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Master's thesis

Cointegration and causality between market indices and selected macroeconomic variables in three Nordic countries

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ABSTRACT

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The purpose of this study is to identify and examine the long-term and short-term relationships between market indices and selected macroeconomic variables in three different Nordic countries (Finland, Sweden and Norway). In the focus are the long-term cointegrating relationships as well as the short-term causal relationships between the market indices and similar macroeconomic variables for each country. In the literature review a great number of similar studies are presented and examined, but until now, no focused examination for these countries have been conducted.

For each country, an all-share index is chosen to represent the markets and the selected four macroeconomic variables are consumer price index, long-term interest rate, exchange rate and industrial production index. Data is in monthly frequency and the time period is from the June 2000 to June 2018, 217 months in total. The main study methods are the Johansen's cointegration test, vector error correction models and Granger causality tests. From the cointegration tests it can be concluded, that for each country, a cointegrating relationship exists, meaning that in long-term the market indices and macroeconomic variables move together. Natures of these found relationships are analysed further with the VECM. Short-term causal relationships are found to exist between some of the macroeconomic variables and market indices from both VECM and Granger causality tests. The nature of found relationships, both long-term and short-term, vary for each country, implying that macroeconomic fundamentals are different for each country and the markets react to changes in macroeconomic variables differently across these countries.

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Tämä tutkielman tarkoituksena on tunnistaa ja tarkastella pitkän ja lyhyen ajan suhteita markkinaindeksien ja valittujen makrotaloudellisten muuttujien välillä kolmessa Pohjoismaassa (Suomessa, Ruotsissa ja Norjassa). Lähemmässä tarkastelussa ovat pitkän aikavälin yhteisintegroituneet suhteet sekä lyhyen aikavälin kausaalit suhteet markkinaindeksien ja makrotaloudellisten muuttujien välillä jokaisessa maassa. Kirjallisuuskatsauksessa tarkastellaan runsaasti samantapaisia tutkimuksia, mutta tähän mennessä yhtä yksityiskohtaista tarkastelua näille maille ei ole tehty.

Jokaiselle maalle on valittu markkinaindeksi ja neljä valittua makrotaloudellista muuttujaa ovat kuluttajahintaindeksi, pitkän ajan korko, valuuttakurssi sekä teollisuustuotannon indeksi. Data on kuukausittaisessa muodossa aikaväliltä heinäkuusta 2000 heinäkuuhun 2018, kaiken kaikkiaan siis 217 kuukautta. Päätutkimusmetodit ovat Johansenin yhteisintegroituvuustestit, vektorivirhekorjausmallit ja Grangerin kausaliteettitestit. Yhteisintegroituvuustesteistä jokaiselle maalle havaitaan yhteisintegroituva suhde pitkälle aikavälille, mikä tarkoittaa, että markkinaindeksit ja makrotaloudelliset muuttujat kehittyvät yhdessä ajan mittaan. Pitkän aikavälin suhteita analysoidaan tarkemmin vektorivirhekorjausmalleilla. Lyhyen aikavälin kausaaleja suhteita havaitaan sekä vektorivirhekorjausmalleilla että Grangerin kausaliteettitesteillä makrotaloudellisten muuttujien ja markkinaindeksien välillä. Löydettyjen pitkäaikaisten ja lyhytaikaisten suhteiden välillä on eroja eri maissa, mikä kertoo, että makrotaloudelliset perusteet vaihtelevat maakohtaisesti ja markkinat reagoivat eri tavalla makrotaloudellisiin muutoksiin.

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With this thesis, one chapter of my life comes to an end. The years in LUT have been full of experiences that I will cherish for the rest of my life. As one door closes, another one opens; and I am excited to see what the future holds.

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Timo Taavitsainen

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1 INTRODUCTION

Typically changes in stock markets are explained by the past development of stocks and different securities as well as by more company level factors, but what is the role of macroeconomic changes and policies in stock market development? Understanding the relationships between macroeconomic variables and stock markets has been in the past focus of many studies (Fama 1981; James, Koreisha & Partch 1985; Fama 1990). Arguably, the understanding of these relationships has become more and more important during the 21st century as markets have been shaken by several crises all around the globe.

From these early studies of the 1980s, which focused on the US markets and economy, a new wave of modern research has emerged in the past few decades as interest between the macroeconomics and stock markets have risen while the econometric tools and models have evolved, greatly helping to understand these long-term and short-term relationships. This development has made it possible to study these relationships for a wide variety of markets, from largest to the smallest, as well as studying the effects of domestic macroeconomic factors all the way to global factors. For example, the studies range from the recent studies done on well established, developed, economies such as Germany (Plíhal 2016) to the examination of macro and stock relationships in developing and small African economies (Suhaibu, Harvey & Amidu 2017). While the availability of studies for different countries and regions has increased, so has the variety of used macroeconomic variables in these studies. As the early studies focused mainly on the relationships between stock markets and few selected macroeconomic variables of interest rate, inflation and real economic activity, the more recent studies implement macroeconomic variables of different scales from domestic indicators to global indicators, such as different interest rates and industrial indices.

In this thesis, under the focus are the three small and open economies of Finland, Sweden and Norway. These three countries are economically similar on many aspects, but they also have number of key differences, such as Finland and Sweden being part of the EU, while Finland is also part of the Eurozone and while Norway is not part of the EU. These differences make an interesting point when comparing the found results of this study and might help us understand the underlying macroeconomic and market fundamentals for these countries.

1.1 Problem discussion and justification

The relationships between macroeconomic variables and stock markets have been researched widely in the past. Fama (1981; 1990) has researched the relationship between stock returns and inflation and production both. His findings include the observing of negative relationship between stock returns and inflation (1981, 563) and calculating effects that changes in productions has on stock returns (1990, 1107). James et al. (1985) expand on the earlier research of Fama and investigate the relationships between stock returns and some macroeconomic variables, such as expected inflation and money growth. As most of the older research done on the topic, these also focus on the stock markets and macro variables of United States.

More recently research have been focusing on wider variety of countries, markets, and macroeconomic variables. Zhang and Jiang (2011) have done a research between macro variables and stock markets in China. Similar research has been conducted by Yan-chun and Liang (2008). Cointegration and causality research between these factors can be found for other big Asian economies, such as India (Seth & Tripathi, 2014) and Singapore (Maysami, Howe & Hamzah, 2004). These relationships have also been studied for the Japanese markets and macro variables (Mukherjee & Naka, 1995) and Korea (Kwon & Shin, 1999). For some European countries research of this nature can be found. Nasseh and Strauss (2006) have done cointegration test between stock prices and macroeconomic activities for six European economies (France, Germany, Italy, Netherlands, Switzerland, and the UK). Overlapping Nasseh's and Strauss' research is study conducted by Peiró (2016), where the three largest European economies, France, Germany, and the UK, are studied.

From these earlier studies it can be seen, that both long-term and short-term relationships between variety of macroeconomic variables and stock markets have been previously researched. Great number of these studies have been conducted by using cointegration and causality tests and are presented thoroughly in the literature reviews of this study. However, there are several points that need covering. Firstly, research of this nature has been done to a lesser degree on smaller and open economies such as those of Nordic countries'. For example, Sweden and Norway are only a small part of the study by Kollias, Papadamou & Siriopoulos (2016), while the study done on Norway by Gjerde & Sættem (1999) is already two decades old. Secondly, the older research might be somewhat outdated as the time periods used in some of the research do not cover the global financial crisis. This presents us a clear research gap, where the long-term and short-term relationships between stock markets and macroeconomic variables in Nordic countries and in recent history should be researched.

1.2 Research questions

In the focus of this research is to study the relationships between stock market indices and macroeconomic variables in selected Nordic countries of Finland, Sweden and Norway. The choice of these countries is briefly explained above and in the interest are to study both short-term and long-term relationships between the chosen market indices and macroeconomic variables. From this the two main research questions of this research can be presented as:

- *Is there long-term relationship between stock indices and selected macroeconomic variables in the selected Nordic countries?*
- *Are there short-term causal relationships between the market indices and macroeconomic variables?*

To analyse if the long-term relationships exists, a cointegration test is used (*Johansen's cointegration*). The understanding of possibly found cointegrating relationship is expanded upon by implementing the vector error correction models. To understand the relationships between variables better Granger causality tests are done. For this purpose, supporting research questions are made:

- *Which macroeconomic variables are significant to the market indices in long-term?*
- *Are found significant long-term relationships between market indices and macroeconomic variables positive or negative?*
- *Are found short-term causal relationships unidirectional or bidirectional?*

Comparing the results from the test and models for each country can give us insight on the unique aspects of each country's stock markets and macroeconomic environment.

From the extensive number of studies observing a cointegrating relationship for stock markets and variety of different macroeconomic variables, it is hypothesized that cointegrating relationships are also found for each of the three countries in this study. Also, from the literature review we can draw expectations for the relationships that can be found for the cointegrating relationships for the three countries. Mainly, we can hypothesize whether the relationship will be negative or positive. Hypothesized findings for the relationships can be drawn from the studies of Fama (1981), Geske & Roll (1983), James et al. (1985), and Mukherjee & Naka (1995). From the early studies, the found relationships between the inflation (CPI) and stock markets are negative. In similar fashion, negative relationship is hypothesized between the interest rate and stock markets. Positive relationship is hypothesized to be found between the industrial production and the market indices. The relationship between exchange rate and market indices is not as straight forward as it has been found to be both positive and negative in previous studies. However, in this study a negative relationship is hypothesized between all the three countries due their nature of being heavily dependent on importing goods and services.

Hypothesizing findings from the short-term relationships found from the causality tests is not as straightforward as with the long-term cointegration tests. This is due the fact that from previous studies, contradicting findings are common. These contradictions can be seen as findings of opposite unidirectional short-term relationships for similar variables in different studies as well as observations of bidirectional causalities in some studies. From these observations on the previous studies, no clear and well-defined hypothesises can be made for the causality test. However, a unidirectional relationship can be observed to be more commonly found in previous similar studies and more often the relationship is noted to be unidirectional from macroeconomic variables to the stock market variables (e.g. per Dritsaki 2005; Kwon & Shin 1999; Kollias et al. 2016; Plíhal 2016). Findings from causality tests in previous studies are more closely examined in the literature review below.

Findings from this study will have a variety of implications to investors and policymakers. For investors the information about the levels of cointegration and causality in these markets will be valuable information when considering one’s investments and plans to invest to these markets. Understanding the relationships between macroeconomic factors and stock markets will help investors to choose optimal markets to invest and prepare for upcoming movements of the stock markets when announcement and changes in macro environment are due. For policymakers, it is crucial to understand the relationships between the markets and macro variables as their decision will most likely to affect both. In order to have the desirable effects of the markets and to avoid unwanted effects it is important to understand fully the relationships between these factors.

1.3 Theoretical background

Behind all of the studies considering macroeconomic variables and stock markets, there is a one theory needs to be taken into account. This is the theory of market efficiency (efficient market hypothesis, EMH), developed mainly by Eugene Fama in the 1960s. In its most basic definition market efficiency means that stock prices reflect all the available information, which can also be noted as the strong form of market efficiency (Fama 1991, 1575). Alongside the strong form of market efficiency there are two other forms: semi-strong form and weak form. With weak form, the stock prices are determined only by the common information about the past development of the said stock and cannot be analysed to achieve excess returns, while semi-strong form also includes all of the available public information.

The relevancy of market efficiency comes under observation as we study the cointegration and causality between the stock markets and macroeconomic variables. Geske & Roll (1983, 402) conclude in their study that asset prices reflect the information available on different variables that describe the economy. This finding supports the idea that stock prices do indeed reflect on information sources other than solely the past information of stock's development. However, Fama (1990, 1090) notes, that information from these macroeconomic variables are not fully included in the explaining of market development, thus meaning that market efficiency in its strongest form would not exist. This point is also repeated by Fama (1991, 1575-1576) in his later work on efficient markets.

The form of market efficiency is related to the causal relationships, that are observed from the econometric models. Observing a unidirectional causality from stock markets to macroeconomic variables would indicate that not all information is reflected on the stock market changes. In a case of opposite unidirectional causality, the weakest form of market efficiency could be dismissed as the stock development would not base solely on the past information of said stock. Granger (1986) argues, that in efficient markets there should be a lack of predictability, thus implying that cointegrated systems would not be market efficient, as arbitrage opportunities would rise. In this case the market efficiency has been defined as situation when there would not be arbitrage opportunities in the markets. This note is however dismissed by Dwyer & Wallace (1992), who conclude that presence of cointegration (or lack of cointegration) does not indicate the inefficiency of the markets as cointegrating relationships are dependent on the econometric model used to describe the system and cointegrating relationships are not alone basis for arbitrage opportunities to exist.

2 LITERATURE REVIEW

2.1 Stock markets and inflation

In the early studies of long-term relationships between macroeconomic variables and stock markets evidence supporting the relationships has been found. This early research focuses mostly on the relationship between stock market returns and inflation. In his research, Fama (1981, 562) points out the strong evidence for existing negative relationship between of inflation and stock returns in the US markets between period 1953-1977. The same conclusion is made by Geske and Roll (1983, 28-29). This negative correlation has been mostly thought to be true for most of the similar research studying the relationships between stock returns and inflation. This negative relationship has been explained to be caused by the fact, that increase in inflation will cause increase in discount rate used to evaluate stocks, yet at the same time increase in cash flows, due the rise of inflation, will not be enough to neutralize the effects of increased discount rate (Tripathi & Seth 2014, 306). An increase in inflation will also most likely cause the policymakers to react to the increase and cause stricter economic policies to take place (Maysami et al. 2004, 54).

Some research has been done for the European markets and macroeconomic variables, that support the findings of Fama's (1981) and Geske's and Roll's (1983) research. This research has been focusing on the either the biggest markets inside the EU or the emerging markets in the fringes of Europe. Nasseh and Strauss (2000) have researched the long-term relationships between the stock market indices and selection of macroeconomic variables for six European countries (France, Germany, Italy, Netherlands, Switzerland, and the UK). They conclude from their use of cointegration tests and variance decomposition, that all of the tested European markets are cointegrated with consumer price index. Inflation rate have been found to be unidirectionally and causally related to the Athens' stock market and that a long-run relationship exists between the markets and the inflation (Dritsaki 2005, 45). However, cyclical, bidirectional relationship, for Greek stock market was observed by Filis (2010, 884) as he concludes that there is a positive effect from CPI to stock market, while stock market has a negative impact on CPI in return. Research conducted by Ansotegui & Esteban (2002, 850-851) also observe a negative relationship between inflation and Madrid's stock index on their research, with observation that increase in inflation and negative reaction, that stock index has, stays in the system for long periods of time, but not as strongly as at the outset of the change. This observation is aligned with the observations of Fama (1981) and supporting the idea, that stock markets do not compensate on the negative impacts of inflation.

Similar findings for Asian countries, developed or developing, can be found in abundance. The findings from these markets and economies are generally aligned with findings from European countries and with research of Fama (1981 & 1990) and Geske & Roll (1985). For example, a long-term relationship is found between inflation and KSE 100 index of Pakistani stock exchange in a research conducted by Ahmed et al. (2017, 1513-1516). However, from Ahmed's et al. study no short-term causality is found between inflation rate and KSE 100 index. For Japanese markets and macroeconomic variables, a cointegration has been found for the Tokyo Stock Exchange and inflation (Mukherjee & Naka 1995, 236). The relationship between Japanese stock markets and inflation exhibit the negative relationship as presented by Fama (1981). However, contradictory findings for Japan is presented by Humpe & Macmillan (2009, 118), who do not find significant relationship between NKY225 index of Tokyo Stock Exchange and consumer price index. Existence of negative long-term relationship has also been found for Indian markets by Tripathi and Seth (2014, 310-311). Contradicting observations are found for China's markets from the studies of Liu & Shrestha (2008) and Liu & Sun (2008), as negative long-term relationship is noted by Liu & Shrestha (2008, 751) and a positive one by Liu & Sun (2008, 320) between consumer price index and Shanghai Stock Exchange.

