model stability

In this case, model stability is ensured by checking the eigenvalue stability condition. As shown in table 7, all modulus is less than one and in figure 4 above, all the eigenvalues lie inside the unit circle thus, both VAR models under the study satisfy the stability condition. Appendix E shows further the stability results for different periods of the two models as seen in tables 31 – 36 and figures 6 – 11

4.2 NORMALITY TEST (JARQUE BERA TEST)

The goodness-of-fit tests play an important role in statistical applications, especially in the case of testing for normality. Normality may be the most common assumption in applying statistical procedures especially in the regression analysis where the unobserved disturbance vector ε_t or the error terms are assumed to be normally distributed. Thus, it is very important to note that any analysis and recommendations done without checking the normality of the data can result into substantially incorrect statements in the analysis of economic models especially by decision makers. Thus, a test on normality based on the observable regression residuals is an absolute 'must' in any regression analysis (Thadewald & Büning, 2007).

The Jarque-Bera (JB) test is the most used goodness of fit test applied in the assessment of the distributional structure of data. It is a parametric test that helps understand the research problem for better decision making, prediction, and estimation purposes. The test is applied to confirm whether or not that the null hypothesis hold. The null hypothesis states that there is no significant difference between the data at hand and the normal distribution versus the alternative hypothesis which that a significant difference exists (Aslam et al., 2021).

Hypothesis

H0: The residual terms are normal distributed, if P-value > 5%
H1: The residual terms are not normally distributed, if P-value < 5%

From Appendix D, the tables show that the Jarque-Bera test for normality does not reject the null hypothesis for normally distributed residuals.

4.3 AUTOCORRELATION

In order to be able to draw valid inference based on the estimated parameters in a regression model, it is important that the error terms are white noise. This implies that the error terms have expected zero mean, no autocorrelations, constant variance, and normal distribution of errors (Hatemi-J, 2004).

Autocorrelation determines the relationship between a variable and its lagged values. That is, it occurs where the current values of a given variable in a times series are dependent on its past values (Chris, 2019). The Lagrange multiplier test is used to give a proper weighting to the residual autocorrelation in the VAR models and this is calculated by regressing the estimated residuals on the lagged residuals as well as the regressors in the model (Johansen, 1995). A 95% confidence interval is constructed for each coefficient and the decision rule is to reject the null hypothesis in case the coefficient lies outside the predetermined range. In other words, the autocorrelation coefficient is statistically different from zero where its value is greater than the P-value of 5% i.e., (Chris, 2019).

Hypothesis

Null Hypothesis: H_0: $\rho = 0$

The correlation coefficient is not significantly different from zero, thus there is no significant correlation.

Alternate Hypothesis: H_a: $\rho \neq 0$

The correlation coefficient is significantly different from zero thus there is significant correlation.

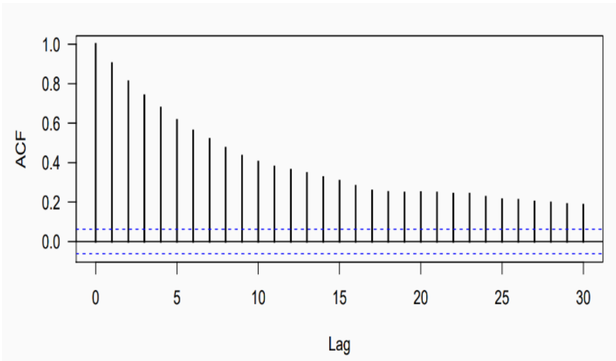

Figure 5: Autocorrelation Function

Figure 4 is an e autocorrelation function (ACF) that shows autocorrelations on the Y-axis and the number of lags on the X-axis. It is observed that this figure has a structure with an exponentially decaying pattern which implies a decreasing autocorrelation as more lags are added in the model. This means that the time series has a correlation on itself thus yielding a random walk.

From Appendix C, the tables show that there is no existence of autocorrelation in both models as the lag values are greater than the P-value of 5percent thus the null hypothesis of no autocorrelation be rejected.

5 RESULTS

5.1 VECTOR AUTOREGRESSION RESULTS

The tables under appendix G report the summarized results in terms of the VAR coefficients for the two selected markets' response to the specific macroeconomic factors. The results are based on the time series data which covers the period from 1st January 2010 – 31st December 2020 and is further broken down into the pre-oil crisis, post-oil crisis and the overall full period.

The Akaike Information Criteria (AIC) has been used in optimal lag selection as shown in the Appendix B under tables B1 – B3. This is suitable for use where a model has more than three variables (Levendis, 2018) hence an optimal lag length of 2 has been recommended for use in all periods under the OSEBX market index and during the pre-oil and post oil crisis periods under the OMXC20 index. However, AIC recommends for the usage of only one lag during the overall full period in the OMXC20 market. In this case, the results show that unlike under the OSEBX market index where oil prices are the only variable which have been consistently significant in all the three periods, this has not been the case under the OMXC20 index. Oil prices have been significant in only the pre-oil crisis period and the full period. Inflation only has its impact in the pre-oil crisis period under the OMXC20index and not anywhere else. In addition, the unemployment rate is only significant during the post-oil crisis and full periods under the OSEBX market while under the OMXC20index, non-significance is reported. GDP and interest rates appear to be significant only once during the pre-oil crisis and post-oil crisis periods respectively, only under the OSEBX market. It should be noted that exchange rates have remained insignificant throughout the three periods regardless of the market index.

5.2 GRANGER CAUSALITY TEST RESULTS

The Granger causality test in this study helps to determine how macroeconomic variables can impose effects on the stock markets of Norway and Denmark. The test is run in such a way that each of the macroeconomic variables is excluded at a time. The excluded variable is said to granger cause the stock return if its p-value is less than five percent ($p < 0.05$). Table 7 below shows the granger causality test results for the two models during the different period segmentations.

Table 8: Granger causality test results for Model 1& 2

		Model 1			Model 2		
		Pre-oil crisis	Post-oil crisis	Overall period	Pre-oil crisis	Post-oil crisis	Overall period
Equation	Excluded	P-value	P-value	P-value	P-value	P-value	P-value
Index returns	Oil prices	0.030	0.003	0.002	0.033	0.489	0.047
Index returns	Interest rates	0.093	0.146	0.010	0.346	0.776	0.166
Index returns	inflation	0.588	0.122	0.299	0.029	0.817	0.762
Index returns	Unemployment rate	0.072	0.001	0.001	0.656	0.317	0.844
Index returns	Exchange rates	0.626	0.831	0.754	0.781	0.490	0.802
Index returns	GDP	0.012	0.986	0.102	0.653	0.921	0.964

p-value < 5% denotes significance level

From the pre-oil-crisis table, it is noticeable that only two macroeconomic variables granger cause stock returns in each of the two market indices. Oil prices happen to have an impact on stock returns in both markets while GDP and inflation separately impact stock returns in the OSEBX index and OMXC20 index respectively. The level of significance for these variables is expressed by a value less than the determined significance level of 5%. On the other hand, other variables in this period show insignificant results hence do not influence stock returns.

During the post-oil crisis, we observe that only two macroeconomic variables are significant and have an impact on stock returns for the case of the Norwegian stock market i.e., oil prices and unemployment. However, on the other hand, none of the factors in the OMXC20 index is significant hence there is no evidence to justify that changes in such factors can explain the stock returns.