Some reasoning behind a possibly found positive relationship between stock markets and consumer price index is presented by Maysami et al. (2004). Their investigation of relationships between macroeconomic variables and stock market returns in Singapore contradict this thought negative relationship between stock returns and inflation. Their research finds a significant positive relationship between inflation and stock returns. Speculated reasons for this presented by the research is that Singapore's government has an active role in the economy and it actively tries to prevent price escalations. Other possible reason for this positive relationship is the possibility to hedge against inflation by holding stocks. (Maysami et al. 2004, 68)

2.2 Stock markets and exchange rates

Exchange rates affect greatly the competitiveness of country in a global scale as exchange rates are one of the key factors with regards to the successfulness of trade of each country (Plíhal 2016, 2103). Research on the relationship between exchange rate and stock markets have yielded mixed results in the past. However, most of the research support the idea of cointegration and long-run relationship existing between exchange rate and stock markets performance and movement. More often, a negative relationship between exchange rate and stock market indices are observed, as depreciating currency increases the amount of exports as the local products come cheaper in other currencies, thus increasing the operational incomes of companies (Liu & Shrestha 2008, 747).

Kollias et al. (2016) have studied the relationships between eight different European economies and markets. For the study four countries with national currencies are chosen and four with Euro as their currency. The four countries with national currencies are the UK, Sweden, Denmark, and Norway while the four Euro currency countries are Germany, France, Spain, and Italy. The results from this research are mixed as for the period after the financial crisis there is cointegration for all the eight countries while for the pre-crisis period differences among the countries were observed. These differences range from the significance of the integration to the negativity/positivity of the relationship. Most interesting regards to this research are the findings for Norway and Sweden: Norway is found to be bidirectionally causal between exchange rate and stock markets, whereas for Sweden the relationship seems to be unidirectional from stock markets to exchange rate. (Kollias et al. 2016, 215 & 261-271)

A negative relationship between exchange rate and stock markets have been observed by several studies done on individual countries. Yan-chun and Liang (2008) find, that a negative correlation and relationship exists between Shanghai's stock exchange and the exchange rate for monthly data during years 2000 to 2005. For emerging Thailand's market similar findings are made by Brahmasrene and Jiranyakul (2007) who observe that this cointegration exists for the time period of 1992-1997 and that cointegration is non-existent after the Asian crisis that started later in the year 1997. Similarly, no cointegration nor Granger causality was found for Germany’s DAX index and exchange rate for data from 1999 to 2015 (Plíhal 2016, 2107).

Tripathi and Aggarwal (2015) have researched the relationship between macroeconomic variables and stock markets in BRICS countries (Brazil, Russia, India, China, and South Africa) for years of 1997 to 2014. One of these macro variables investigated is the exchange rate of each country and the findings from the study indicate a significant negative relationship between exchange rate and stock prices in Russia, South Africa, and India. One of the more interesting findings from the study is, that there seems not to be any level of cointegration between the macroeconomic variables and stock markets in any of the countries in the time period after the global financial crisis of 2008. However, for the total time period of 17 years significant cointegration is found for markets of Russia and China and for pre-crisis period significant cointegration is observed for Russia, India, and China. (Tripathi & Aggarwal 2015, 17)

Contradicting these findings is, that a positive relationship has been found between exchange rate and Singapore’s stock exchange by Maysami et al. (2004, 68-69), who rationalize this relationship with Singapore’s high levels of world trade: while domestic currency is strong, the lower cost of imports allows local manufacturers to be more competitive in a global scale. Partially, similar findings have been made by Kalyanaraman (2015, 339-343), by observing a positive relationship between some market indices in Saudi Arabian markets and negative relationships with some market indices.

As presented above, the relationship between stock markets and exchange rate have been found to be either negative or positive, depending on different countries and markets. The effect of exchange rate to individual company’s stock development depends heavily on that is the said company import or export dependent. For export-oriented companies, appreciation of currency will most likely give a boost to profitability, whereas opposite effect would take place for an import-oriented company (Bahmani-Oskooee & Saha 2016, 57-58). This is a fact, that one has to keep in mind when examining the cointegration and causality between the stock markets and exchange rates in Nordic countries as in this study. Bahmani-Oskooee & Saha (2016, 57) also point out, that most studies have found relationship between stock markets and exchange rates to be significant in short-term and not as much in long-term.

Wong (2017) supports the views of Bahmani-Oskooee & Saha with findings that short-term and negative relationship with exchange rates and stock returns are common, but not in any way the only possible conclusion to be made from the studies on these relationships. Wong's study finds that there exist unidirectional causalities for both ways for different countries. This can be attributed to multiple different reasons, for example to the different fundamentals and development states of stock markets between different countries and markets. Overall, this means that no single conclusion can be drawn from different studies, but what is important is to recognize that different countries function based on different fundamentals. (Wong 2017, 340-341 & 351)

Critique to the existing research is done by Liu and Wan (2012) who argue that using Johansen cointegration method and Granger causality, which are two very commonly used methods, tests create false observations of cointegration and causality between exchange rates and stock markets. They present alternative findings, that observed cointegration from other studies is caused by the extreme movements caused by the recent global financial crisis, thus Liu and Wan argue that there is not observable cointegration between Shanghai stock markets and CNY/USD exchange rate and that only unidirectional causality from exchange rates to stock index is present in the post-crisis period. (Liu & Wan 2012, 6056-6059)

2.3 Stock markets and interest rates

The research covering the relationships between interest rates and markets is abundant and consists variety of studies conducted with different methods. Geske and Roll (1983) conclude from their research that a negative relationship exists between short-term interest rates and stock returns in US markets. Supporting findings are made by James et al. (1985) for negative relationship and the presented reasoning behind this relationship is that short-term interest rates reflect the expected inflation, which (as presented above) has a negative relationship with stock returns according to Fama (1981). Long-term interest rates effect on stock markets are also often thought to be negative as changes in long-term interest rates (such as government bond rates) affect the discount rate, as they also affect the nominal risk-free rate as short-term interest rates (Mukherjee & Naka 1995, 225).

Some other points about the negative relationship between interest rates and stock market indices is brought up by Bernanke & Kuttner (2005). They present that the negative relationship is mostly explained by the changes in the expected future dividends and future excess returns. This is somewhat contradictory to the previous findings of Fama (1981) and Mukherjee & Naka (1995) who credit the effects of relationship for the effects of interest rates to the real interest rates. Bernanke & Kuttner argue, that the lesser effects of real interest rates are due the short-term effects that the changes in interest rates have on these real interest rates. They argue that these effects are more long lasting for expected future dividends and future excess returns. (Bernanke & Kuttner 2005, 1253)

Peiró (2016, 291-294) observes supporting findings in his study on three biggest economies of Europe (Germany, France, and the UK) as the existence of negative relationship between long-term interest rates and stock market indices is observed for years 1969-2012. For Madrid's stock exchange and short-term interest rates, a negative long-run relationship is found and unidirectional effect from interest rate to the stock index by Ansotegui and Esteban (2002, 851). Similarly, for Athens stock exchange supporting evidence for negative relationship with interest rates and stock exchange indices can be found with unidirectional causality from interest rate to index with Granger causality (Dritsaki 2005, 45). For US and Canadian markets, the long-run relationship is found between interest rates and stock indices by Sawhney, Anoruo, and Feridun (2006, 11), who conclude that the US stock markets are unidirectional Granger-caused by interest rates whereas the Canadian stock index and interest rates have bidirectional Granger-cause relationship.

Similar negative relationship between interest rates and stock markets can be also found in Asian economies. For both Shanghai and Shenzhen stock exchange, a cointegration relationship is found with heteroscedastic cointegration model between the markets and both short and long interest rates for years 1992 to 2001 (Liu & Shrestha 2008, 753). Yan-chun and Liang (2008, 321) observe also negative relationship between Shanghai stock exchange and long-term interest rates with Johansen's cointegration test for interval from 2000 to 2005. For Singapore's stock market a negative relationship is found with cointegration and causality test for years 1982-2002 (Wong, Khan & Du 2006, 45-47). However, in the Wong's et al. (2006, 48) research cointegration is found overall for the whole period (1982-2002) and especially strong in the time period before the Asian crisis but after the year 1997 the level of cointegration is considerably weaker.

Consensus among researchers seem to be especially strong, when considering the negative relationship between the long-term interest rates and stock markets around the world. Same cannot be said for the relationship with short-term interest rates. Contradicting evidence pointing out a positive relationship can be found with markets of different sizes and types. In the thorough study on six different European economies and markets evidence for negative relationship between long-run interest rates and stock indices is found while simultaneously a positive relationship is found with short-term interest rates in the study by Nasseh and Strauss (2000, 242). This positive relationship is reasoned with explanation that short-term interest rates do not affect strongly the stock markets and that short-term interest rates acts as proxy for other macroeconomic variables, such as production (Nasseh & Strauss 2000, 240). Similar findings are done by Mukherjee and Naka (1995) for Japanese stock markets and short and long-term interest rates. While long-term government bond rates have a negative relationship with Tokyo's stock index, the short-term call money rates have positive relationship (Mukherjee & Naka 1995, 231-236). Mukherjee and Naka (1995, 232) speculate that for Japanese markets short-term interest rates do not affect the nominal risk-free rate used in discounting as strongly as long-term interest rates. Same reasoning is behind the findings of Maysami et al. (2004, 68) for the positive relationship between Singapore's stock markets and short-term interest rates.

Very different finding compared to these, above presented, research is found for the Turkish stock index and interest rates by Aickalin, Aktas and Unal (2008). From their research they conclude that indeed a long-run relationship exists between the stock index and interest rates but that the causality is unidirectional from the stock markets to the interest rates, which is reasoned to be due the high number of foreign investors in the Turkish stock markets (Aickalin et al. 2008, 13). No long-run relationship is found between Indian stock markets and interest rates for the whole of the time period from 1997 to 2011 but interest rate is the only macroeconomic variable found to be cointegrated with stock index in the time period after the global financial crisis (Tripathi & Seth 2014, 310-311). As Wong et al. (2006) found a diminishing effect between interest rates and Singapore's stock index, in the same study they observe that after the there is no cointegration between macroeconomic variables, including interest rates, and the US stock markets. This lack of long-run relationship is argued to be caused by the turbulence in financial world during the years of 1987-1997 (Wong et al. 2006, 48).

2.4 Stock markets and industrial production

Number of studies which use the gross domestic production growth ratio as a macroeconomic variable to study the relationships between real economic activity and stock markets is relatively low. This might be due the fact, that there is an array of variables which are similar in nature as GDP growth rate but are more easily measured in a shorter frequency (e.g. monthly, weekly). Some of these variables are, which are used instead of the GDP growth rate, are for example, the nominal GDP, industrial production and value added of industry (VAI). Most commonly used variable to measure the real activity of economy is the industrial production, be that for example, the manufacturing industrial production or total industrial production as a whole.

James et al. (1985, 1382) observe a significant and a positive relationship between expected real output and stock returns with a lag of few months. A positive relationship between stock returns and increase in real activity is presented by Fama (1981, 563). Supporting evidence for this is found by Geske and Roll (1983). Fama (1990, 1107) concludes that increase in stock returns will in turn increase the future production. From this observation it can be expected, that with causality tests a positive bidirectional causality should be present between stock markets and variables measuring production or real output. This positive relationship is quite logical as increases in production implies a higher rate of cashflow which in turn increase the returns of the companies in the stock markets (Nasseh & Strauss 2000, 231).

Industrial production is used a proxy for GDP by Nasseh and Strauss (2000, 234) in their study of the six European economies. The findings for all the six countries support the findings of Fama (1981 & 1990) and Geske & Roll (1983). Supporting evidence is presented by Peiró (2016, 292) for the three biggest European economies using similarly the industrial production as variable for domestic macroeconomic activity. Study done on the Athens stock exchange supports the idea of bidirectional causality between the domestic real activity and stock markets as well as the long-run positive relationship with Johansen cointegration test (Dritsaki 2005, 43-45). Even more supporting evidence is presented by Ansotegui and Esteban (2002, 856) who conclude, that there exists a long-run relationship between industrial production and stock index in Madrid’s stock exchange. Sawhney’s et al. (2006, 11) research conclude the same findings (cointegration and bidirectional causality) for Canadian stock index and GDP as macroeconomic variable. Also, positive long-run relationship between industrial production is found between stock exchange and industrial production in the markets of United States (Humpe & Macmillan 2009, 116). Highly relevant in the interest of this study, is the study by Gjerde & Sættem (1999), who only found one macroeconomic variable to have a long-term relationship with Norway’s stock markets, this macroeconomic variable being industrial production.

This long-run relationship has been found not only from the European and North American markets and countries. For Korean stock index and industrial production, there is found to be a long-run positive relationship and a bidirectional causal relationship (Kwon & Shin 1999, 79-80). Positive cointegrating relationship for Japanese markets and industrial production, following the research done for US and Europe, is found by Mukherjee & Naka (1995) in their study. Maysami’s et al. (2004) study tells us the same story: Singapore’s stock market indices and real activity proxy have a positive cointegrating relationship. For Chinese stock markets and industrial production, a positive relation is presented by Liu & Shrestha (2008, 753) in their research. For Mexican markets a supporting positive long-run relationship is observed with cointegration tests (Castillo-Ponce, De Lourdes Rodriguez-Espinosa & Gayton-Alfaro 2015, 30).

Researchers seem to be extensively unanimous about the long-run positive relationship between stock markets and GDP (or domestic activity proxies). However, there are some contradicting evidence about the causality between the factors. Contradicting the bidirectional causality, Sawhney et al. (2006, 11) conclude that there is only a unidirectional causal relationship between GDP and stock market index in the US with GDP Granger-causing the stock prices. Similar observation is done by Acikalin et al. (2008, 14) for Turkish stock markets and GDP. And even more supporting this unidirectional causality is the study for New Zealand’s stock markets where GDP is used as a macroeconomic variable (Gan et al. 2006, 97).

Even more different are the findings from the study conducted by Zhang and Jiang (2011), where they found no long-run relationship between Shanghai stock index and industry value added, a proxy for domestic growth, nor a Granger causality between the two. These findings of Zhang and Jiang are a straight contradiction of finding from study by Liu & Shrestha (2008). Both studies have even used index from Shanghai exchange rate. Reason behind these very contradicting findings to highly similar variables is the fact that Liu & Shrestha use data from almost decade earlier than Zhang & Jiang (2011). There is a possibility, that in the different decades the fundamentals of macroeconomics and stock markets have shifted due some changes in them. These changes might have been caused by the rapid changes in the market environments in China caused by the globalization and side effects of this, such as global financial crisis.

3 METHODOLOGY AND DATA

In this chapter the theory of methods, models, and tests used in this thesis are presented with subchapter dedicated for each. First of all, the basis for the methodology is the vector autoregressive model, on which the different tests are built upon. Vector autoregressive model is chosen as it has been used for similar research in abundance in the past. For example, Ansotegui's & Esteban's (2002) base methodology of their research on VAR model as well as Wong et al. (2006) on their research. However, as most of the cointegration research rely on the Johansen's cointegration tests, VAR models need to be expanded upon. The traditional VAR models needs to be turned into vector error correction model (VECM) (Brooks 2008, 350). This means, that most of the studies considering the long-run relationships between stock indices and macroeconomic variables use this VECM variation of VAR models.

In order to be sure, that the time series that are planned to be used in our models and test are non-stationary, unit root tests are conducted to these series. Augmented Dickey-Fuller test is chosen to be used in this research as it is one of the most used test for unit roots alongside with Phillips-Perron test. For example, Perió (2016), Dritsaki (2005), and Ansotegui and Esteban (2002) have used augmented Dickey-Fuller tests in their studies to test for the stationarity in their variables. There has been, however, some criticism towards both of the augmented Dickey-Fuller and Phillips-Perron tests. Both Franses (1998, 84) and Brooks (2008, 330-331) give critique to the power of these tests. Especially with smaller sample these tests tend to have hard time deciding whether to reject the null hypothesis or not.

Combination of VECM and Johansen's cointegration tests has been used in numerous researches of similar topic. This combination has been used by Mukherjee & Naka (1995), Nasseh & Strauss (2000), and Brahmasrene & Jiranyakul (2007) just to name a few. This shows us, that there is good reasoning and great amount of previous research to back up the usage of Johansen's cointegration and VECM as our tool for analysis of these long-run relationships between macroeconomic variables and Nordic markets.

In addition of Johansen's cointegration tests, Granger causality is used in this research to study the nature of the relationships between markets and macroeconomic variables. Granger causality has been used in the past extensively in similar research considering markets and macro variables. Plíhal (2016), Gan et al. (2006), and Tripathi & Seth (2014) have used the Granger causality in tandem with Johansen's cointegration in their studies to support the long-run relationship analysis with the short-term causal relationship analysis.

3.1 Vector autoregressive models

Vector autoregressive (VAR) models were popularized by Sims (1980) in his paper, where the model is presented as a next step in time series analysis and as an extension of univariate autoregressive models to a multivariate model. VAR model can be considered as a combination of univariate time series models (such as moving average and autoregressive process) and simultaneous equations methods (Brooks 2008, 290). In a VAR model, all of the variables used are considered to be endogenous, making it more flexible to a wider array of variables. The simplest form of VAR would be a bivariate model with only two variables, and this could be presented as following (Brooks 2008, 291):

$$y_{1t} = \beta_{10} + \beta_{11} y_{1t-1} + \cdots + \beta_{1k} y_{1t-k} + \alpha_{11} y_{2t-1} + \cdots + \alpha_{1k} y_{2t-k} + u_{1t} \qquad (1)$$
$$y_{2t} = \beta_{20} + \beta_{21} y_{2t-1} + \cdots + \beta_{2k} y_{2t-k} + \alpha_{21} y_{1t-1} + \cdots + \alpha_{2k} y_{1t-k} + u_{2t} \qquad (2)$$

Where both y_{1t} and y_{2t} indicate the two variables of the model, k indicates the number of previous observations used in the model, and u_{it} is the noise disturbance term. The value of the variable is thus formulated from the previous values of the variable, the previous values of the other variable, and the noise disturbance term.

There are many advantages in using the VAR models compared to either univariate time series models or simultaneous equations models. Because of these advantages of VAR modelling, it is chosen to be used in this research as it provides the means for studying the cointegration and causality of the chosen variables. One of the perks of using VAR is the simplicity and compactness, that the models can be expressed using the model (Brooks 2008, 290-291). Another advantage is, that there is no need to specify variables either exogenous or endogenous as all the variables are automatically treated as endogenous variables (McNees 1986, 5). Other important advantage is the flexibility and at the same time, the simplicity of the models: the inclusion of lags from the other variables makes the model more flexible and captivating of features and at the same time as the equations are linear, simply ordinary least squares (OLS) can be used for each of the equations in the model (Brooks 2008, 291).

Of course, there are some drawbacks from using VAR modelling. As the models themselves are quite compact and easy to understand, the results from these equations can be the opposite. VAR models generate huge number of parameters and interpreting all of these can be a hard and time-consuming task (Brooks, 2008, 292). Some other problems with VAR models are, that they have rather restrictive statistical assumptions behind them, mostly the linearity of the equations, and the lack of theoretical information used in the construction of the model (McNees 1986, 5). However, in our case the advantages outweigh the disadvantages and thus VAR is used as the base model in this study.

3.2 Stationarity and unit root testing

As we are using VAR models as the basis of our modelling and analysis, it is important that all of the time series used in the models are stationary as OLS are used in the parameter estimation of VAR model (Lütkepohl 2005, 24-25). Brooks (2008, 318) defines stationarity simply as constancy in mean, variance, and autocovariance in a time series. This means, that in case of non-stationarity several assumptions behind OSL is broken and thus it is not BLUE anymore. For a non-stationary series, it is often characteristic that a “shock” caused by unexpected change in a variable or an error term does not die out in the system in a short time period but lingers in the system for eternity and the effect can even get stronger as time passes (Brooks 2008, 318-319). For a stationary process, it is normal that the effects of the “shock” die out quickly in the system. A good example of stationary process is a white noise process, where the values are all purely random (Lütkepohl 2005, 24).

There are two different kinds of non-stationarity: random walk model with drift (3) and trend-stationary process (4). Random walk model with drift is a stochastic non-stationarity while trend-stationarity process is deterministic. (Brooks 2008, 322)

$$y_t = \mu + y_{t-1} + u_t \tag{3}$$

In this case the value of the variable is not only determined by the previous value of the variable and the error term but also by the drift term denominated as μ.

$$y_t = \alpha + \beta t + u_t \tag{4}$$

There is, however, one slight problem we face when using financial and macroeconomic data in our VAR model: these time series tend most of the time be non-stationary as they follow trends, deterministically drift out of mean, and have long lasting shocks (Lütkepohl 2005, 237). This means that data is not often usable in our analysis as is and something has to be done with it in order to make it stationary. Most of the time non-stationarity in macroeconomic and financial data is stochastic non-stationarity, thus in this research how to deal with non-stationarity in random walk model can be dealt with efficiently. This can be done with differencing the variable. This is done by subtracting the previous value of the variable from the current variable. Using the equation (3) as example and following Brooks (2008, 322), the differencing operation would be the following:

$$y_t - y_{t-1} = \mu + u_t \tag{5}$$

$$\Delta y_t = \mu + u_t \tag{6}$$

Thus $\Delta y_t = y_t - y_{t-1}$. From this, new variable is formed, that it consists the subtraction of the previous value from the current one, thus eliminating the effect, that the trend term has in the system. These steps of differencing can also be called the unit root process and now the time series has been "differenced once" (Brooks 2008, 322). When differencing once, the time series is enough to eliminate the non-stationarity, it is said to be containing one unit root, which is often expressed as I(1). As most financial data indeed contain one unit root, it can be expected, that also in this research time series used all require to be differenced once to eliminate the non-stationarity.

In this study, two different tests for stationarity are used: Augmented Dickey-Fuller and Phillip-Perron tests. Two different tests are used in order to validate the findings and to make sure that conclusions drawn about the stationarity of the variables are robust. Both of these tests are introduced below.

3.2.1 Augmented Dickey-Fuller

To test the presence of the unit roots in time series used in this thesis, augmented Dickey-Fuller (ADF) test is used, which is presented in the formula (7). The ADF test is preferred over the ordinary Dickey-Fuller test as it assumes that the error terms of the variable follow a white noise procedure and not be autocorrelated. The null hypothesis of the test is, that it contains a unit root, which can also be expressed as $H_o: \psi = 0$ and in turn the alternative hypothesis is, that the variable is stationary, which can be expressed as $H_1: \psi < 0$.

$$\Delta y_t = \psi y_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta y_{t-1} + u_t \tag{7}$$

Where ψ is the parameter that is being tested in the ADF and the p is the number of lag terms incorporated to the test (Franses 1998, 81). The reasoning behind the usage of lags in the test is, that the lags might include the dynamic structure present in the dependent variable, although the one problem with the usage of ADF is the choice of the lag length used in the test. Two solutions for this problem is proposed by Brooks (2008, 329). Firstly, different information criterion can be calculated and used to determine the optimal lag length. Secondly, the frequency of the data can be used to determine the suitable number of lags used: for example, in this thesis monthly data is used, thus number of lags used in the test would be 12. There are few issues that comes with not optimally selected lag length. If selected lag length is too small, the errors that remain in the ADF test might be biased and if the lag length is too large, the test will not be as powerful as possible (Zivot & Wang 2006, 121).

3.2.2 Phillips-Perron

Alternative test to stationarity and unit root testing is the Phillips-Perron (PP) test. The main difference between ADF and PP tests are that in PP test, the residuals are allowed to be autocorrelated by the automatic correction procedure (Brooks 2008, 330). Unlike ADF test, in PP test, there is no lagged differences added to the equation (Kirchgässner et al. 2013, 173). The regression itself used for the test is thus a stripped-down version of the ADF test regression (Zivot & Wang 2006, 127):

$$\Delta y_t = \psi y_{t-1} + u_t \tag{8}$$

Here the null hypothesis is the same as in Augmented Dickey-Fuller, that a unit root is contained in the time series, $H_o: \psi = 0$. Alternative hypothesis is that there is no unit root present in the time series, $H_1: \psi < 0$. However, depending on the time series under testing, there might be a need to add a constant term (α) and a trend term (βt) (Ghysels & Marcellino 2018, 194). This addition of constant and trend term also applied to the ADF test. The test statistic used in PP test to calculate the t-values are quite complicated and are not presented in this examination.

There are some advantages that the PP test has over the ADF test. One is that error terms in PP are robust to the heteroscedasticity and another one is, that there is no need to define the lag length for the PP test (Zivot & Wang 2006, 127). Kočenda & Černý (2014, 72) point out, that despite these small differences, PP and ADF test are quite similar in their testing and very often give the same results.

3.3 Johansen's cointegration and vector error correction model

The long-run relationships between macroeconomic variables and stock markets have been research with variety of different methods. For example, Fama (1981) utilizes regression and cross correlation analysis in his early study. Geske and Roll (1983) use autoregressive integrated moving average (ARIMA) model in their study. Somewhat similar model, vector autoregressive moving average (VARMA), is in turn used by James et al. (1985) in their study. In essence all, these models and model used in this thesis are interested in how the different used variables move together in time.

However, there is one method of investigating long-run relationships, that has been used extensively in research concerning the relationships between macroeconomic variables and stock markets. This method is Johansen's cointegration test, which has been used in most of the research presented above in the literature review. Johansen's test for integration is based on the vector autoregressive (VAR) models created for set of variables (Brooks 2008, 350). Johansen's cointegration method is used instead of another widely used cointegration testing method, Engle-Granger method, as Johansen's method allows cointegration testing a system of equation without requiring any specific variables to be normalized (Phillips 1991, 287). Estimators provided for cointegrating vectors by Johansen's method are more efficient when compared to Engle-Granger method (Brooks 2008, 354).

There are few steps that need to be taken before a Johansen's cointegration can be applied to a model. The basis of Johansen's cointegration is, that the variables used in the model are integrated to the order of one (expressed I(1)). Testing for the presence of one unit root (I(1)) can be done with ADF and PP tests as demonstrated above. The created VAR model needs to be converted to a vector error correction model (VECM). A basic VECM for a VAR of *k* lags is the following (Brooks 2008, 350):

$$\Delta y_t = \Pi y_{t-k} + \Gamma_1 \Delta y_{t-1} + \Gamma_2 \Delta y_{t-2} + \cdots + \Gamma_{k-1} \Delta y_{t-(k-1)} + u_t \tag{9}$$

Where

$$\Pi = \left(\sum_{i=1}^{k} \beta_i\right) - I_g \tag{10}$$

and

$$\Gamma_i = \left(\sum_{j=1}^{i} \beta_j\right) - I_g \tag{11}$$

In these equations, the Γ represents the coefficient, which is also referred as *short-run impact matrices* (Zivot & Wang 2006, 456). However, the main focus of Johansen's cointegration is the Π, which is the long-run coefficient matrix. In the test, the rank of the Π is examined to determine the cointegration between the variables, ys, by the eigenvalues of the Π matrix (Franses 1998, 222). The test statistic can be formulated as follows:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{g} ln(1 - \hat{\lambda}_i) \tag{12}$$

$$\lambda_{max} = -T\, ln(1 - \hat{\lambda}_i + 1) \tag{13}$$

Where $\hat{\lambda}$ is the estimated values of the ordered eigenvalues from the Π matrix. The *r* is the number of cointegrating vectors with null hypothesis and the T is the number of observations in the time series. Null hypothesis of λ_{trace} test is that at most there exists *r* number of cointegrating vectors, with alternative hypothesis, that there is more cointegrating vectors than *r*. The null hypothesis of λ_{max} is a simple test, that there is *r* number of cointegrating vectors against the alternative hypothesis that there is *r* + 1 cointegrating vectors. (Brooks 2008, 351)

Cointegrated variables contain the same stochastic trend, which binds them together and they cannot drift apart from one another (Enders 2004, 372). If a system is found to contain a cointegrated relationship, the VECM offers a tool to specify and analyse the found cointegrating vector (Lütkepohl 2005, 287). With error correction terms, that can be retrieved from the VECM, we can examine the deviation that the system takes from the long-run equilibria and analyse the directions and speed of the changes done by the variables in order to return back to the equilibrium state (Verbeek 2017, 379).

VECM can also be utilized to examine the short-term relationship between variables. This same procedure could be done similarly using standard VAR models for the first differences of the variables but VECM used for this has its advantages over standard VAR. This is due the problem of possible misspecification when using the VAR in first differences. Using VECM for short-term relationship examination also makes sense as we are already using the VECM for long-term relationship analysis. (Mukeherjee & Naka 1995, 233-236)

3.4 Granger causality

VAR models might include a substantial number of lags and parameters depending on the model. It can be difficult to understand and see what variables are significant to others in a system of many variables. The explanatory power of variables on other variables in the system can be tested with Granger causality tests. In its essence Granger causality tests is a joint hypothesis tests that tests, does the changes in one variable cause changes in another. (Brooks 2008, 298).

Generally, the test between two variables can be presented as follows:

$$y_{1t} = \alpha_0 + \sum_{i=1}^{m} \alpha_i y_{1t-i} + \sum_{j=1}^{m} \beta_j y_{2t-j} + u_t \tag{14}$$

$$y_{2t} = \beta_0 + \sum_{j=1}^{m} \beta_j y_{2t-j} + \sum_{i=1}^{m} \alpha_i y_{1t-i} + u_t \tag{15}$$

Where y_1 and y_2 are the two variables tested for causality and αs represents the parameter estimates for the first variable and βs the parameters for the second variable. Idea is to test if the values of the variables change, while restricting the values of other to zero (Brooks 2002, 338). If the variables used in the VAR model are stationary, the test can be constructed as simple F-test where individual variables can be tested against other variables while restricting their values one at a time (Lütkepohl 2005, 44). The null hypothesis for this test would be that past values of variable does not explain the current value of other variable. For example, using formulas 13 and 14 above, this can be expressed as y_{2t} does not Granger-cause y_{1t} if and only if $\beta_j = 0$ for j = 1, 2, … m (Kirchgässner et al. 2013, 139).

In essence, Granger causality is used to test the short-term effects, that one variable has over the other and this causality is often expressed as, for example, y_1 *Granger causes* y_2 (Lütkepohl 2005, 42). The former example is known as unidirectional Granger causality, where only one set of lags of the variable causes changes in other, but it is possible that both variables cause changes in other simultaneously. This situation is known as bidirectional Granger causality. In a situation where neither of the variable Granger-cause other, it is said that the variables are independent. In a case that there is no Granger causality between the variables would mean that the value of the sum of the previous values of the other variable ($\sum_{j=1}^{m} \beta_j y_{2t-j}$ and/or $\sum_{i=1}^{m} \alpha_i y_{1t-i}$) would be zero (Franses 1998, 208). This would mean, that the lags of the other variable do not have explanatory power for the other variable. One factor that must be kept in mind when using Granger-causality in our analysis is, that while the test tells us if the current value of the variable is correlated with past values of other variable, it does not tell us if there exists real causality between the variables (Brooks 2008, 298).

3.5 Data

Data for this study will consist of variables chosen to represent each of the three selected countries, Finland, Sweden, and Norway. To represent the markets, a time series of stock indices is used. A selection of four macroeconomic variables are used for each country to represent the macroeconomic environment and changes throughout the study period. The stock indices and macroeconomic variables are chosen to be as closely comparable between the different countries as possible. This will help in drawing conclusion and comparing the findings from each of the countries. Indices chosen for each of the country all stock indices that note all of the changed stocks in each of the countries' stock exchanges respectively. Macroeconomic variables are chosen to represent a variety of different aspects of macroeconomics, both more and less globally influenced variables. These macroeconomic variables used are the consumer price index, long term interest rate, US dollar exchange rate and industrial production index. Similar variables have been used in studies all the way from early studies of Fama (1981) and Geske & Roll (1983) to the numerous studies of cointegration and causality from recent years, which are presented in the literature review of this study above. All of the used variables are presented in more detail for each country in below in different subchapters.