Finally in the Overall Full period case, a number of variables are seen to be significant and hence granger cause stock returns. Oil prices, interest rates and unemployment have a value less than 5% in the OSEBX market while in the OMXC20 market, unlike other factors only Oil prices happen to be significant. It is also important to note that Oil prices are significant in both market indices where a p-value of 0.002 is recorded in the OSEBX market while that of OMXC20 is 0.047.

Furthermore, the unemployment rate has also been significant in both the post-oil crisis and the overall full periods out of the three period subdivisions with a p-value 0f 0.001 respectively only in the OSEBX market. It is also observed that Oil prices impact stock returns in all the three periods for the case of the OSEBX market index while the stock returns of the OMXC20 index are impacted only two times that is to say; during the pre-oil crisis period and the full period.

6 DISCUSSIONS

Oil Prices

The results show the relationship between Oil prices and the stock returns for both model estimates. It follows that oil prices have more explanatory power in the OSEBX market than in the OMXC20 market since all its periods have significant results. Only two periods register significant results for the second model. This implies that there is a causal link between oil prices and stock returns that is, any changes that occur in such oil prices have an impact on stock returns. While significant, it cna be observed that the hypothesis which asserts a positive relationship between oil prices and index returns only holds during the first lag of the post-oil crisis period. Contrary to the results by Khan et al., (2021), it is interesting to see that significant negative results are obtained for all periods under model 1 and during the pre-oil crisis and overall full periods for model 2. This implies that a fall in oil prices can cause stock prices to increase in the two economies. It should be noted that world petroleum prices declined during the period between 2014 and 2016 due to an oversupply of petroleum compared to the falling demand. Starting in mid-June 2014, petroleum prices which had peaked at $107.95 per barrel began to fall worldwide, and that drop continued at a significantly accelerated rate through the end of January 2015, to $44.08 per barrel, thus recording a drop of 59.2 percent in a space of 7 months. Oil prices continued to drop further to $24 in January 2016. (Mead & Stiger, 2015).

Table 9: VAR model and Granger Causality results for oil prices and stock returns relationship

Period		Model 1 (OSEBX Index)			Model 2 (OMXC20 Index)		
	Lag	VAR Coef.	VAR P-value	G. Causality P-value	VAR Coef.	VAR P-value	G. Causality P-value
Pre-oil crisis	L1.	-0.2772333	0.385	0.030	-0.3659606	0.232	0.033
	L2.	-0.67228	0.017		-0.6577134	0.025	
Post-Oil crisis	L1.	0.4262407	0.044	0.003	-0.0551671	0.641	0.489
	L2.	-0.5980964	0.001		-0.1283872	0.308	
Overall Period	L1.	0.0374863	0.787	0.002	-0.1891425	0.047	0.047
	L2.	-0.4902425	0.000				

p-value < 5% denotes significance level

However, much as prices fell over more than a half, the two economies still managed to thrive. On one hand, Norway has been influenced by how the global economy performs hence such low oil prices triggered the implementation of supportive mechanisms like low interest rates, increased public spending and corporate restructuring towards less petroleum-intensive sectors (Knudsen, 2016). On the other hand, since oil is traded in USD on the world market, to some extent the impact of the falling oil prices on Denmark's revenue was offset by the sharp increase in the USD exchange rates for example, in the second half of 2014 the exchange rates stood at about DKK 5.5 per USD and by April 2015, they had peaked at almost DKK 7 per USD. Despite lower oil prices, in the short term it pays for producers to carry on production for as long as the crude oil price exceeds the marginal operating costs. Therefore, it may be profitable to produce oil even when oil prices are very low (Danish Energy Agency, 2016). Thus, the significantly negative relationship between oil prices and stock returns being observed in the models debunks the hypothesis that these two variables have a positive relationship between them.

Interest rates.

The findings show that there is no possibility of getting any significant relations between the interest rates and the OMXC20 index returns during all the period segments and during the pre-oil crisis and post-oil crisis periods for the case of the OSEBX index. Lack of evidence to support the claims of the hypothesis renders it therefore to be rejected for these periods. Similar results are obtained in the Omodero & Mlanga (2019) study but for Denmark's case, an explanation to this could be that since 2012, Denmark has been implementing a Negative Interest Rate policy (NIRP) as a monetary policy transmission mechanism with an intention of maintaining a fixed exchange rate against the Euro (Krogstrup et al., 2020). In the same way, Norway has also been maintaining a very low policy rate since mid-2009 which never exceeds 2 percent. The monetary policies in the two countries have been aimed at bringing about financial stability in the respective economies. Thus, at this point, any movements in the index returns may not be attributable to changes in the interest rates as the previous research points out.

Table 10: VAR model and Granger Causality results for interest rates and stock returns relationship

Period	Model 1 (OSEBX Index)				Model 2 (OMXC20 Index)		
	Lag	VAR Coef.	VAR P-value	G. Causality P-value	VAR Coef.	VAR P-value	G. Causality P-value
Pre-oil crisis	L1.	0.0586291	0.318	0.093	-0.181255	0.164	0.346
	L2.	-0.1245827	0.057		0.0372531	0.758	
Post-Oil crisis	L1.	-0.0931356	0.116	0.146	0.035715	0.859	0.776
	L2.	-0.0219214	0.742		0.1025739	0.496	
Overall Period	L1.	-0.0437738	0.236	0.010	-0.0854813	0.166	0.166
	L2.	-0.1004073	0.009				

p-value < 5% denotes significance level

During the overall full period under the OSEBX market, a negative performance has been recorded but only the results at lag two are significant. These negative results conform with the hypothesis which contends for the existence of a negative relationship, that is to say, index returns tend to fall as interest rates increase. This is a confirmation that in the long run during the full period, the hypothesis holds.

Inflation

From the VAR model results, it can be observed that apart from the first lag during the pre-oil crisis in the OMXC20 model, inflation has no significant impact on the stock returns in the two markets under study. However, contrary to the results of Omodero & Mlanga (2019), it can be noted that this significant relationship is positive which makes the hypothesis applicable especially in the short run. For the rest of the periods in both models, the hypothesis has to be rejected since the granger causality test results and the VAR model estimates results show no evidence that inflation can be a good predictor of the stock market performance.

Table 11: VAR model and Granger Causality results for inflation and stock returns relationship

Period	Model 1 (OSEBX Index)				Model 2 (OMXC20 Index)		
	Lag	VAR Coef.	VAR P-value	G. Causality P-value	VAR Coef.	VAR P-value	G. Causality P-value
Pre-oil crisis	L1.	0.0064513	0.724	0.588	0.0597014	0.030	0.029
	L2.	-0.0176777	0.303		0.0009104	0.974	
Post-Oil crisis	L1.	0.0288984	0.059	0.122	0.0151914	0.531	0.817
	L2.	-0.0157344	0.355		0.0012465	0.960	
Overall Period	L1.	0.00939	0.377	0.299	0.0057345	0.762	0.762
	L2.	-0.0143055	0.188				

p-value < 5% denotes significance level

At this point, stock returns cannot provide a hedge against inflation as stated by the hypothesis. However, this result can be attributed to the inflation policies which have been adapted in the economies of both Norway and Denmark for quite some good time, aimed at bringing about stability hence as a result, the effect of inflation in the low inflation economies may not have much impact on the respective stock markets regardless of the period.

Exchange rates

The results produced show no evidence of the exchange rates to have any significant effect on the stock market indices, at any lag and during all the three periods. On the basis of such outcomes, the hypothesis which assumes a negative relationship between the two variables is not upheld thus resulting into its rejection. However, similar findings have also been observed in the previous papers discussed in the literature review under the empirical studies for example Omodero & Mlanga (2019) and Gay (2016).

Table 12: VAR model and Granger Causality results for Exchange rates and stock returns relationship

Period		Model 1 (OSEBX Index)			Model 2 (OMXC20 Index)		
	Lag	VAR Coef.	VAR P-value	G. Causality P-value	VAR Coef.	VAR P-value	G. Causality P-value
Pre-oil crisis	L1.	-0.0523038	0.451	0.626	-0.025793	0.721	0.781
	L2.	0.0485618	0.414		-0.0361665	0.559	
Post-Oil crisis	L1.	-0.0003871	0.992	0.371	-0.0441543	0.463	0.490
	L2.	-0.0196095	0.551		0.0625595	0.274	
Overall Period	L1.	-0.0048091	0.870	0.566	0.0097386	0.802	0.802
	L2.	-0.0192997	0.487				

p-value < 5% denotes significance level

Given the fact that Norway and Denmark are commodity exporting countries, a possible explanation for this performance for Denmark's case could be that it maintains a fixed exchange rate policy which aims at keeping the krone stable against the Euro so as to achieve stable economic development. A central rate of 7.46038 krone per Euro with a fluctuation band of +/- 2.25% is being maintained to achieve this stability. In addition, Danmarks Nationalbank through the monetary policy also uses interest rates to manage exchange rate stability and this further provides a platform for low and stable inflation in the country (Danmarks Nationalbank, 2021). As a result, such a stability- oriented fixed exchange rate policy confines the movements of the exchange rates at low levels thereby causing a marginal or no impact on the stock market. On the other hand, Norway employs a floating exchange rate policy but never the less, the Norwegian krone has been relatively stable against European currencies especially the Euro and the dollar over the years with less fluctuations. In that way, such prolonged stability in the exchange rates of the two countries has made them to have a weak explanatory power on the movements of the stock market returns.

Unemployment rate.

The OSEBX market index shows the most significance given the results from the VAR models during the post-oil crisis and the overall full periods. This implies that there is a link between unemployment and the OSEBX index returns while no such link has been reported under the OMXC20 market. These results are further confirmed by the granger causality test. In this way, the OMXC20 model renders the hypothesis to be rejected during the two periods. However, the results under the OSEBX model show that there are varying signs when it comes to the relationship between the variables, fluctuating between positive and negative but it can be noted that the hypothesis holds mostly in the long run at lag two. The reasoning behind such reactions could be attributed to the fluctuating levels of employment.

Table 13: VAR model and Granger Causality results for Unemployment rate and stock returns relationship

Period		Model 1 (OSEBX Index)			Model 2 (OMXC20 Index)		
	Lag	VAR Coef.	VAR P-value	G. Causality P-value	VAR Coef.	VAR P-value	G. Causality P-value
Pre-oil crisis	L1.	0.0497598	0.234	0.072	-0.0352809	0.400	0.656
	L2.	-0.0729231	0.068		0.0283976	0.484	
Post-Oil crisis	L1.	0.0262226	0.004	0.001	0.023306	0.199	0.317
	L2.	-0.0187816	0.037		-0.0152897	0.363	
Overall Period	L1.	0.0158129	0.020	0.001	0.0032791	0.844	0.844
	L2.	-0.0195471	0.004				

p-value < 5% denotes significance level

During the pre-oil crisis period, both models present similar results as none of the two market indices shows any significance from both the VAR model estimates and the granger causality test. This happens to be an interesting result as it buttresses the assertions that unemployment rate and stock prices do not hold any lasting stable relationship and hence there is no causal effect from unemployment to stock prices (Farsio & Fazel, 2013). This implies that at this point, it is hard to confirm that unemployment can explain the market returns of both market indices. In this case, it has been discovered that the results are not in line with the findings by Pan, (2018) in addition to the hypothesis which asserts that unemployment and stock returns have a negative relationship.

Gross Domestic Product (GDP)

Regarding the empirical results for the two models which are presented during the post-oil crisis and full periods, the hypothesis which contends that GDP and the stock markets have a positive relationship is not upheld. As shown in table 14, there is no evidence to justify the existence of any causal link running from GDP to the stock markets given the results from the grange causality test and the VAR model. This means that any changes that may occur in the GDP for the

Norwegian and Danish economies are not significant in predicting movements in stock prices and any stock price changes that occur are basically not attributed to real economic activities movements in the long run.

Table 14: VAR model and Granger Causality results for GDP and stock returns relationship

Period	Model 1 (OSEBX Index)				Model 2 (OMXC20 Index)		
	Lag	VAR Coef.	VAR P-value	G. Causality P-value	VAR Coef.	VAR P-value	G. Causality P-value
Pre-oil crisis	L1.	-3.410904	0.031	0.012	1.661119	0.416	0.653
	L2.	3.026687	0.084		1.317313	0.532	
Post-Oil crisis	L1.	-0.0796561	0.925	0.986	-0.6280836	0.684	0.921
	L2.	-0.103683	0.903		-0.0127425	0.994	
Overall Period	L1.	-1.231997	0.084	0.102	-0.0567227	0.964	0.964
	L2.	1.019348	0.150				

p-value < 5% denotes significance level

However, when focus is put on the pre-oil crisis period for the two markets, it can be observed that GDP is only significant under the OSEBX market index unlike in the OMXC20 market based on the granger causality test results. This signifies existence of a link between the two variables and according to the VAR model results, GDP is negatively related to the stock market index returns at least in the short run. This result violates the assumption of existence of positive relationship given by the hypothesis. We can observe that the results obtained are inconsistent with the findings of Oskooe (2010) and Omodero & Mlanga (2019) whose studies show that GDP and stock prices are positively related.

7 CONCLUSION AND LIMITATIONS

This study has been conducted to ascertain whether Macroeconomic variables have an impact on the stock market performance of OSEBX market in Norway and the OMXC20 index in Denmark during the sample period 2010 to 2020. Two models have been created and each model has a separate market index from each of the two aforementioned countries as the dependent variable while the independent variables include Oil prices, Unemployment, Exchange rates, Gross Domestic Product, Interest rates and Inflation. The whole sample period has been broken down further to generate two sub-periods with the oil price crisis period separating them apart. This has been done to get an in-depth understanding of the dynamics of the stock markets. The vector autoregression and the Granger causality test have been used as the major tools to scrutinize the causal link between the dependent and independent variables under study.

Given the high level of volatility in the returns of the stock markets, the empirical results show that there is a significant link between most macroeconomic variables and the stock market returns especially under model 1 (for OSEBX market) than in Model 2 (OMXC20 market). Oil prices appear to show the most consistent significant impact in almost all periods for both models except during the post-oil crisis period for the OMXC20 market while the exchange rates show no significance at all regardless of the model or period. From the results, it is further indicated that only the hypothesis for inflation holds in the short run while those for interest rates, unemployment rate and oil prices hold especially in the long run, given all the hypotheses tested under this study.