Natural logarithms are taken of some variables, namely market indices, consumer price indices and industrial production indices. There are several reasons on transforming these variables to the logarithmic forms. Mainly, these reasons are to make the interpretation and analysing the results easier. Brooks (2008, 608) lists three reasons, why logarithmic transformation may be useful: (1) rescaling the data with logarithms can help with problem of inconstant variances, (2) logarithms help with transforming the data closer to the normal distribution, and (3) help with making non-linear, multiplicative relationship between different variables into additive, linear, one. Transforming the variables with natural logarithms also scales the data in a way, that extreme observations are not as strong in the system as before, thus also helping with the possibility of heteroscedasticity (Brooks 2008, 138). Logarithmic transformation is not done on interest rate and exchange rate macroeconomic variables as interest rates are already in percentage from and exchange rates in some cases have a value that would make the logarithmic values to be negative.

All of the data used in this study is in monthly time series and the time period that is used in this research is from July of 2000 to July of 2018. This means, that the data will include total of 217 months for each variable for each country. The amount of data points for each country is thus 1085 and total of 3255 data points for all of the three countries combined. This time period has been chosen for this study to include recent data from all of the countries and to include several economic ups and downs from the past years (mainly the IT bubble of the early 2000’s, the financial crisis of 2008 and the subsequent euro crisis). All the data for the variables is retrieved from Thomson Reuters’ DataStream database. In the Table 1 below, summary and short definitions for the variables are given.

Table 1 Summary and definitions of Variables used

Finland	Definition
OMX_HEL	Natural logarithm of OMX Helsinki All-Share Index (OMXHPI)
CPI_FIN	Natural logarithm of Consumer Price Index for Finland
INT_FIN	Yield of ten-year maturity bond, Government of Finland
EX_FIN	Euro to US Dollar (EUR/USD) exchange rate
IP_FIN	Total Industrial Production Index, Finland
Sweden	Definition
OMX_STO	Natural logarithm of OMX Stockholm All-Share Index (OMXSPI)
CPI_SWE	Natural logarithm of Consumer Price Index for Finland
INT_SWE	Yield of ten-year maturity bond, Government of Sweden
EX_SWE	Swedish Krone to US Dollar (SEK/USD) exchange rate
IP_SWE	Manufacturing Industrial Production Index, Sweden
Norway	Definition
OSE_ALL	Natural logarithm of Oslo Bors All-Share Index (OSEAX)
CPI_NOR	Natural logarithm of Consumer Price Index for Finland
INT_NOR	Yield of ten-year maturity benchmark bond, Government of Norway
EX_NOR	Norwegian Krone to US Dollar (NOK/USD) exchange rate
IP_NOR	Manufacturing Industrial Production Index, Norway

3.5.1 Data for Finland

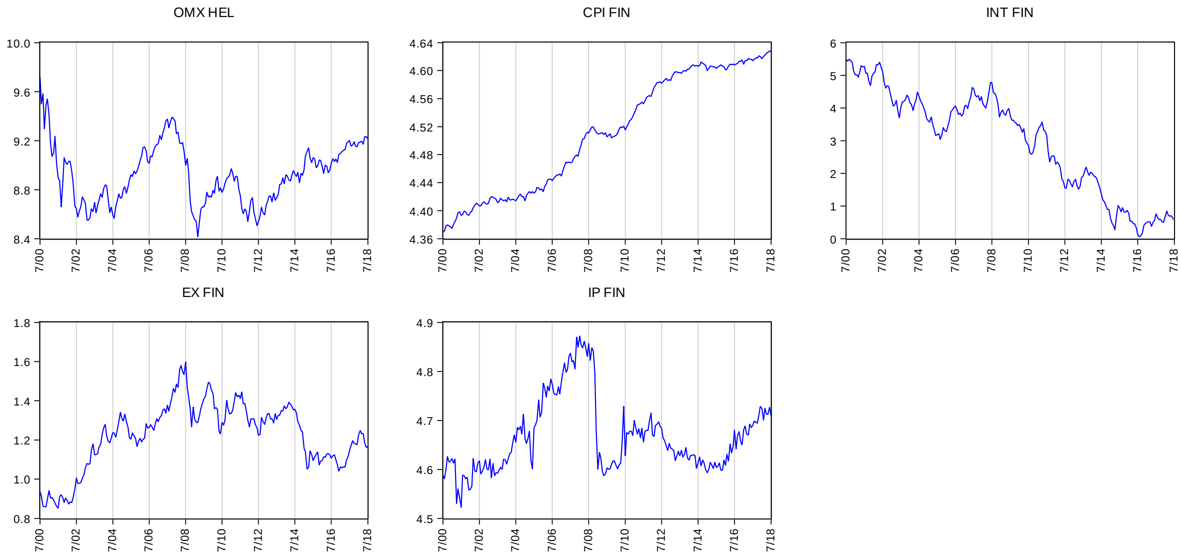

Figure 1 Time series plots of variables used for Finland

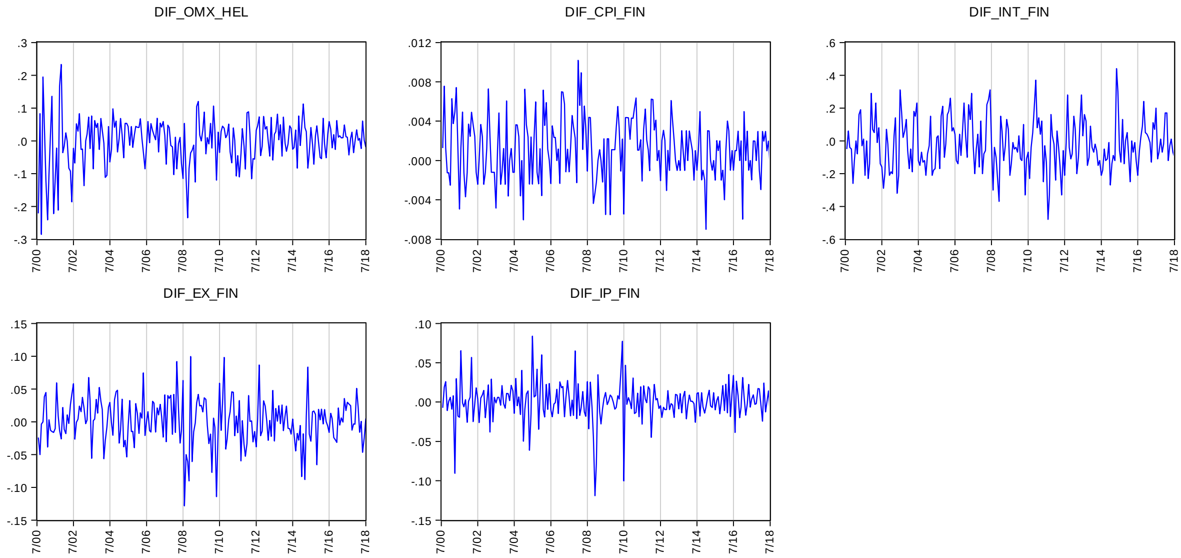

Figure 2 Time series plots for differenced variables for Finland

Index selected to reflect the market changes in Finland is the OMX Helsinki All-Share index (OMXHPI). This index includes all the stocks exchanged in the Helsinki Stock Exchange and is aimed to reflect the changes and movements of the markets as a whole (NASDAQ). Before the log-transformation, the average value for the index between July 2000 and July 2018 is 7730,31 points and the values range from the minimum of 4516,59 to 16676,69 points. The maximum value is the first data point in the time series, July 2000, in the height of IT bubble of early 2000's. After the bubble bursting in the second half of 2000, the stock index took a sharp decline and started a substantial clime in the end of 2004. Another high point is achieved in the October of 2007, with achieving a value of 12002,97 points, after which the markets started declining rapidly due the international finance crisis. The index reaches its lowest point in the March of 2009, one and half years after the finance crisis started, bottoming at value of 4516,59 points. After declining to the lowest value, the index has been climbing steadily, with only minor downturns, reaching value of 10034,54 points at the end of time series in the July of 2018. However, in this study the index is log-transformed for the reasons stated above. From this point forward OMX_HEL is used to stand for this log-transformed variable. The time series of log-transformed OMX_HEL is plotted in the Figure 1 and the descriptive statistics presented in the Table 1.

Consumer price index is used, as one of the macroeconomic variables, to depict the consumer price level during the study period and the inflation rate, when the index is differenced. The consumer price index (CPI) is an indexed value, where the value of 2015 is indexed to 100. At the start of the time series the value of the CPI is 79,00 points. The index grows steadily throughout the whole series, only having a slight downturn in the second half of the 2008, also due the global finance crisis. The highest value is achieved in the end of the examination period, in July of 2018, with value of 102,30 points. This means that the consumer price index has increased a total of 23,30 points during the 217-month period. Log-transformed values of CPI are used in this study. These log-transformed values are denominated by CPI_FIN in this study. In Figure 1 and Table 1 are represented the time series plot as well as the descriptive statistic of the variable respectively.

The long-term interest rate macroeconomic variable for Finland is represented by the monthly average yield of Government of Finland’s 10-year maturity bond. The yield has been its highest in the September 2000, with yield of 5,49 percent, during the study period and the lowest yield has been in the August 2016, with the yield being only 0,06 percent. There has been a clear decline in the yield of the bond during the whole series, only with slight growth period between the start of 2006 and middle of 2008. On average the yield has been 2,97 percent between the July 2000 and July 2018. In this study the yield is denominated by INT_FIN and the plot and descriptive statistic are presented in the Figure 1 and Table 1.

Third macroeconomic variable for Finland is the Euro to United States dollar exchange rate (EUR/USD). During the examination period euro has been on weakest in July of 2001, with the exchange rate being 0,85. From the early 2000s the euro has appreciated to US dollar quite rapidly until the July 2008, when the exchange rate reached its highest value of 1,60. After this there has been a general trend of depreciation, with some short periods of moderate appreciation. At the end of the period the exchange rate was 1,17.

As a proxy for real activities in the economy, macroeconomic variable of industrial production is used. The index used is the total industrial production index, with 2015 value indexed to 100. Included in the total industrial production is the total output produced by the different industry sectors, such as manufacturing, mining and electricity. During the study period, the industrial production in Finland has had drastic ups and downs. From the start of the millennia, the industrial production has increased drastically. However, this growth came to a screeching halt when the crisis of the 2008 hit. From the highest industrial production value in the summer 2008 the production had decreased by around 25 percent during the autumn of the same year, which can be seen in the Figure 1. There on production has been on low levels with very minimal growth during the last ten years period. The total growth of the past ten years has been shadowed by the periods of declining production also in the 2012-2014 period. Overall, the industrial production has been struggling and has not yet even reached the total volume of early 2008. For same reason as mentioned previously, the industrial production index in log-transformed and this transformed value is denominated by IP_FIN in this study.

Table 2 Descriptive statistics for Finland

	OMX_HEL	CPI_FIN	INT_FIN	EX_FIN	IP_FIN
Mean	8.922547	4.510405	2.967650	1.221617	4.666462
Median	8.916222	4.510860	3.410000	1.247950	4.648230
Maximum	9.721767	4.627910	5.490000	1.597150	4.872139
Minimum	8.415513	4.369448	0.060000	0.851700	4.522875
Std. Dev.	0.243169	0.083905	1.588958	0.167397	0.075439
Skewness	0.404319	-0.077203	-0.323044	-0.445308	0.985790
Kurtosis	2.771931	1.456090	1.797303	2.676473	3.344364
Jarque-Bera	6.382600	21.76781	16.85284	8.118195	36.21830
Probability	0.041118	0.000019	0.000219	0.017265	0.000000
Sum	1936.193	978.7579	643.9800	265.0909	1012.622
Sum Sq. Dev.	12.77233	1.520654	545.3543	6.052687	1.229274
Observations	217	217	217	217	217

3.5.2 Data for Sweden

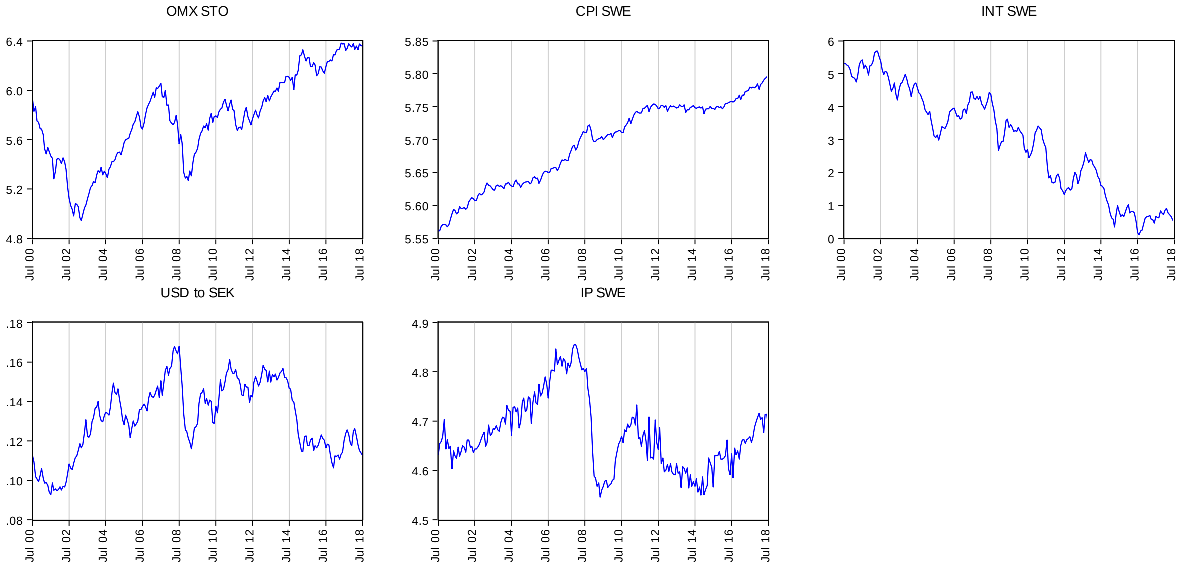

Figure 3 Time series plots of variables used for Sweden

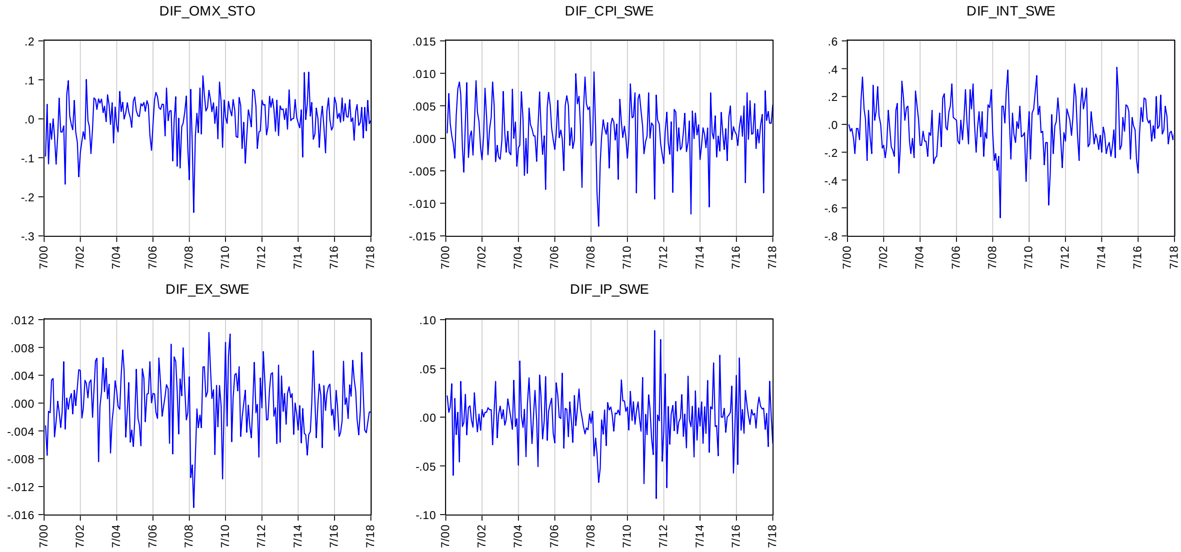

Figure 4 Time series plots for differenced variables used for Sweden

In the same fashion as for Finland, the all share index for Stockholm’s stock exchange is used in this study. The OMX Stockholm All-Share Index (OMXSPI) includes all the shares listed in the exchange, as the name suggests. This index reflects overall best Swedish markets and thus is chosen to be used in this study as it best suits our needs. The first half of the study period is very similar to Finland’s all share index: decline after the IT bubble, strong growth until the rapid decline due the financial crisis in the 2007. From the height of 426,09 points in the July of 2007, the stock markets dove to the value of 193,57 points in the January of

2009. This is a very small dive when comparing to Finnish stock markets. From this bottom the markets have recovered with quite a good pace, surpassing the previous top of July 2007 in the January 2014. The highest value of the index is just before the end of the examination period, in the May of 2015 with value of 586,78 points. The index is log-transformed in this study and the transformed variable is from now on nominated as OMX_STO. The plot of the time series can be seen in the Figures 2 and the descriptive statistic in Table 2.