The findings from this study may have important implications for decision making by investors. The fact that macroeconomic factors have imposed varying effects and significance on the returns of each of the two markets may prove useful for portfolio diversification strategies as well as achieving better risk– return tradeoffs. From a policy perspective, the findings provide information that can be based on to formulate and implement macroeconomic policies that are aimed at bringing about financial market stability in the economy. Considering the Oil prices as the global variable that exists in the study, domestic policy makers may have limited actions to regulate them, however prudent policy formulation and implementation may help sterilize against their adverse effects (Abugri, 2008).

Looking at the limitations of this study, the Vector Autoregression has been used as a main method in establishing the link between macroeconomic variables and stock returns especially after components have been made stationary. In most cases, time series data is not always stationary hence stationarity has to be induced through differencing. This is seen as a weakness of the VAR estimation method as a lot of important information regarding any long-term relationships between the variables is lost. It is possible to establish a model that combines variables in both their levels and first differences especially if two or more variables are cointegrated. Methods especially the Vector Error Correlation Model (VECM) can be efficient in overcoming this drawback (Levendis, 2018). Besides, other methods can also be used to examine the link between variables for example Ordinary Least Squares method (OLS), Autoregressive Conditional Heteroskedasticity (ARCH), Generalized Autoregressive Conditional Heteroskedasticity (GARCH), Integrated GARCH (IGARCH) among other methods which could produce varying results in relation to studying about variables and how they are correlated to one another.

Six macroeconomic factors have been used as predictor variables in the analysis of their relationship with stock market performance. However, these are not the only factors which can affect the economy as a whole. Future studies can also put into consideration factors other than the ones used in this study or can include new factors in addition to the ones being used. In addition, firm specific factors have also been overlooked in this study and this can also be a starting point for conducting future research.

Currently the world is facing a global pandemic, Covid19 and has led to various governments to put in place measures that could alleviate or end this major problem for example the frequent economic lockdowns. This has disrupted the smooth running of so many economic activities worldwide. The last bit of this study's sample period covers part of that time when the pandemic broke out. That is, in late 2019 through to 2020 but this factor has not been included in the study. This can be an interesting factor any future research can focus on when analyzing stock market performance.

This study has also focused on analyzing a unidirectional relationship. That is, macroeconomic factors predict stock returns. It would be intriguing to conduct a future study that considers a bi-directional relationship or unidirectional relationship running from the stock markets' performance to the macroeconomic variables, a gap that hasn't been covered in this study.

The data sources from which the GDP time series data was obtained do not provide data with monthly and daily frequencies. This gives a challenging task to covert such data to any of the two frequencies or it may require one to employ the quarterly or the annual frequencies in which this GDP data is presented. For this study, a monthly frequency has been used and hence this creates a gap upon which future research can be done while using any of other data frequencies.

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9 APPENDIX

9.1 APPENDIX A: STATIONARITY TESTS

Table 15: Augmented Dickey-Fuller test

Augmented Dickey-Fuller test for unit root		Number of obs =	127				
			---------- Interpolated Dickey-Fuller ---------				
	Model 1 (OSEBX index)		Model 2 (OMXC20 index)				
	Test statistic Z(t)	p-value Z(t)	Test statistic Z(t)	p-value Z(t)	1% critical value	5% critical value	10% critical value
Index returns	-5.695	0.0000	-5.030	0.0000	-3.501	-2.888	-2.578
Oil prices	-1.182	0.6811	-1.182	0.6811	-3.501	-2.888	-2.578
Interest rates	-1.314	0.6227	-1.687	0.438	-3.501	-2.888	-2.578
Inflation	-2.478	0.1209	-1.341	0.6102	-3.501	-2.888	-2.578
Unemployment rate	-3.659	0.0047	-1.043	0.7373	-3.501	-2.888	-2.578
Exchange rate	-0.625	0.8652	-1.590	0.4886	-3.501	-2.888	-2.578
GDP	-1.391	0.5865	-0.292	0.9266	-3.501	-2.888	-2.578

Table 16: Differenced Augmented Dickey-Fuller test

Augmented Dickey-Fuller test for unit root		Number of obs =	126				
			---------- Interpolated Dickey-Fuller ---------				
	Model 1 (OSEBX index)		Model 2 (OMXC20 index)				
	Test statistic Z(t)	p-value Z(t)	Test statistic Z(t)	p-value Z(t)	1% critical value	5% critical value	10% critical value
Index returns	-8.108	0.0000	-7.957	0.0000	-3.501	-2.888	-2.578
Oil prices	-6.140	0.0000	-6.140	0.0000	-3.501	-2.888	-2.578
Interest rates	-4.775	0.0001	-4.462	0.0002	-3.501	-2.888	-2.578
Inflation	-4.544	0.0002	-6.253	0.0000	-3.501	-2.888	-2.578
Unemployment rate	-6.985	0.0000	-6.068	0.0000	-3.501	-2.888	-2.578
Exchange rate	-5.077	0.0000	-5.476	0.0000	-3.501	-2.888	-2.578
GDP	-6.289	0.0000	-6.855	0.0000	-3.501	-2.888	-2.578

Table 17: Phillips-Perron test

	Test statistic Z(t)	p-value Z(t)	Test statistic Z(t)	p-value Z(t)	1% critical value	5% critical value	10% critical value
Phillips-Perron test for unit root					Number of obs =	131	
					Newey-West lags =	4	
	Model 1 (OSEBX index)		Model 2 (OMXC20 index)				
Index returns	-11.359	0.0000	-10.381	0.0000	-3.500	-2.888	-2.578
Oil prices	-1.622	0.4719	-1.622	0.4719	-3.500	-2.888	-2.578
Interest rates	-0.938	0.7752	-1.942	0.3124	-3.500	-2.888	-2.578
Inflation	-2.493	0.1173	-1.492	0.5373	-3.500	-2.888	-2.578
Unemployment rate	-4.708	0.0001	-1.291	0.6331	-3.500	-2.888	-2.578
Exchange rate	-0.988	0.7578	-2.022	0.2768	-3.500	-2.888	-2.578
GDP	-1.108	0.7117	-0.627	0.8647	-3.500	-2.888	-2.578

Table 18: Differenced Phillips-Perron test

	Test statistic Z(t)	p-value Z(t)	Test statistic Z(t)	p-value Z(t)	1% critical value	5% critical value	10% critical value
Phillips-Perron test for unit root					Number of obs =	130	
						Newey-West lags =	4
	Model 1 (OSEBX index)		Model 2 (OMXC20 index)				
Index returns	-25.482	0.0000	-25.120	0.0000	-3.500	-2.888	-2.578
Oil prices	-9.498	0.0000	-9.498	0.0000	-3.500	-2.888	-2.578
Interest rates	-10.538	0.0000	-8.786	0.0000	-3.500	-2.888	-2.578
Inflation	-11.37	0.0000	-10.828	0.0000	-3.500	-2.888	-2.578
Unemployment rate	-11.941	0.0000	-9.824	0.0000	-3.500	-2.888	-2.578
Exchange rate	-7.579	0.0000	-8.844	0.0000	-3.500	-2.888	-2.578
GDP	-10.105	0.0000	-11.505	0.0000	-3.500	-2.888	-2.578

9.2 APPENDIX B: OPTIMAL LAG LENGTH SELECTION FOR MODELS 1 & 2

Table 19: Pre-Oil Crisis Period

Selection-order criteria

Sample: 2010m7 - 2014m6 Number of obs = 48

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
Model 1 (OSEBX Index)								
0	463.453				1.3e-17	-19.0189	-18.9157*	-18.746*
1	525.758	124.61	49	0.000	7.6e-18	-19.5733	-18.7483	-17.3902
2	581.743	111.97	49	0.000	6.5e-18*	-22.6002*	-18.3174	-15.771
3	635.503	107.52	49	0.000	7.7e-18	-19.8643	-17.7939	-14.0592
4	694.094	117.18	49	0.000	1.2e-17	-20.0626	-17.4717	-12.5486
5	794.406	200.62*	49	0.000	8.2e-18	-20.4622	-18.8878	-12.7764
Model 2 (OMXC20 Index)								
0	509.372				1.9e-18	-20.9322	-20.829	-20.6593*
1	569.01	119.28	49	0.000	1.3e-18	-21.3754	-20.5504*	-19.1923
2	617.958	97.897	49	0.000	1.4e-18*	-25.4562*	-19.8264	-17.28
3	657.049	78.182	49	0.005	3.1e-18	-20.9604	-18.6917	-14.9569
4	732.973	151.85	49	0.000	2.3e-18	-22.0822	-19.0917	-14.1686
5	862.949	259.95*	49	0.000	4.7e-19	-21.3733	-21.7438	-15.6324

Endogenous: oil prices interest rates inflation unemployment rate Exchange rates GDP index returns

Exogenous: _cons

Table 20: Post-Oil Crisis Period

Selection-order criteria

Sample: 2016m1 - 2020m12 Number of obs = 60

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
Model 1 (OSEBX Index)								
0	379.869				9.4e-15	-12.429	-12.3334	-12.1846*
1	464.975	170.21	49	0.000	2.9e-15*	-13.6325	-12.8679*	-11.6778
2	498.166	66.382	49	0.050	5.2e-15	-13.7317*	-11.6719	-9.44044
3	541.6	86.867	49	0.001	7.4e-15	-12.92	-10.8173	-7.5445
4	600.279	117.36	49	0.000	7.7e-15	-13.1055	-10.471	-6.15676
5	663.95	127.34*	49	0.000	9.5e-15	-13.2426	-10.291	-4.93542
Model 2 (OMXC20 Index)								
0	590.081				8.5e-18	-19.436	-19.3404*	-19.1917*
1	645.04	109.92	49	0.000	7.1e-18*	-18.8584	-18.8701	-17.68
2	670.753	51.426	49	0.379	1.6e-17	-19.6347*	-17.4248	-15.1933
3	707.52	73.534	49	0.013	2.9e-17	-18.4507	-16.348	-13.0752
4	765.302	115.56	49	0.000	3.2e-17	-18.7434	-15.9717	-11.6575
5	838.764	146.92*	49	0.000	2.8e-17	-19.5588	-16.1181	-10.7626

Endogenous: oil prices interest rates inflation unemployment rate Exchange rates GDP index returns

Exogenous: _cons

Table 21: Overall Full Period

Selection-order criteria
Sample: 2010m7 - 2020m12 Number of obs = 126

				Model 1 (OSEBX Index)				
lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	857.36				3.2e-15	-13.4978	-13.4338	-13.3402*
1	941.718	168.72	49	0.000	1.9e-15	-14.059	-13.5469*	-12.7985
2	995.226	107.02	49	0.000	1.7e-15*	-14.1306*	-13.1703	-11.767
3	1026.41	62.36	49	0.095	2.3e-15	-13.8477	-12.4394	-10.3811
4	1061.43	70.047*	49	0.026	3.0e-15	-13.6259	-11.7694	-9.0563
5	1092.03	61.196	49	0.113	4.3e-15	-13.3338	-11.0292	-7.6612
				Model 2 (OMXC20 index)				
lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	1179.83				1.9e-17	-18.6164	-18.5524*	-18.4588*
1	1245.28	130.89	49	0.000	1.5e-17*	-18.8774*	-18.3653	-17.6169
2	1284.2	77.851	49	0.005	1.8e-17	-18.7175	-17.7573	-16.3539
3	1313.22	58.035	49	0.177	2.5e-17	-18.4003	-16.992	-14.9338
4	1356.75	87.063	49	0.001	2.8e-17	-18.3135	-16.4571	-13.744
5	1390.84	68.184*	49	0.036	3.7e-17	-18.0769	-15.7723	-12.4043

Endogenous: oil prices interest rates inflation unemployment rate
Exchange rates GDP index returns
Exogenous: _cons

Diagnostic Tests (Appendices C, D & E)

9.3 APPENDIX C: AUTOCORRELATION TEST FOR MODEL 1 & 2

Table 22: Pre-Oil Crisis Period

Lagrange Multiplier test (Jan 2010 – June 2014)						
H0: No Residual Autocorrelation at Lag Order p						
	Model 1 (OSEBX index)			Model 2 (OMXC20 index)		
Lag	chi2	df	Prob > chi2	chi2	df	Prob > chi2
L1.	59.0687	49	0.15361	49.0266	49	0.47206
L2.	52.3549	49	0.34513	56.0599	49	0.22718

Table 23: Post-Oil Crisis Period

Lagrange Multiplier test (Jan 2016 – Dec 2020)						
H0: No Residual Autocorrelation at Lag Order p						
	Model 1 (OSEBX index)			Model 2 (OMXC20 index)		
Lag	chi2	df	Prob > chi2	chi2	df	Prob > chi2
L1.	68.5154	49	0.03416	50.1034	49	0.42939
L2.	54.1755	49	0.28356	49.9332	49	0.43605

Table 24: Overall Full Period

Lagrange Multiplier test for full model (2010 - 2020)						
H0: No Residual Autocorrelation at Lag Order p						
	Model 1 (OSEBX index)			Model 2 (OMXC20 index)		
Lag	chi2	df	Prob > chi2	chi2	df	Prob > chi2
L1.	44.8899	49	0.64039	69.6409	49	0.05784
L2.	61.3853	49	0.11028			

9.4 APPENDIX D: NORMALITY TEST (JARQUE BERA TEST) FOR MODEL 1

Table 25: Pre-Oil Crisis Period

Jarque-Bera test

Equation	chi2	df	Prob > chi2
Oil prices	4.877	2	0.08730
Interest rates	31.228	2	0.54350
Inflation	1.551	2	0.46052
Unemployment rate	8.383	2	0.07512
Exchange rates	2.315	2	0.31428
GDP	1.192	2	0.05090
OSEBX returns	0.510	2	0.77473
ALL	50.057	14	0.23860

Table 26: Post-Oil Crisis Period

Jarque-Bera test

Equation	chi2	df	Prob > chi2
Oil prices	86.385	2	0.69043
Interest rates	2.897	2	0.23494
Inflation	0.322	2	0.05121
Unemployment rate	1.389	2	0.49932
Exchange rates	0.286	2	0.06681
GDP	3.378	2	0.18471
OSEBX returns	0.798	2	0.67099
ALL	95.455	14	0.09783