Consumer price index macroeconomic variable in Sweden’s case is an index with values from 1980 indexed to 100. At the start of the examination period the index is at value of 260 points and at the end 330,33 points. This means that the index has increased just over 70 points during the 217-month period. During this period, the CPI has increased steadily in Sweden with only minor downward movement during autumn of 2008, which is very similar what happened in Finland during the same period. CPI variable used in this study is log-transformed from the original indexed values, which is represented by CPI_SWE.

The yield from government bonds with ten-year maturity is used as long-term interest rate for Sweden in same fashion as corresponding yield rate is used for Finland. The overall trend for the interest rate has been a downward one for the whole period. The yield reached its maximum value of 5,69 percent in the April and May of 2002. From there on the yield has diminished to the value of 0,6 percent at the end of the examination period. However, the minimum for the yield was August of 2016, with being only 0,1 percent. With the overall downward trend, there has been few periods of increase, mainly in 2005-2007 and in 2015. The interest rate is not a transformed value and is represented by INT_SWE. The plot can be found in Figures 2 and descriptive statistics in Table 2.

The exchange rate between Swedish krone and US dollar (SEK/USD) has had distinguishable upward and downward periods during the 18 year period. At the early 2000s, the SEK was relatively weak when compared to the situation after few years. At its weakest, in July of 2001, one koruna was only 0,097 US dollars. Seven years later, at its highest point, the koruna was 0,168 US dollars. This means that the exchange rate had a substantial increase of over 70 percent. After this there was, however, a rapid decline in the exchange rate. The decline did not last long, and there was a period of strong SEK until the depreciation in 2014. From there on the exchange has been relatively weak, with the ending exchange rate in July 2018 being 0,11. The exchange rate is the other macroeconomic variable that is not log-transformed and is nominated by EX_SWE in this study.

The fourth macroeconomic variable used for Sweden differs slightly when compared to Finland. For Sweden, as a proxy for real economic activity, manufacturing industrial production index is used. This index only includes the industrial production only from the manufacturing sector of Sweden. This production index follows closely that of Finland's industrial production index: early 2000s were period of strong growth brought to abrupt stop by the finance crisis in the 2008. In just over a year the manufacturing industrial production decreased by almost 27 percent from the January 2008's value of 128,4 to May 2009's bottom value of 94,2 points. After this there was a period of rapid growth followed by another period of decreasing industrial production. For the last two years, the industrial production has shown signs of recovery and the examination period ended with value of 109,2 points. Variable IP_SWE used in this study is the log-transformed version of the manufacturing industrial production index, of which descriptive statistics can be found in the Table 2 and the graph depicting the development from the Figures 2.

Table 3 Descriptive statistics for Sweden

	OMX_STO	CPI_SWE	INT_SWE	EX_SWE	IP_SWE
Mean	5.772714	5.693945	2.970599	0.131375	4.672298
Median	5.786836	5.709068	3.250000	0.132737	4.661551
Maximum	6.382070	5.800092	5.690000	0.167943	4.855150
Minimum	4.942142	5.560682	0.100000	0.092687	4.545420
Std. Dev.	0.365239	0.063291	1.594268	0.018450	0.074619
Skewness	-0.208552	-0.358212	-0.164585	-0.223406	0.589097
Kurtosis	2.288162	1.826974	1.761294	2.140551	2.686648
Jarque-Bera	6.154564	17.08200	14.85315	8.483749	13.43891
Probability	0.046084	0.000195	0.000595	0.014381	0.001207
Sum	1252.679	1235.586	644.6200	28.50831	1013.889
Sum Sq. Dev.	28.81428	0.865246	549.0054	0.073523	1.202683
Observations	217	217	217	217	217

3.5.3 Data for Norway

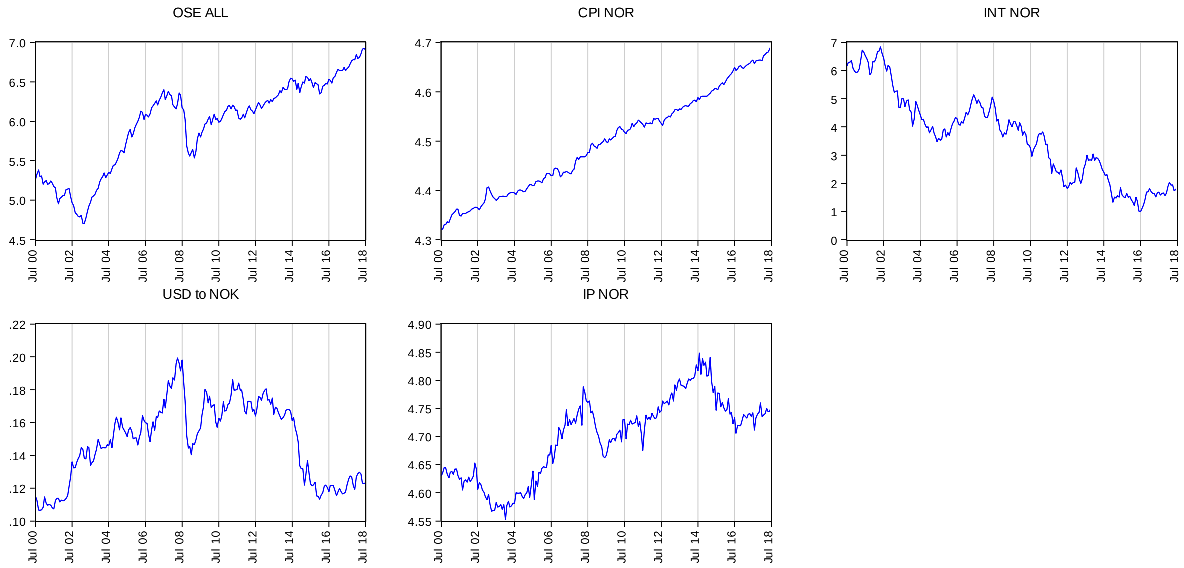

Figure 5 Time series plots of variables used for Norway

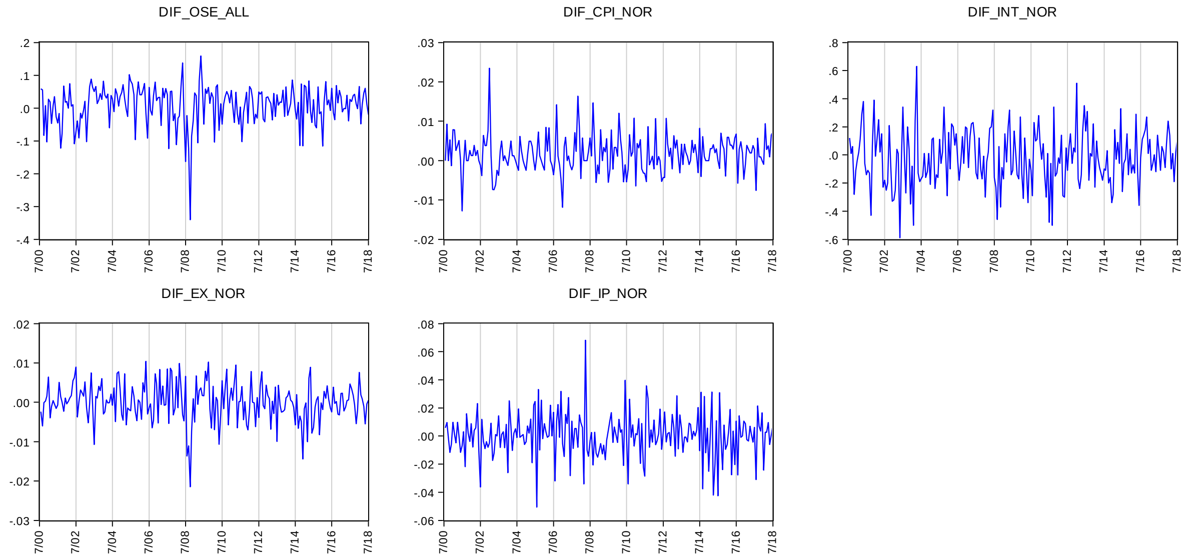

Figure 6 Time series plots for differenced variables used for Norway

To represent the markets of Norway, Oslo Bors All-Share Index (OSEAX) is chosen. This is the index that includes all the stock exchanged in the Oslo Stock Exchange, which means that it is best suited to this study when markets development and movements are concerned. Norway's stock market has developed similarly during the study period compared to Finland and Sweden, with expectation that the movement and changes are relatively mild. The period of strong, starting from value of 110,53 points in February 2003, growth until the mid-2007, when the markets achieved value of 601,48, is followed by decline till March 2009. The comparably slight and short-lived decline was quickly replaced by a period of stable growth continuing until the end of the study period, topping at the value of 1018,32 points in June 2018. The All-share index is log-transformed, as are the previously presented market indices. OSE_ALL represents this log-transformed variant of the variable, of which descriptive statistics can be found in Table 3 and plot in Figures 3.

From the Figures 3, it can be seen, that consumer price index for Norway has had a stable growth for the whole study period. The consumer price is an indexed value, where the value for 2015 is set to 100. When compared to Sweden and Finland, the index had much lower decrease in the crisis of the 2008 and overall the development has been more stable. The lowest value for the index is the starting point of the period with value of 75,3 points and the peak value is the end point of the period, 109,3 points. This means, that the consumer prices have increased total of 34 points throughout the whole 217-month period. Relatively, when compared to Sweden and Finland, Norway’s CPI has increased much more, where Sweden’s and Finland’s CPI development is much closer together. As with other CPI variables, Norway’s variable (CPI_NOR) is log-transformed, before used in this study’s tests and models.

Similar differences can also be seen in the interest rate macroeconomic variable for Norway (nominated as INT_NOR): while the interest rate has been decreasing for the whole period, the rate has never dropped as low as Finland’s or Sweden’s interest rates. Government benchmark bond with ten-year maturity is used as the proxy for long term interest rate in similar fashion as for the two other countries. The highest the interest rate has been during the study period is about two years into the examination, in May of 2002 being 6,84 percent, and lowest in the July of 2016 with 0,99 percent.

The exchange rate between Norwegian krone (NOK) and US dollar (NOK/USD) follows the same patterns as Swedish krone’s and euro’s exchange rates. The NOK was relatively weak against the US dollar in the start of the study period, with its weakest exchange rate in the October 2000 when the exchange rate was one krone to 0,1065 USD. From there on, the NOK appreciated rapidly until the first half of 2008, when the NOK had appreciated to 0,1993 by the May of 2008, almost doubling in eight years. After the sudden drop in the last half of 2008, the NOK appreciated again for some time until again depreciating in the second half of 2014. After this the exchange rate has stayed at relatively low level. The exchange rate is nominated by EX_NOR in this study.

The final macroeconomic variable for Norway is the manufacturing industrial production index. This is similar index as used for Sweden, where the index includes only the industrial production from the manufacturing sector of Norway. The index is indexed to value of 100 in the year 2005. The industrial production in Norway developed leading to 2008 crisis rapidly and after the crisis production levels recovered much faster than Finland's and Sweden's industrial productions, which have not even to this day surpassed the production levels of the highs achieved before the crisis. Norway achieved the same level of manufacturing production as the pre-crisis in the first half of 2013. From this the industrial production kept growing until the smaller decrease in the production in the latter half of 2014.

Table 4 Descriptive statistics for Norway

	OSE_ALL	CPI_NOR	INT_NOR	EX_NOR	IP_NOR
Mean	5.960428	4.496370	3.616774	0.148512	4.699006
Median	6.123654	4.498698	3.770000	0.151469	4.719391
Maximum	6.925909	4.694096	6.840000	0.199334	4.848116
Minimum	4.705287	4.321480	0.990000	0.106500	4.552824
Std. Dev.	0.563558	0.101035	1.567444	0.023888	0.071965
Skewness	-0.551003	0.130301	0.218388	-0.109431	-0.213143
Kurtosis	2.231871	1.856777	2.064588	1.890738	2.024233
Jarque-Bera	16.31513	12.43113	9.636337	11.55853	10.25181
Probability	0.000287	0.001998	0.008082	0.003091	0.005941
Sum	1293.413	975.7122	784.8400	32.22710	1019.684
Sum Sq. Dev.	68.60099	2.204936	530.6865	0.123253	1.118652
Observations	217	217	217	217	217

4 RESULTS

4.1 Augmented Dickey-Fuller and Phillips-Perron

In this chapter the results from the two different unit root tests, Augmented Dickey-Fuller and Phillips-Perron, are presented for all the countries and all the variables. In ADF and PP tests, the number of lags is automatically chosen by the Eviews program and the lag length is decided by Akaike Information Criterion (AIC). Lag length for all of the ADF tests can be anything ranging from 0 to 14 time periods (time period interval recommended by Eviews). As mentioned earlier, we can expect all the variables for each country to contain a unit root and to be I(1).

Table 5 On level ADF and PP test results for Finland.

Intermediate ADF test results FINLAND

Series	Prob.	Lag	Max Lag	Obs
OMX_HEL	0.0584	1	14	215
CPI_FIN	0.8691	14	14	202
INT_FIN	0.7791	2	14	214
EX_FIN	0.2859	0	14	216
IP_FIN	0.3402	2	14	214

Intermediate Phillips-Perron test results FINLAND

Series	Prob.	Bandwidth	Obs
OMX_HEL	0.0116	4.0	216
CPI_FIN	0.7317	7.0	216
INT_FIN	0.7921	3.0	216
EX_FIN	0.2564	4.0	216
IP_FIN	0.1773	4.0	216

In the table 5 the unit root test results for Finland are presented. As we can see, the results from tests are mostly aligned with the expectation that financial time series data contains one unit root and integrated to the order of one (I(1)). Looking the results, we can confidently conclude that for all of the macroeconomic variables, the null hypothesis of unit root presence is accepted. The null hypothesis is confirmed very strongly for the CPI_FIN and INT_FIN by the both tests. Both tests also support the acceptance of null hypothesis for EX_FIN and IP_FIN macroeconomic variables but not with same strength as for the other two macroeconomic variables.