Table 27: Overall Full Period

Jarque-Bera test

Equation	chi2	df	Prob > chi2
Oil prices	518.110	2	0.15974
Interest rates	96.390	2	0.09534
Inflation	1.378	2	0.50203
Unemployment rate	908.247	2	0.64567
Exchange rates	1.149	2	0.06306
GDP	0.260	2	0.87817
OSEBX returns	3.836	2	0.14688
ALL	1529.370	14	0.24060

Normality test (Jarque Bera test) for Model 2

Table 28: Pre-Oil Crisis Period

Jarque-Bera test

Equation	chi2	df	Prob > chi2
Oil prices	10.943	2	0.36420
Interest rates	4.425	2	0.10942
Inflation	97.754	2	0.06340
Unemployment rate	3.408	2	0.18196
Exchange rates	1.158	2	0.56035
GDP	29.484	2	0.05534
OMXC20returns	1.096	2	0.57817
ALL	148.269	14	0.05569

Table 29: Post-Oil Crisis Period

Jarque-Bera test

Equation	chi2	df	Prob > chi2
Oil prices	125.507	2	0.39988
Interest rates	0.362	2	0.03450
Inflation	42.499	2	0.24571
Unemployment rate	7.221	2	0.12703
Exchange rates	1.099	2	0.57710
GDP	10.384	2	0.10556
OMXC20returns	0.592	2	0.74366
ALL	187.665	14	0.32450

Table 30: Overall Full Period

Jarque-Bera test

Equation	chi2	df	Prob > chi2
Oil prices	903.544	2	0.63135
Interest rates	571.064	2	0.07909
Inflation	38.984	2	0.17435
Unemployment rate	20.847	2	0.23783
Exchange rates	7.609	2	0.02227
GDP	79.693	2	0.26450
OMXC20returns	1.191	2	0.55119
ALL	1622.931	14	0.45542

9.5 APPENDIX E: MODEL STABILITY FOR MODEL 1

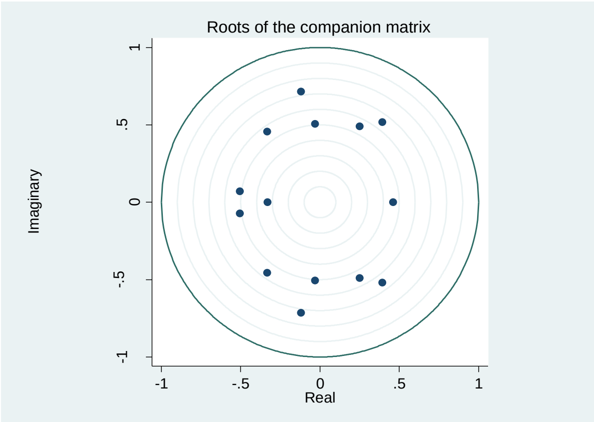
Table 31: Pre-oil Crisis Period

Eigenvalue stability condition

Eigenvalue	Modulus
-.1203179 + .7145895i	.724648
-.1203179 - .7145895i	.724648
.392083 + .5182538i	.649858
.392083 - .5182538i	.649858
-.3325246 + .4557387i	.564155
-.3325246 - .4557387i	.564155
.2506837 + .4896591i	.550098
.2506837 - .4896591i	.550098
-.5047232 + .07113584i	.509711
-.5047232 - .07113584i	.509711
-.03111695 + .5060023i	.506958
-.03111695 - .5060023i	.506958
.4597748	.459775
-.3299787	.329979

All the modulus is less than one.
VAR satisfies stability condition.

Figure 6: Pre-oil Crisis Period



All the eigenvalues lie inside the unit circle.

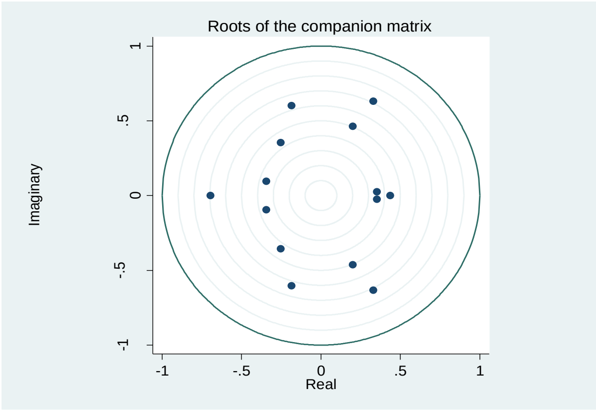
Table 32: Post-Oil Crisis Period

Eigenvalue stability condition

Eigenvalue	Modulus
.3303619 + .6317959i	.712955
.3303619 - .6317959i	.712955
-.6962525	.696253
-.1855476 + .6025908i	.630511
-.1855476 - .6025908i	.630511
.200716 + .4629893i	.504625
.200716 - .4629893i	.504625
-.2548041 + .354732i	.436761
-.2548041 - .354732i	.436761
.4356375	.435638
-.3435235 + .09526527i	.356488
-.3435235 - .09526527i	.356488
.350969 + .02493378i	.351854
.350969 - .02493378i	.351854

All the modulus is less than one.
VAR satisfies stability condition.

Figure 7: Post-oi Crisis Period



All the eigenvalues lie inside the unit circle.

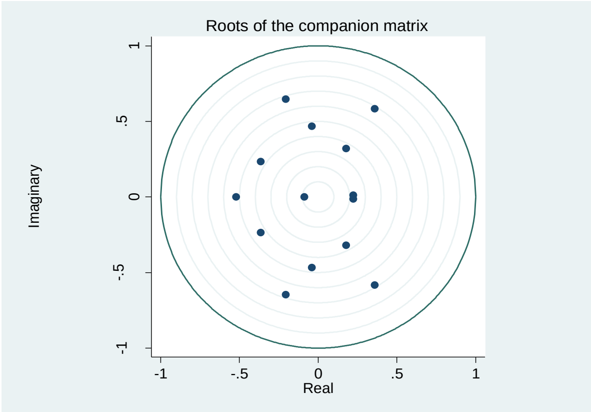
Table 33: Overall Full Period

Eigenvalue stability condition

Eigenvalue	Modulus
.3588254 + .5834757i	.684981
.3588254 - .5834757i	.684981
-.2055849 + .6464443i	.678348
-.2055849 - .6464443i	.678348
-.5221694	.522169
-.03993503 + .4670666i	.468771
-.03993503 - .4670666i	.468771
-.3655761 + .2352508i	.434728
-.3655761 - .2352508i	.434728
.1762621 + .3194701i	.364869
.1762621 - .3194701i	.364869
.2237983 + .01202357i	.224121
.2237983 - .01202357i	.224121
-.08807238	.088072

All the modulus is less than one.
VAR satisfies stability condition.

Figure 8: Overall Full Period



All the eigenvalues lie inside the unit circle.