However, quite unexpectedly, test give slightly different probabilities to accepting the null hypothesis for the market variable, OMX_HEL. This small difference with given p-values for the variable is critical, as with the value given by the PP test, the test would reject the null hypothesis (not contain unit root) with 5% significance level. The ADF test accepts the null hypothesis with 5% significance but barely, with overall more forgiving probabilities. As we cannot with strongest certainty to conclude that the OMX_HEL does not contain unit root, the null hypothesis of unit root presence is accepted for the variable. Time and time again unit root presence is observed for similar variables in similar markets and conditions in literature. Unit root presence is also much clearer for the other market variables used in this study. With the results of ADF and PP tests in the first differences conclude us clearly that null hypothesis of unit root presence can be reject with high confidence. The lack of unit roots in the differenced variables confirm us that the variables are integrated only to order of one, I(1), and not to a higher order, such as I(2).

Table 6 First differences ADF and PP test results for Finland.

Intermediate ADF test results DIF_FINLAND

Series	Prob.	Lag	Max Lag	Obs
DIF_OMX_HEL	0.0000	0	14	215
DIF_CPI_FIN	0.0130	14	14	201
DIF_INT_FIN	0.0000	1	14	214
DIF_EX_FIN	0.0000	0	14	215
DIF_IP_FIN	0.0000	1	14	214

Intermediate Phillips-Perron test results DIF_FINLAND

Series	Prob.	Bandwidth	Obs
DIF_OMX_HEL	0.0000	3.0	215
DIF_CPI_FIN	0.0000	9.0	215
DIF_INT_FIN	0.0000	1.0	215
DIF_EX_FIN	0.0000	3.0	215
DIF_IP_FIN	0.0000	3.0	215

From the table 7, we can see that, on level, unit root presence is much clearer all around when compared to Finland’s ADF and PP test results. Contrary to Finland, there is found to be unit root in Sweden’s market index. OMX_STO, with great probability (over 0,88 with ADF and almost 0,80 with PP). Weakest probabilities are given to IP_SWE and EX_SWE from both tests. However, both of these variables have probabilities with which the null hypothesis is accepted with 5% significance level. Here the same difference between the two tests can be seen as with test results for Finland: PP test results are usually stricter than ADF test results. The unit root presence can also be accepted for both variables CPI_SWE and INT_SWE with relatively high confidence from both tests. With these given test results, we can conclude, that the null hypothesis is accepted for all of the tested variables for Sweden, and thus unit root is present in all variables.

From ADF and PP test tabulated for the first differences of variables for Sweden, we can very confidently conclude that these variables are not integrated to a higher degree than one. Table 8 clearly and strongly indicate, that the null hypothesis of unit root presence can be rejected in favour of the alternative hypothesis of no unit root presence in any of the variables.

Table 7 On level ADF and PP test results for Sweden.

Intermediate ADF test results SWEDEN

Series	Prob.	Lag	Max Lag	Obs
OMX_STO	0.8824	0	14	216
CPI_SWE	0.8843	14	14	202
INT_SWE	0.7425	1	14	215
EX_SWE	0.3194	9	14	207
IP_SWE	0.2078	5	14	211

Intermediate Phillips-Perron test results SWEDEN

Series	Prob.	Bandwidth	Obs
OMX_STO	0.7978	6.0	216
CPI_SWE	0.3271	88.0	216
INT_SWE	0.7828	3.0	216
EX_SWE	0.2890	6.0	216
IP_SWE	0.1390	8.0	216

Table 8 First differences ADF and PP test results for Sweden.

Intermediate ADF test results DIF SWEDEN

Series	Prob.	Lag	Max Lag	Obs
DIF_OMX_STO	0.0000	0	14	215
DIF_CPI_SWE	0.0193	13	14	202
DIF_INT_SWE	0.0000	3	14	212
DIF_EX_SWE	0.0000	8	14	207
DIF_IP_SWE	0.0000	3	14	212

Intermediate Phillips-Perron test results DIF SWEDEN

Series	Prob.	Bandwidth	Obs
DIF_OMX_STO	0.0000	5.0	215
DIF_CPI_SWE	0.0000	70.0	215
DIF_INT_SWE	0.0000	1.0	215
DIF_EX_SWE	0.0000	5.0	215
DIF_IP_SWE	0.0000	7.0	215

ADF and PP tests for Norway's variables can be found in the table 9. Compared to Finland's and Sweden's test results, the results for Norway have the highest probabilities of null hypothesis acceptance. In general, the strength of probabilities for the variables is significant at 5% level, but the highest probabilities from both tests are given to CPI_NOR variable. Coming close in the probabilities is the OSE_ALL variable. While the weakest probabilities are given for the EX_NOR, the probabilities are still relatively strong. After assurance, that all the variables are I(1), we can examine the ADF and PP test results for first differences of variables for Norway.

From table 10 we can see the test for differenced variables of Norway. From this we can see the same that we have already concluded for the variables differenced for the other two countries: with high confidence we can reject the null hypothesis of unit root presence for all of the variables.

Table 9 On level ADF and PP test results for Norway.

Intermediate ADF test results NORWAY

Series	Prob.	Lag	Max Lag	Obs
OSE_ALL	0.8881	1	14	215
CPI_NOR	0.9980	13	14	203
INT_NOR	0.6232	0	14	216
EX_NOR	0.3642	1	14	215
IP_NOR	0.7627	2	14	214

Intermediate Phillips-Perron test results NORWAY

Series	Prob.	Bandwidth	Obs
OSE_ALL	0.8765	4.0	216
CPI_NOR	0.9948	23.0	216
INT_NOR	0.6108	1.0	216
EX_NOR	0.3790	4.0	216
IP_NOR	0.6472	4.0	216

Table 10 First differences ADF and PP test results for Norway.

Intermediate ADF test results DIF_NORWAY

Series	Prob.	Lag	Max Lag	Obs
DIF_OSE_ALL	0.0000	0	14	215
DIF_CPI_NOR	0.0004	12	14	203
DIF_INT_NOR	0.0000	0	14	215
DIF_EX_NOR	0.0000	0	14	215
DIF_IP_NOR	0.0000	1	14	214

Intermediate Phillips-Perron test results DIF_NORWAY

Series	Prob.	Bandwidth	Obs
DIF_OSE_ALL	0.0000	2.0	215
DIF_CPI_NOR	0.0000	25.0	215
DIF_INT_NOR	0.0000	3.0	215
DIF_EX_NOR	0.0000	2.0	215
DIF_IP_NOR	0.0000	2.0	215

4.2 Lag length selection

Before we can analyse and discuss the results from cointegration and causality tests, the optimal lag length must be found for the models for each country. Choosing the optimal lag length is important as the choice will be a trade-off between the goodness-of-fit and the number of parameters used in the models (Verbeek 2017, 319). Eview's offers a lag order selection criteria tool, which lists the optimal lag length for the chosen variables with five different selection criteria: (1) sequential modified LR test statistic (LR), (2) Final prediction error (FPE), (3) Akaike Information criterion (AIC), (4) Schwarz Information criterion (SC), and (5) Hannan-Quinn Information criterion (HQ). The general idea is to choose the model which minimizes the criterion for that individual criteria (Zivot & Wang 2006, 390).

There are strength and weaknesses for each of the different criterions. For example, SC and HQ are considered to be more consistent with their lag selection than the other criterions but this does not outright mean that others are not as good (Lütkepohl 2005, 150-151). Generally, FPE and AIC are recommended for models with smaller sample sizes while SC and HQ are preferred in larger sample sizes (Zahid & Asghar 2007; Liew 2004). However, Ivanov & Kilian (2005) conclude from their comparison of different lag length criteria for VAR models, that AIC yields the best optimal length suggestion, when data used is in monthly frequency as it is in this study. Findings from Gonzalo's & Pitarakis' (2002, 419) study of different information criteria also gives us assurance, that fear of overestimation by AIC is not relevant, especially in systems with large dimensions.

Hendry & Juselius (2001, 6-7) argue that choosing slightly longer lag length might be advantageous for VAR models used for cointegration testing, as increasing the lag length might help with the possible autocorrelation in the residuals of the variables. This would mean that possible overestimation of lag length by AIC and/or SC might not be as harmful as in other cases. Also, notable factor is the how commonly in use are the different criteria. By far the most widely used information criteria in studies of market and macroeconomic relationships using cointegration and causality tests is the AIC, which is used, for example, by Maysami et al. (2004), Dritsaki (2005), Sawhney et al. (2006), and Plíhal (2016). According all of these above-mentioned factors, the suggestion strength of AIC comes more and more relevant when considering the nature of systems applied in this study.

Another suggestion to take into account when comparing the different lag length criteria, is to use the LR's suggestion as guidance for the final selection of the lag length used as it has been noted to help to pick the optimal lag length when used in combination of other criteria (Hatemi-J & Hacker 2009, 1125). There are unfortunately some issues with using LR criteria for financial data, such as it has assumption that error terms from each equation are normally distributed (Brooks 2008, 294). This is the reason why in this study the role of LR criteria is left to be only somewhat loosely guidance giving while the main focus is on the other four information criteria.

Table 11 Lag order selection for Finland

VAR Lag Order Selection Criteria
Endogenous variables: OMX_HEL CPI_FIN INT_FIN EX_FIN IP_FIN
Exogenous variables: C
Date: 13/12/18 Time: 17:00
Sample: 2000M07 2018M07
Included observations: 205

Lag	LogL	LR	FPE	AIC	SC	HQ
0	511.4821	NA	4.92e-09	-4.941289	-4.860240	-4.908507
1	2184.234	3247.586	5.13e-16	-21.01691	-20.53062*	-20.82022*
2	2210.982	50.62615*	5.05e-16*	-21.03397*	-20.14243	-20.67336
3	2227.770	30.95582	5.47e-16	-20.95386	-19.65707	-20.42934
4	2243.553	28.33251	6.00e-16	-20.86393	-19.16190	-20.17550
5	2255.836	21.45027	6.81e-16	-20.73987	-18.63259	-19.88752
6	2265.707	16.75538	7.94e-16	-20.59226	-18.07974	-19.57600
7	2286.382	34.08851	8.33e-16	-20.55006	-17.63230	-19.36990
8	2302.310	25.48495	9.19e-16	-20.46156	-17.13855	-19.11748
9	2325.230	35.55416	9.48e-16	-20.44127	-16.71301	-18.93328
10	2340.422	22.82559	1.06e-15	-20.34558	-16.21208	-18.67368
11	2363.009	32.83421	1.10e-15	-20.32204	-15.78330	-18.48623
12	2386.850	33.49262	1.14e-15	-20.31073	-15.36674	-18.31100

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

In the table 11, the optimal lag chosen per the different criterions are listed for Finland. The maximum amount of lags allowed for the testing is 12 (also for Sweden and Norway) as the data is monthly. Thus, the amount of maximum lags allowed can be up to a year. From the table we can see that all of the different criterion gives rather similar results for the optimal lag amount. LR, FPE, and AIC suggest using two lags while SC and AIC suggest using only one lag. These results are consistent with the conclusions of Zivot & Wang (2006, 390) and Lütkepohl (2005, 150) that AIC and FPE might give higher optimal lag length as they tend to overestimate the optimal VAR order. However, lag of two periods could be considered an optimal length for this system, but upon building the cointegrating equation and VECM with two lags we can observe, that there exists notable autocorrelation in the residual of the model when using two lags (see appendix 2). Thus, the lag length is increased to three periods to eliminate this autocorrelation effect from the residuals of the model. This is done due the suggestions of Hendry & Juselius (2001) mentioned above, notes of LR guidance by Hatemi-J & Hacker (2009) and as data in this study is in monthly format.

Table 12 Lag order selection for Sweden

VAR Lag Order Selection Criteria
Endogenous variables: OMX_STO CPI_SWE INT_SWE EX_SWE IP_SWE
Exogenous variables: C
Date: 13/12/18 Time: 17:40
Sample: 2000M07 2018M07
Included observations: 205

Lag	LogL	LR	FPE	AIC	SC	HQ
0	992.2993	NA	4.51e-11	-9.632189	-9.551140	-9.599406
1	2563.311	3050.062	1.27e-17	-24.71523	-24.22894*	-24.51854
2	2605.596	80.03187	1.07e-17*	-24.88387*	-23.99233	-24.52326*
3	2623.833	33.62693	1.15e-17	-24.81788	-23.52110	-24.29337
4	2645.789	39.41388	1.19e-17	-24.78819	-23.08616	-24.09976
5	2678.724	57.51499	1.10e-17	-24.86560	-22.75832	-24.01326
6	2688.583	16.73683	1.28e-17	-24.71788	-22.20536	-23.70163
7	2708.806	33.34315	1.35e-17	-24.67128	-21.75351	-23.49111
8	2733.892	40.13796	1.36e-17	-24.67212	-21.34911	-23.32804
9	2761.625	43.01914	1.34e-17	-24.69878	-20.97052	-23.19079
10	2778.564	25.45063	1.47e-17	-24.62014	-20.48664	-22.94824
11	2797.315	27.25759	1.59e-17	-24.55917	-20.02043	-22.72336
12	2825.967	40.25264*	1.57e-17	-24.59480	-19.65081	-22.59508

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

The criteria in Sweden's case give us suggestions closely resembling the suggestions given to Finland. Here again, the SC and HQ criteria find using only one lag the optimal length while the other test opt out for using longer lags. However, this time, while AIC and FPE suggest using two lags, the LR comes to a greatly different result. The LR criteria suggest using lag of 12 months. From these suggestions lag length used in this study for Sweden, first using two lags is implemented, but from the autocorrelation tests for the residuals of the VECM, we can see that there is autocorrelation. After testing and finding autocorrelation, when using three lags, using four lags in the system is settled for as then the autocorrelation is not a problem in the VECM (see appendix 3). Reasoning behind this comes strongly from the notes, conclusions and suggestions mentioned above: for example, the strength of AIC with monthly data (Ivanov & Kilian 2005) and opting for longer lag length per the comments of Hendry & Juselius (2001). The very long lag length suggested by LR also gives us reason to apply longer lag length to Sweden's model than the use of only one lag per the SC and HQ and the elimination of autocorrelation from the residuals of the VECM.

Table 13 Lag order selection for Norway

VAR Lag Order Selection Criteria
Endogenous variables: OSE_ALL CPI_NOR INT_NOR EX_NOR IP_NOR
Exogenous variables: C
Date: 13/12/18 Time: 18:04
Sample: 2000M07 2018M07
Included observations: 205

Lag	LogL	LR	FPE	AIC	SC	HQ
0	871.4496	NA	1.47e-10	-8.453167	-8.372118	-8.420384
1	2540.471	3240.343	1.59e-17	-24.49240	-24.00610*	-24.29570*
2	2580.452	75.67202	1.37e-17*	-24.63856*	-23.74702	-24.27795
3	2595.185	27.16661	1.52e-17	-24.53839	-23.24161	-24.01387
4	2605.215	18.00398	1.76e-17	-24.39234	-22.69031	-23.70391
5	2624.813	34.22619	1.86e-17	-24.33964	-22.23237	-23.48730
6	2639.745	25.34715	2.06e-17	-24.24141	-21.72889	-23.22516
7	2662.630	37.73195	2.12e-17	-24.22078	-21.30301	-23.04061
8	2677.118	23.18138	2.37e-17	-24.11822	-20.79521	-22.77415
9	2702.115	38.77658*	2.40e-17	-24.11820	-20.38994	-22.61021
10	2720.011	26.88734	2.61e-17	-24.04889	-19.91539	-22.37699
11	2731.696	16.98499	3.02e-17	-23.91898	-19.38024	-22.08317
12	2750.921	27.00976	3.27e-17	-23.86265	-18.91866	-21.86292

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

From table 13, we can see the different lag length criteria for Norway. These suggestions follow closely the example set by the criteria for Finland and especially closely the suggestions for Sweden. As with Finland and Sweden, tests for autocorrelation in the residual of VECM with two lags are conducted (appendix 4). This time, however, there does not seem to be similar problem with autocorrelation as with the two previous systems. This means that using two lags for Norway's model is sufficient.