Model Stability for Model 2

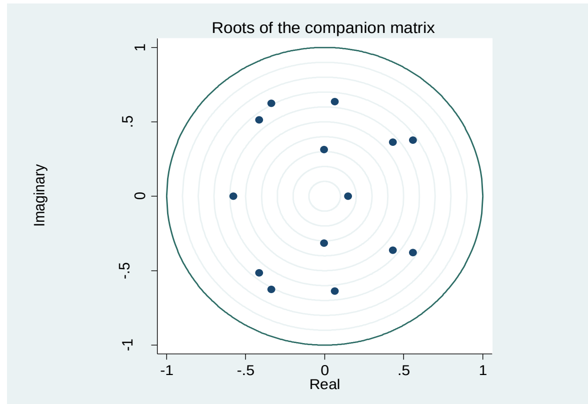
Table 34: Pre-Oil Crisis Period

Eigenvalue stability condition

Eigenvalue	Modulus
-.3372366 + .6251673i	.710326
-.3372366 - .6251673i	.710326
.558745 + .3782963i	.674762
.558745 - .3782963i	.674762
-.4156334 + .5143622i	.661301
-.4156334 - .5143622i	.661301
.06487438 + .6363786i	.639677
.06487438 - .6363786i	.639677
-.5774903	.57749
.4316494 + .3630567i	.564031
.4316494 - .3630567i	.564031
-.00454306 + .3145418i	.314575
-.00454306 - .3145418i	.314575
.1467784	.146778

All the modulus is less than one.
VAR satisfies stability condition.

Figure 9: Pre-oil Crisis Period



All the eigenvalues lie inside the unit circle.

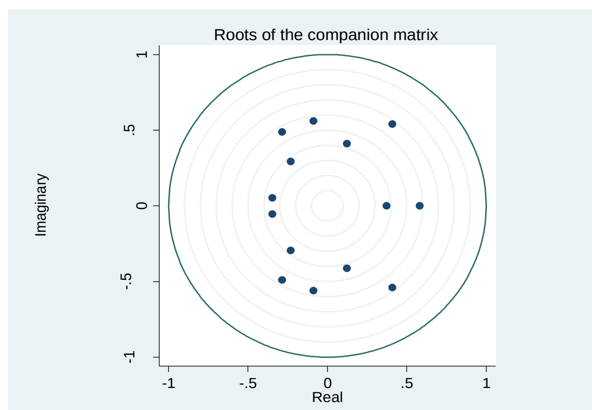
Table 35: Post-Oil Crisis Period

Eigenvalue stability condition

Eigenvalue	Modulus
.4089916 + .5404448i	.677757
.4089916 - .5404448i	.677757
.5811207	.581121
-.0873422 + .5604971i	.567262
-.0873422 - .5604971i	.567262
-.2850417 + .4893354i	.566302
-.2850417 - .4893354i	.566302
.1235496 + .4113432i	.429497
.1235496 - .4113432i	.429497
-.2302603 + .2943495i	.373713
-.2302603 - .2943495i	.373713
.3714894	.371489
-.3463898 + .05367781i	.350524
-.3463898 - .05367781i	.350524

All the modulus is less than one.
VAR satisfies stability condition.

Figure 10: Post-oil Crisis Period

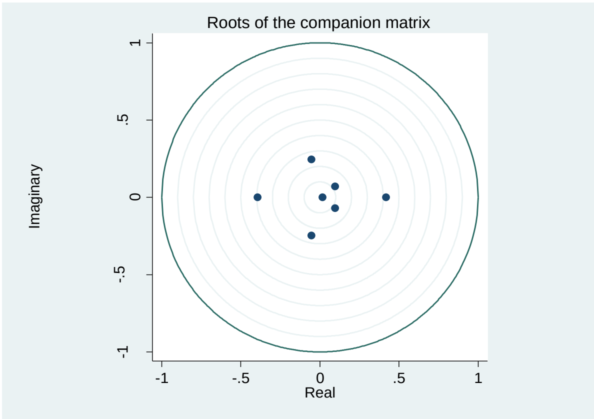


All the eigenvalues lie inside the unit circle.

Table 36: Overall Full Period

```
Eigenvalue stability condition
+----------------------------------------+
|         Eigenvalue         |  Modulus   |
|----------------------------+------------|
|    .416582                 |  .416582   |
|  -.3949532                 |  .394953   |
|  -.0536762 +  .2463683i    |  .252148   |
|  -.0536762 -  .2463683i    |  .252148   |
|  .09511182 + .06973391i    |  .117937   |
|  .09511182 - .06973391i    |  .117937   |
|  .01636188                 |  .016362   |
+----------------------------------------+
All the modulus is less than one.
VAR satisfies stability condition.
```

Figure 11: Overall Full Period



All the eigenvalues lie inside the unit circle.

9.6 APPENDIX F: GRANGER CAUSALITY TEST FOR MODEL 1 & 2

Table 37: Pre-Oil Crisis Period

Granger causality wald test for pre-oil crisis period (Jan 2010 - June 2014)							
H0: The variables do not Granger cause the stock returns at Lag Order p							
		Model1 (OSEBX index)			Model 2 (OMXC20 index)		
Equation	Excluded	chi2	df	Prob > chi2	chi2	df	Prob > chi2
Index returns	Oil prices	7.0068	2	0.030	6.8376	2	0.033
Index returns	Interest rates	4.7607	2	0.093	2.1218	2	0.346
Index returns	inflation	1.0616	2	0.588	7.1136	2	0.029
Index returns	Unemployment rate	5.2587	2	0.072	0.84463	2	0.656
Index returns	Exchange rates	0.93598	2	0.626	0.49412	2	0.781
Index returns	GDP	8.7879	2	0.012	0.85349	2	0.653
Index returns	ALL	42.407	12	0.000	18.229	12	0.109

p-value < 5% denotes significance level

Table 38: Post-Oil Crisis Period

Granger causality wald test for post-oil crisis period (Jan 2016 - Dec 2020)							
H0: The variables do not Granger cause the stock returns at Lag Order p							
		Model 1 (OSEBX index)			Model 2 (OMXC20 index)		
Equation	Excluded	chi2	df	Prob > chi2	chi2	df	Prob > chi2
Index returns	Oil prices	11.688	2	0.003	1.4312	2	0.489
Index returns	Interest rates	3.8456	2	0.146	0.50774	2	0.776
Index returns	inflation	4.1993	2	0.122	0.40328	2	0.817
Index returns	Unemployment rate	14.174	2	0.001	2.2998	2	0.317
Index returns	Exchange rates	0.371	2	0.831	1.4257	2	0.490
Index returns	GDP	0.02892	2	0.986	0.16525	2	0.921
Index returns	ALL	44.88	12	0.000	7.6945	12	0.809

p-value < 5% denotes significance level

Table 39: Overall Full Period

Granger causality wald test for full model (2010 - 2020)							
H0: The variables do not Granger cause the stock returns at Lag Order p							
		Model 1 (OSEBX index)			Model 2 (OMXC20 index)		
Equation	Excluded	chi2	df	Prob > chi2	chi2	df	Prob > chi2
Index returns	Oil prices	12.734	2	0.002	3.9343	1	0.047
Index returns	Interest rates	9.1459	2	0.010	1.9228	1	0.166
Index returns	inflation	2.418	2	0.299	0.09194	1	0.762
Index returns	Unemployment rate	15.015	2	0.001	0.03878	1	0.844
Index returns	Exchange rates	0.566	2	0.754	0.06314	1	0.802
Index returns	GDP	4.5671	2	0.102	0.00205	1	0.964
Index returns	ALL	52.444	12	0.000	6.7987	6	0.340