4.3 Johansen's cointegration results

Johansen's cointegration test is applied in this study for all of the three countries under study. From these tests we can conclude, if there exists cointegrating relationships between the variables for each of the countries. Johansen's cointegration test is chosen to be used in this study per the reasons presented in the earlier methodology chapter. All of the tests are built using the number of lags as reasoned above with the different lag length criteria for each country: three for Finland, four for Sweden and two for Norway. As many of the studies examined in the literature review of this study conclude, that set of macroeconomic variables and stock market indices include a cointegrating relationship, it is hypothesized that a cointegrating relationship is also found to exist for all of the three countries examined below. Especially the findings of Mukherjee & Naka (1995), that there is cointegrating relationship between stock index and the very similar set of macroeconomic variables gives us strong indication to believe existence of cointegrating relationships in the models of this study.

For each country and set of variables, the number of cointegrating relationships is tested by two different methods. These two methods are trace test and maximum eigenvalue test, which are shortly introduced in the methodology chapter of this study. In practice, neither of the test can be considered better than the other (Lütkepohl 2005, 334). However, there are presented some justifications for both of the tests to be used over the other. Hunter et al. (2017, 158) present, that trace test should be preferred over the max eigenvalue test due the observation, that max eigenvalue test might in some rare cases be inconclusive with no ability to accept or reject cointegrating ranks correctly. This rare case of inconclusive results is because the max eigenvalue test only covers the alternative option of cointegrating rank of one higher than the rank under testing, while the trace test covers all the other possible rank values (Hunter et. al. 2017, 158). Similar conclusions are drawn in study of Lütkepohl, Saikkonen & Trenkler (2001, 305), where they recommend using trace test based on their simulations, but they do not discredit max eigenvalue test at all and encourage using both tests side by side.

Where Hunter et al. (2017, 158) recommend using max eigenvalue test to check the results from trace test, Enders (2004) disagrees with this idea. Enders (2004, 354) points out that in a case when being certain of the number of cointegrating vectors is important that the more restricted hypothesis testing of max eigenvalue test comes to advantage as this makes pinning down the number of cointegrating vectors more efficient. This advantage is acknowledged also by Lütkepohl et al. (2001, 296). However, Hendry & Juselius (2000, 96) emphasize that all the available information should be used when considering the number of cointegrating vectors, such as theoretical background and economic interpretability.

Table 14 Johansen's cointegration for Finland

Sample (adjusted): 2000M11 2018M07
Included observations: 213 after adjustments
Trend assumption: Linear deterministic trend
Series: OMX_HEL CPI_FIN INT_FIN EX_FIN IP_FIN
Lags interval (in first differences): 1 to 3

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.149553	78.15203	69.81889	0.0093
At most 1	0.075707	43.64760	47.85613	0.1176
At most 2	0.066186	26.87887	29.79707	0.1046
At most 3	0.050027	12.29316	15.49471	0.1434
At most 4	0.006372	1.361599	3.841466	0.2433

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.149553	34.50443	33.87687	0.0421
At most 1	0.075707	16.76873	27.58434	0.5999
At most 2	0.066186	14.58571	21.13162	0.3190
At most 3	0.050027	10.93156	14.26460	0.1577
At most 4	0.006372	1.361599	3.841466	0.2433

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

From table 14, we can see the Johansen’s cointegration ranks tested by trace test and max eigenvalue test for Finland’s variables. Both test indicate to an existence of cointegrating equation in the system with 5% confidence level. While the rejection of null hypothesis with trace test is stronger than with max eigenvalue test, the max eigenvalue test accepts the hypothesis of one cointegrating equation with much more confidence than the trace test. The probability given by the trace test for the at most 1 cointegrating equation is only 0.1176, just above the 10% significance level. However, the max eigenvalue test's much more confident probability of 0.5999 gives confidence in concluding that there is one cointegrating equation in Finland's system for the market index and the macroeconomic variables.

Table 15 Johansen's cointegration for Sweden

Sample (adjusted): 2000M12 2018M07
Included observations: 212 after adjustments
Trend assumption: Linear deterministic trend
Series: OMX_STO CPI_SWE INT_SWE EX_SWE IP_SWE
Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.137799	68.84824	69.81889	0.0596
At most 1	0.082017	37.41566	47.85613	0.3282
At most 2	0.048980	19.27340	29.79707	0.4734
At most 3	0.039875	8.626752	15.49471	0.4010
At most 4	4.66E-07	9.88E-05	3.841466	0.9933

Trace test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.137799	31.43257	33.87687	0.0952
At most 1	0.082017	18.14226	27.58434	0.4833
At most 2	0.048980	10.64665	21.13162	0.6824
At most 3	0.039875	8.626653	14.26460	0.3185
At most 4	4.66E-07	9.88E-05	3.841466	0.9933

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

The tests for corresponding system for Swedish variables can be seen in the table 15. From these two tests there is conclusion made, that there is not a single cointegrating equation in the system with 5% significance level. However, this does not mean that the hypothesis of cointegrating equations is outright rejected. As examining the results from the two cointegration rank test, it can be observed, that in fact both tests accept one cointegrating vector with 10% significance level. With trace test, the hypothesis of no cointegrating vectors is accepted only marginally as the trace statistic is ~68.85 while the critical value is ~69.82 and the corresponding probability given to the test is 0.0596 (only very narrowly accepting the hypothesis). The same test statistic and probability given with max eigenvalue test is not as narrow but still within the 10% significance level. Notable also is the fact that when testing the VECM with two lags, one cointegrating equation was concluded from the test within the 5% significance level, while the same was true for the testing of cointegrating relationships with six lagged values. While using the six lagged values, the residuals from the VECM were not auto correlated but the overall interpretational power of the model would suffer. With these above-mentioned factors taken into account, it is concluded that there exists one cointegrating equation in the system for Sweden.

Table 16 Johansen's cointegration for Norway

Sample (adjusted): 2000M10 2018M07
Included observations: 214 after adjustments
Trend assumption: Linear deterministic trend
Series: OSE_ALL CPI_NOR INT_NOR EX_NOR IP_NOR
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.131844	76.12501	69.81889	0.0144
At most 1	0.108594	45.86892	47.85613	0.0760
At most 2	0.059639	21.26847	29.79707	0.3411
At most 3	0.036615	8.109210	15.49471	0.4538
At most 4	0.000592	0.126648	3.841466	0.7219

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.131844	30.25609	33.87687	0.1274
At most 1	0.108594	24.60045	27.58434	0.1151
At most 2	0.059639	13.15926	21.13162	0.4377
At most 3	0.036615	7.982562	14.26460	0.3805
At most 4	0.000592	0.126648	3.841466	0.7219

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

From the table 16, we can see the cointegration rank tests for Norway's system. The results from these tests gives us opposite results when comparing the results from trace and max eigenvalue tests for Sweden as this time trace test indicates that there is one cointegrating vector while max eigenvalue test concludes, that there are no cointegrating vectors. Again, we have to examine the two tests more closely in order to make sound conclusion about the number of cointegrating relationships. Trace test statistic for the rejection of null hypothesis that there is no cointegration is ~76.13 while the critical value is ~69.82, which gives us reasonable confidence to accept this conclusion while the acceptance of the null hypothesis of one cointegration vector with trace test is also reasonable. For maximum eigenvalue test, the null hypothesis of no cointegrating vectors is accepted outright as the test statistic is ~30.26, which is reasonably strongly under the critical value of ~33.88. With these observations we can conclude, that there is one cointegrating vector for Norway's system.

4.4 Long-run vector error correction results

After concluding above, that all the system we are analysing are cointegrated to the rank of one, we can analyse this found long-run equilibrium with vector error correction models. With findings from these models, we can determine which macroeconomic variables have a long-run relationship with the market indices of each country respectively. For each cointegration vector, the statistical significance and theoretical implication of individual macroeconomic variables are assessed. All of the found cointegrating vectors from the Johansen's cointegration test are presented in the Table 17, one cointegrating equation for each country respectively. As we are interested in the effects and relationships between the macroeconomic variables and market indices, the market indices variables are listed in the equations first and normalized to the value of one. To analyse the relationships from these normalized equations, we must retrieve the equation in the form, that the market indices are represented in the left-hand side of the equations. As mentioned earlier this study, the residuals of the models have been tested for autocorrelation (see appendices 6-8) and have been concluded not to be auto correlated in the residuals.

Generally, the cointegrated equation can be expressed as the following, before we transform the equation to the form, where we can analyse it (see Mukherjee & Naka 1995; Maysami et al. 2004; Humpe & Macmillan 2009; Ansotegui & Esteban 2002).

$$\beta_t = (MARKET_t \quad CPI_t \quad INT_t \quad EX_t \quad IP_t \quad C) \tag{16}$$

Where the β_t is the error correction term and the $MARKET_t$ represents the normalized market index. This is the form of cointegrating equation that Eviews gives us and can be seen in the Table 17. This is the error corrected version of the cointegrating equation, that is presented in the formula 16 above. With slight modifications, we can express the cointegrating equation in a form, that can give us insight on the long-term equilibrium that the variables have.

Table 17 Cointegrating equations from VEC models

Standard errors in ( ) & t-statistics in [ ]		Standard errors in ( ) & t-statistics in [ ]		Standard errors in ( ) & t-statistics in [ ]	
Cointegrating Eq:	CointEq1	Cointegrating Eq:	CointEq1	Cointegrating Eq:	CointEq1
OMX_HEL(-1)	1.000000	OMX_STO(-1)	1.000000	OSE_ALL(-1)	1.000000
CPI_FIN(-1)	-39.46808	CPI_SWE(-1)	4.585450	CPI_NOR(-1)	0.309377
	(8.46639)		(2.59956)		(2.14163)
	[-4.66174]		[1.76393]		[0.14446]
INT_FIN(-1)	-2.240352	INT_SWE(-1)	0.376859	INT_NOR(-1)	0.418838
	(0.43891)		(0.09475)		(0.11364)
	[-5.10434]		[3.97723]		[3.68558]
EX_FIN(-1)	8.346489	EX_SWE(-1)	-11.37927	EX_NOR(-1)	1.263206
	(2.00103)		(4.02371)		(3.12773)
	[4.17109]		[-2.82805]		[0.40387]
IP_FIN(-1)	-14.68096	IP_SWE(-1)	1.589542	IP_NOR(-1)	-0.452971
	(3.73683)		(0.77194)		(1.73555)
	[-3.92872]		[2.05916]		[-0.26100]
C	234.0412	C	-38.92012	C	-6.920996

From the first column of the Table 17, we can see the normalized cointegrating equation for Finalnd's market index OMX_HEL and the four macroeconomic variables (CPI_FIN, INT_FIN, EX_FIN, IP_FIN). The error correction version for the cointegrating equation is the following:

$$\beta_t = (1.00,\ -39.47,\ -2.24,\ 8.35,\ -14.68,\ 234.04) \tag{17}$$

From this equation the normalized equation for OMX_HEL can be achieved with modifying in such a way, that the normalized value is left for the LHS of the equation while moving the other variables to the RHS. After these modifications, the relationships of macroeconomic variables and the market index can be analyzed from the following equation:

$$OMX\ HEL = 39.47 CPI\ FIN + 2.24 INT\ FIN - 8.35 EX\ FIN + 14.68 IP\ FIN - 234.04 \quad (18)$$

The equation above tells us the long-run relationship, that OMX_HEL has with the macroeconomic variables in order to sustain the long-term equilibrium state. In the Table 17 we can find the t-statistics for each of the variables and we can conclude, that each of the four macroeconomic variables are significant at 5% significance level. The relationship between the consumer price index (CPI_FIN) and the market index (OMX_HEL) seems to be positive, which is opposite of what was hypothesized earlier in this study. Although not unheard of, the positive relationship between CPI and stock markets is concluded by less studies than a negative one. In Finland’s case, there might be several reasons why this positive relationship exists in a long-run. Firstly, the positive relationship might be due the nature of investors. For example, when the inflation rate rises, investors might transfer their assets from static bank deposits to instruments with higher yield, such as stocks and bonds, to battle the effects of inflation would otherwise have on their savings. Secondly, the increase in consumer price index might signal increase in economic activity, and thus cause a positive long-term relationship between the CPI and stock index (Maysami et al. 2004, 54).

Another conclusion that can be drawn from the presented long-term equilibrium above, is that long-term interest rate and market index have a positive relationship. Again, this is contrary to what was hypothesized earlier in this study. Usually it is thought, that the increase in long-term interest rates would draw investors away from stock markets and focus on bond markets. However, this might not always be the case as we have seen in the recent history of European economic development. For many years after the financial crisis of 2008 and subsequental eurocrisis the long-term interest rates were low, even at times negative. These low interest rates were paired with poor performance in the stock markets, which might have left investors to wait for better time in the general economic environment. After Europe started recovering from the financial crisis, the interest rates started to increase again at the same time as the stock markets recovered from the crisis. Thus in Finland’s case, the positive relationship is most likely due the strong signal, that the increase in interest rates has for the economy overall, encouraging growth in the stock markets. This positive relationship noted in this cointergrating context does not outright mean that the commonly noted negative effect and reasons behind that does not exist for Finland, but that this positive relationship, due the overall improvement in economic environment, overpowers this commonly found relationship.

A negative relationship for long-term is found to exists for EX_FIN and OMX_FIN. As the exchange rate used in this study is in form of EUR/USD, this means that as euro depreciates, the market index increases. This is in line with the hypothesized findings, which is similary concluded by Mukherjee & Naka (1995) and Liu & Shrestha (2008). Finland is a country where companies largely rely on exporting of goods and services and as the currency in Finland is euro, the same positive effects of euro appriciating can be applied to all exporting goods out of the eurozone and the changes in this exchange rate are not at all local for Finland as is the case in the two other countries, Sweden and Norway, as they have their own national currencies. And lastly, as hypothesized, a positive long-run relationship is found to exists between the OMX_HEL and IP_FIN. This positive connection between the two was noted by Fama (1981) and Geske & Roll (1983) and follows the reasoning, that increase in industrial production increases the cashflows to the companies, which in turn increase the returns and stock markets.

From the second column of the Table 17, we can see the cointegrating equation found for Sweden. Again, this equation is in the error correction form, which can be expressed as follows:

$$\beta_t = (1.00, \ \ 4.59, \ \ 0.38, \ \ -11.38, \ \ 1.59, \ \ -38.92) \tag{19}$$

After modifying the equation so that we have the normalized market index OMX_STO in the LHS of the equation and the macroeconomic variables in the RHS, we can analyze the long-term relationships between OMX_STO and these four variables:

$$OMX\ STO = -4.59CPI\ SWE - 0.38INT\ SWE + 11.38EX\ SWE - 1.59IP\ SWE + 38.92 \tag{20}$$

The t-statistics in the Table 17 tell us, that all the macroeconomic variables are statistically significant and thus have a long-run relationships with the market index, OMX_STO. First of the significant variables, CPI_SWE, the relationship is negative as was hypothesized. This negative relationship means, that as consumer prices increases the market index decreases. Same findings are presented by Fama (1981) and Geske & Roll (1983), as well as many other studies examined in the literature review earlier in this study. This negative relationship is most likely due, that increase in inflation increases the discount rate for the companies and this effect is even bigger than the increase in the cash flows due the risen consumer prices (Mukherjee & Naka 1995; Tripathi & Seth 2014).

The relationship between long-term interest rate, INT_SWE, and the market index is presented to be negative by the cointegrating equation. Again, this is in line with the hypothesized results as this negative relationship is found to be present in multiple studies that have been presented in the literature review (e.g. see Fama 1981; Geske & Roll 1983; Wongbangpo & Sharma 2002; Nasseh & Strauss 2000). There are multiple reasons why this negative relationship is generally considered to exists and these reasons have been presented in the literature review of this study, but generally higher long-term interest rates increase companies' discount rates and bond markets attract more investors when the yields increase.