p-value < 5% denotes significance level

9.7 APPENDIX G: VECTOR AUTOREGRESSION FOR MODEL 1 & 2

Table 40: Pre-Oil Crisis Period

Vector autoregression time interval (2010 jan – 2014 june) at 2 months lag order.												
	Model 1 (OSEBX index)						Model 2 (OMXC20 index)					
Equation	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Oil prices L1.	-0.2772333	0.3192185	-0.87	0.385	-0.9028901	0.3484234	-0.3659606	0.3059879	-1.20	0.232	-0.9656858	0.2337646
L2.	-0.67228	0.2822189	-2.38	0.017	-1.225419	-0.1191411	-0.6577134	0.2939147	-2.24	0.025	-1.233776	-0.0816511
Interest rates L1.	0.0586291	0.0587631	1.00	0.318	-0.0565446	0.1738027	-0.181255	0.1302764	-1.39	0.164	-0.4365921	0.074082
L2.	-0.1245827	0.0653487	-1.91	0.057	-0.2526637	0.0034984	0.0372531	0.1211335	0.31	0.758	-0.2001641	0.2746703
inflation L1.	0.0064513	0.0182593	0.35	0.724	-0.0293362	0.0422389	0.0597014	0.0275496	2.17	0.030	0.0057053	0.1136975
L2.	-0.0176777	0.0171618	-1.03	0.303	-0.0513143	0.0159589	0.0009104	0.0276851	0.03	0.974	-0.0533513	0.0551721
Unemployment rate L1.	0.0497598	0.0417742	1.19	0.234	-0.0321161	0.1316356	-0.0352809	0.0419481	-0.84	0.400	-0.1174976	0.0469358
L2.	-0.0729231	0.0398958	-1.83	0.068	-0.1511173	0.0052712	0.0283976	0.0405928	0.70	0.484	-0.0511627	0.1079579
Exchange rates L1.	-0.0523038	0.0694146	-0.75	0.451	-0.1883539	0.0837463	-0.025793	0.0721184	-0.36	0.721	-0.1671424	0.1155565
L2.	0.0485618	0.0594583	0.82	0.414	-0.0679743	0.1650979	-0.0361665	0.061878	-0.58	0.559	-0.157445	0.0851121
GDP L1.	-3.410904	1.581871	-2.16	0.031	-6.511313	-0.3104946	1.661119	2.042132	0.81	0.416	-2.341387	5.663624
L2.	3.026687	1.751252	1.73	0.084	-0.4057047	6.459078	1.317313	2.107114	0.63	0.532	-2.812555	5.447181
cons	0.0030021	0.0079159	0.38	0.705	-0.0125127	0.0185169	-0.0008679	0.0074125	-0.12	0.907	-0.0153962	0.0136603

p-value < 5% denotes significance level

Table 41: Post-Oil Crisis Period

Vector autoregression time interval (2016 jan – 2020 dec) at 2 months lag order.												
	Model 1 (OSEBX index)						Model 2 (OMXC20 index)					
Equation	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Oil prices L1.	0.4262407	0.2114105	2.02	0.044	0.0118838	0.8405976	-0.0551671	0.1182054	-0.47	0.641	-0.2868454	0.1765111
L2.	-0.5980964	0.1858875	-3.22	0.001	-0.9624293	-0.2337636	-0.1283872	0.1258556	-1.02	0.308	-0.3750596	0.1182852
Interest rates L1.	-0.0931356	0.0592998	-1.57	0.116	-0.209361	0.0230898	0.035715	0.2011445	0.18	0.859	-0.358521	0.429951
L2.	-0.0219214	0.0665641	-0.33	0.742	-0.1523846	0.1085418	0.1025739	0.1506613	0.68	0.496	-0.1927168	0.3978645
inflation L1.	0.0288984	0.0153138	1.89	0.059	-0.0011161	0.0589128	0.0151914	0.0242727	0.63	0.531	-0.0323823	0.062765
L2.	-0.0157344	0.0170274	-0.92	0.355	-0.0491075	0.0176386	0.0012465	0.0250289	0.05	0.960	-0.0478093	0.0503022
Unemployment rate L1.	0.0262226	0.0091788	2.86	0.004	0.0082326	0.0442126	0.023306	0.0181392	1.28	0.199	-0.0122461	0.0588582
L2.	-0.0187816	0.0089909	-2.09	0.037	-0.0364033	-0.0011598	-0.0152897	0.0168184	-0.91	0.363	-0.0482532	0.0176738
Exchange rates L1.	-0.0003871	0.0384011	-0.01	0.992	-0.0756519	0.0748778	-0.0441543	0.0601317	-0.73	0.463	-0.1620103	0.0737018
L2.	-0.0196095	0.0328503	-0.60	0.551	-0.0839949	0.0447758	0.0625595	0.0571817	1.09	0.274	-0.0495147	0.1746336
GDP L1.	-0.0796561	0.8467469	-0.09	0.925	-1.73925	1.579937	-0.6280836	1.545067	-0.41	0.684	-3.656359	2.400192
L2.	-0.103683	0.846601	-0.12	0.903	-1.762991	1.555625	-0.0127425	1.645736	-0.01	0.994	-3.238326	3.212841
cons	0.0008854	0.0053742	0.16	0.869	-0.0096479	0.0114186	0.0006561	0.0056732	0.12	0.908	-0.0104632	0.0117754

p-value < 5% denotes significance level

Table 42: Overall Full Period

Vector autoregression time interval (2010 – 2020) at a 1 & 2 months lag order.												
	Model 1 (OSEBX index)						Model 2 (OMXC20 index)					
Equation	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Oil prices L1.	0.0374863	0.138963	0.27	0.787	-0.2348761	0.3098487	-0.1891425	0.0953572	-1.98	0.047	-0.3760392	-0.0022458
L2.	-0.4902425	0.1374746	-3.57	0.000	-0.7596879	-0.2207972						
Interest rates L1.	-0.0437738	0.0369128	-1.19	0.236	-0.1161217	0.028574	-0.0854813	0.0616466	-1.39	0.166	-0.2063064	0.0353437
L2.	-0.1004073	0.0382964	-2.62	0.009	-0.1754667	-0.0253478						
inflation L1.	0.00939	0.0106369	0.88	0.377	-0.011458	0.030238	0.0057345	0.0189125	0.30	0.762	-0.0313333	0.0428022
L2.	-0.0143055	0.0108635	-1.32	0.188	-0.0355976	0.0069867						
Unemployment rate L1.	0.0158129	0.0067832	2.33	0.020	0.0025182	0.0291077	0.0032791	0.0166519	0.20	0.844	-0.0293581	0.0359163
L2.	-0.0195471	0.0067379	-2.90	0.004	-0.0327531	-0.0063411						
Exchange rates L1.	-0.0048091	0.0293637	-0.16	0.870	-0.062361	0.0527428	0.0097386	0.0387579	0.25	0.802	-0.0662254	0.0857026
L2.	-0.0192997	0.0277776	-0.69	0.487	-0.0737428	0.0351434						
GDP L1.	-1.231997	0.7127208	-1.73	0.084	-2.628904	0.1649103	-0.0567227	1.253198	-0.05	0.964	-2.512945	2.399499
L2.	1.019348	0.7081912	1.44	0.150	-0.3686809	2.407377						
cons	-0.0016175	0.0041805	-0.39	0.699	-0.0098111	0.0065761	-0.0010222	0.0044998	-0.23	0.820	-0.0098415	0.0077972

p-value < 5% denotes significance level