Contrary to hypothesized findings, the EX_SWE and OMX_STO long-run relationship is found to be positive. This means that in case, where swedish krone appreciates, the market index increases. This goes against the thought relationship, that for a country like Sweden, depriciation of national currency against the US dollar might increase the value of exports and thus positively affect the market index. Although this idea of positive relationship may first seem quite odd, there might be some rational reasons behind these findings. Firstly, the negative effect of lower value for exports might be offset by the lower costs of imported goods and services. This idea of domestic companies gaining advantage of cheaper imported inputs, in order to gain profitability on manufacturing was presented by Maysami et al. (2004, 68-69) for Singaporean markets, which might be also the case for Sweden as the country is heavily relying on imports and exports of goods globally. Secondly, there might exists a positive relationship between the two per similar reason, that the positive relationship was hypothesized for Finland's market index and long-term interest rate. In this case, the stronger national currency might indicate stronger expectations for economy overall thus reflecting to the stock markets and leading to positive relationship.

The most interesting noted long-term relationships is the observed negative relationship between the market index and industrial production. This is contrary to the hypothesized positive relationship as finding similar negative relationship between industrial production and a stock index from a earlier studies is very rare. One case of such negative relationship in long-term is observed by Brahmasrene & Jiranyakul (2007, 24) for Thailand's economy during a Asian economic crisis in the 90s. This means, that theoretical support for this finding is very limited, but theoretical and real world reasons behind this relationship can be hypothesized. Firstly, when examining the figure 3, we can see that there is period in 2011 to 2015, after the financial crisis, when the manufacturing industrial production in Sweden suffers from a period of declining development, meanwhile for the same period, the market index has strong upward trend. This long period of development to the opposite direction for the two variables might give VECM indication of negative relationship existing in the system. The explanation for the stock index's growth while manufacturing index is declining might be indication for the meaningfulness of manufacturing industry to Sweden's economy as whole: while the country's economy orients to other industries, such as service industries and high-technology industries, the role of manufacturing in the economy overall diminishes. While these other industries might have experienced growth in the economy, while the manufacturing industries decline, the market index have been growing alongside these industries and overall positive environment in the economy. Examining the relationship before this time period could help us understand, does the negative relationship exist in the system before the period of opposite movement or have the recent development been enough to change the fundamental relationship between manufacturing and overall market index.

Lastly, we examine the cointegrating equation and long-run relationships for Norway. The unmodified version of the cointegrating equation can be found on the third column of the Table 17. Here we can see that the cointegrating vector for error correction term is the following:

$$\beta_t = (1.00,\ \ 0.31,\ \ 0.42,\ \ 1.26,\ -0.45,\ \ -6.92) \tag{21}$$

And this form of the equation is again modified to reflect the normalized value of the market index, OSE_ALL.

$$OSE\ ALL = -0.31CPI\ NOR - 0.42INT\ NOR - 1.26EX\ NOR + 0.45IP\ NOR + 6.92 \quad (22)$$

From the Table 17, again, we can see the calculated t-statistics for all of the macroeconomic variables and assess the statistical significance of each variable in the equation. This time we have a situation where three of the four macroeconomic variables have a very low t-statistics and thus are not significant to the equation. These three variables are CPI_NOR, EX_NOR and IP_NOR with t-statistics of 0.144, 0.404 and -0.261 respectively. This indicates us, that none of these three variables is statistically significant in the model at 5% significance level. This leaves the only macroeconomic variable, that is significant, to be the long-term interest rate, INT_NOR. The long-run relationship between the market index and the long-run interest rate is found to be a negative one. This is inline with our hypothesized findings (supported by e.g. Fama 1981 and Mukherjee & Naka 1995) as well as the findings from Sweden's cointegrating equation. The reasons behind this negative relationship between the variables can be explained most likely by the same reasons, that are applied for Sweden and are generally accepted in studies about the negative long-run relationship between interest rates and stock markets.

When comparing these findings from the three countries several differences are apparent. Main difference observed is that the long-term relationships for Finland and Sweden are opposite with the CPI, interest rate and exchange rate. With two very similar countries economically, these findings are somewhat surprising. This tells us that under these apparent similarities, there are some fundamental differences between these two nabourhing nordic countries (see Wong 2017, 340-341). The most obvious difference is the fact, that Finland is part of the euro currency while both Sweden and Norway have their own national currencies. With being part of the eurozone, Finnish economy might be more interconnected to the markets of other eurozone economies. Being a relatively small economy in the fringes of eurozone, Finland's markets and macroeconomic variables might be reliant on the signaling effects from the bigger eurozone economies, markets and policies, such as eurozone monetary policies. When examining the sizes of the coefficients from Finland's and Sweden's cointegrating equations, most drastic difference can be seen in the consumer price indices coefficients. Another factor, that might explain the opposite long-term relationships observed for Finland and Sweden (and partly for Norway) is the economic turbulence, that happended during the study period, mainly the eurozone crisis and the global financial crisis. These crisis had a deeper impact on Finland's economy and recovery took longer. This might have affected economic fundamentals and changed how these macroeconomic variables are related to the stock market of Finland. Supporting evidence for this thought explanation is given by Kollias et al. (2016, 261 & 271) as they find, that there exist clear differences between the eurozone countries and other European countries with regards to causality and directionality of the effects of exchange rates, which they explain by the possibilty of different monetary policies in countries with national currencies versus the eurozone countries.

Comparison on these long-term relationship between Norway and the two other countries is challenging from results of this study as the only found significant relationship is with the long-term interest rate. However, the negative relationship between Norway and Sweden is similar, with close approximated size of this negative relationship. Overall, Norway is the country that differs most from the other two in its economic fundamentals, which most likely is due its unique characteristics in Nordic and, especially in Europe, as it is a country with very high GDP per capita (one of the highest in the world) while not being part of the EU. This gives Norway more power over its economic policies and thus might not be as reliant on the market fundamentals of global markets and gives Norway better ability to shield the economy from global crisises as was seen in the recent financial crisis and the euro crisis (Kollias et al. 2016, 218).

4.5 Short-run vector error correction results

Alongside the long-run relationship examination of market indices and macroeconomic variables, the VECM offers a tool to analyze the short-run relationship between the variables. These short-term relationship analysis are based on the differenced values of the variables for chosen amount of lags to the VECM. In this case this means, that the short-term relationships can be examined up to three lags for Finland, four lags for Sweden and two lags for Norway, meaning we can examine the effects of what the different variables have upon each other for up to lag amount of months. The tables for all of these short-term equations are presented in below (see Tables 18, 19 and 20) and these findings are used to support the findings from the Granger causality tests, which are examined in the next chapter of this thesis. This “side-by-side” method of studying and examining both VECM and Granger causality for short-term relationships is also implemented by Wongbangpo & Sharma (2002). From the tables of the short-term relationships, we can see the coefficients presented for each of the listed variables for all of the equations, but in our focus are the listed lagged coefficients for the equation of differenced market indices (first columns on the tables) and how the same market indices relate to the changes of macroeconomic variables (rows two to five in the tables depending on the country).

From the Table 18, we can see the equations and coefficients for Finland. Examining the first column of the table we can see that only macroeconomic variable significant in the explaining the movement in the market index are lagged values of industrial production. Significant are the second and third lagged values. None of the other macroeconomic variables are significant with three lagged values to the D(OMX_HEL). However, the changes of D(OMX_STO) are significant to the values of the D(EX_FIN) in the first lagged value and with the second lagged value to the changes of IP_FIN. The unidirectional relationship from market index to the exchange rate is observed to be a positive one. Similar findings have been made by Tsagkanos & Siripoulos (2013, 114-117) as they note, that in the EU, after financial crisis, the causality runs from the market index to the exchange rate, while the opposite is true in the timeframe before the financial crisis. Supporting findings for bidirectional short-term relationships from market index to industrial production have been made by Dritsaki (2005, 45), Wongpangpo & Sharma (2012, 41) and Kwon & Shin (1999, 78), while this time Plíhal (2016, 2106) only notes a unidirectional causality to exist from stock index to the industrial production.

While this unidirectional causality from the first lag of the market index to the exchange rate and from the second lagged value of market index to industrial production is statistically significant, we can observe that the adjusted R-square of the equations are very poor, which indicates us that power of this short-term relationship is very weak in power. The nature of this short-term unidirectional causality might seem bit out of place at first as Finland’s stock markets are relatively small and thus it is odd to find that movement in OMX_HEL causes movement in the euro/dollar exchange rate. This could be explained by the close interdependence of the european stock markets, as for example, when the stock markets of bigger european economies (such as France and Germany) experience changes, these changes are in turn closely followed in Finland's stock markets. While this collective change in European stock markets will most likely have effect on the euro/dollar exchange rate, in this model this appears as a presented short-term causality from Finland's stock market to the exchange rate. For the reasons why the second lagged values of market index are significant to the industrial production, the increase stock index gives companies more cashflows to increase production as well as confidence for the future. Increasing the production might take some time, which could explain us why the first lagged value of market index is not significant.

Evaluating these short-term relationships for Sweden's model (Table 19), we can observe that with 5% significance level, the fourth lagged variable of consumer price index is significant to the changes in the stock market index variable. With 10% significance level, the third lagged value of long-term interest rate is significant alongside with the second lagged value of industrial production. There is causality from the lagged values of OMX_STO to the macroeconomic variable EX_SWE. The second lagged variable is statistically significant with 5% level while the third lagged value is with 10% level.

Dritsaki (2005, 45) has made similar findings for the Athen's stock exchange, inflation and interest rate as have been observed here, as in her study she concludes that there exists similar unidirectional causality from both inflation and interest rate to the stock market index. The unidirectional causality from market index to exchange rate finding is supported by the findings of Kollias et al. (2016), who note that a similar relationship exists for Swedish national currency and stock markets. This time the observed unidirectional causality is observed to be negative in the second lagged value and positive in the third lagged value. The reason why the second and third lagged values are significant over the first one seems rather odd. This maybe caused by the inertia in the economy or by the fact that it takes time for companies to react to the changes in the markets. For example, it might take some time for companies to place new orders and deliver goods and services earlier agreed upon, thus making the reaction to the exchange rate to be actualized later than in one month.

Table 20 presents us the short-term equations for Norway's model. Here the situation is quite different from the previous two, as several of the macroeconomic variables are significant in explaining the changes in the market index D(OSE_ALL). At 5% significance level, the variables that cause the market index are the first lagged values of D(CPI_NOR), D(INT_NOR) and D(IP_NOR). Increasing the significance level to 10%, the second lagged value of D(EX_NOR) also becomes significant alongside the second lagged value of D(IP_NOR). This noted unidirectional causality is contrary to the findings of Kollias et al. (2016), who observed a bidirectional causality to exist between Norwegian currency's exchange rate and the stock markets. This means that causality from the all of the macroeconomic variables are found to exist. Causality from D(OSE_ALL) to the macroeconomic variables can be observed for interest rate and industrial production at 10% significance level. As the first lagged value of D(OSE_ALL) has causality to the D(INT_NOR) we can conclude, that according to VECM a bidirectional causality can be observed for these two variables in the first lags. Unidirectional causality noted from the VECM for Norway is aligned with findings from Sweden's VECM, where we can also note a similar unidirectional relationship.

This finding of bidirectional causality between interest rate and stock index is supported by the findings of Wongpangpo & Sharma (2002, 41) for multiple Asian economies. However, there have been some contradicting findings made by Plíhal (2016, 2106), concluding that there is a unidirectional causality from stock index to the interest rate in Germany's economy, while the opposite unidirectional relationship is noted by Dritsaki for the markets in Greece (2005, 45). Bidirectional relationship can also be observed for the industrial production and market index as the second lagged value of D(OSE_ALL) is significant for the D(IP_NOR). These findings are inline with the earlier findings from Finland's VECM as well as the previous studies mentioned in Finland's results (e.g. Dritsaki 2005; Wongpangpo & Sharma 2012; Kwon & Shin 1999). The relationship between market index and both long-term interest rate and industrial production is noted to be positive. Positive is also the short-term causality from the exchange rate to market index while the unidirectional relationship from CPI is negative.

Table 18 VECM for Finland

Error Correction:	D(OMX_HEL)	D(CPI_FIN)	D(INT_FIN)	D(EX_FIN)	D(IP_FIN)
CointEq1	0.013733	-0.000260	0.014689	-0.004424	0.002912
	(0.00373)	(0.00017)	(0.00830)	(0.00196)	(0.00131)
	[3.68617]	[-1.50908]	[1.77003]	[-2.25232]	[2.22514]
D(OMX_HEL(-1))	0.006508	0.002489	0.185768	0.118146	0.017384
	(0.06901)	(0.00319)	(0.15372)	(0.03639)	(0.02424)
	[0.09431]	[0.78104]	[1.20846]	[3.24695]	[0.71711]
D(OMX HEL(-2))	-0.123513	-0.000937	0.096752	-0.020372	0.056136
	(0.07013)	(0.00324)	(0.15623)	(0.03698)	(0.02464)
	[-1.76113]	[-0.28918]	[0.61929]	[-0.55088]	[2.27854]
D(OMX_HEL(-3))	-0.120879	0.002361	-0.071728	0.020683	0.021861
	(0.06897)	(0.00319)	(0.15364)	(0.03637)	(0.02423)
	[-1.75266]	[0.74130]	[-0.46686]	[0.56875]	[0.90229]
D(CPI_FIN(-1))	0.111828	0.108409	7.761319	-0.271689	0.553845
	(1.53825)	(0.07104)	(3.42667)	(0.81110)	(0.54037)
	[0.07270]	[1.52606]	[2.26498]	[-0.33496]	[1.02493]
D(CPI_FIN(-2))	0.528643	-0.017801	4.636993	-0.441404	0.490327
	(1.54322)	(0.07127)	(3.43773)	(0.81372)	(0.54212)
	[0.34256]	[-0.24978]	[1.34885]	[-0.54245]	[0.90447]
D(CPI_FIN(-3))	-1.623201	-0.193533	1.823231	-0.445011	0.062359
	(1.55472)	(0.07180)	(3.46336)	(0.81979)	(0.54616)
	[-1.04405]	[-2.69550]	[0.52643]	[-0.54284]	[0.11418]
D(INT_FIN(-1))	0.008087	0.000990	0.300535	0.005249	0.016032
	(0.03252)	(0.00150)	(0.07245)	(0.01715)	(0.01143)
	[0.24863]	[0.65909]	[4.14796]	[0.30607]	[1.40317]
D(INT_FIN(-2))	0.027906	-0.000678	-0.135281	-0.000131	0.007643
	(0.03319)	(0.00153)	(0.07394)	(0.01750)	(0.01166)
	[0.84074]	[-0.44228]	[-1.82960]	[-0.00751]	[0.65552]
D(INT_FIN(-3))	0.022865	0.001362	0.099514	0.020444	0.001141
	(0.03198)	(0.00148)	(0.07123)	(0.01686)	(0.01123)
	[0.71505]	[0.92264]	[1.39705]	[1.21253]	[0.10155]
D(EX_FIN(-1))	-0.091691	-0.002096	-0.020754	0.046836	-0.065983
	(0.13362)	(0.00617)	(0.29765)	(0.07045)	(0.04694)
	[-0.68622]	[-0.33963]	[-0.06973]	[0.66476]	[-1.40573]
D(EX_FIN(-2))	0.069467	0.007690	0.070406	-0.018697	0.098484
	(0.13258)	(0.00612)	(0.29533)	(0.06991)	(0.04657)
	[0.52397]	[1.25594]	[0.23839]	[-0.26745]	[2.11461]
D(EX_FIN(-3))	-0.010466	0.006646	0.074450	0.025075	-0.015025
	(0.13291)	(0.00614)	(0.29608)	(0.07008)	(0.04669)
	[-0.07874]	[1.08282]	[0.25145]	[0.35778]	[-0.32180]
D(IP_FIN(-1))	-0.086461	-0.008580	0.036492	0.007811	-0.246909
	(0.19886)	(0.00918)	(0.44299)	(0.10486)	(0.06986)
	[-0.43478]	[-0.93426]	[0.08238]	[0.07450]	[-3.53446]
D(IP_FIN(-2))	0.343589	0.011524	-0.484163	0.129743	-0.104867
	(0.19798)	(0.00914)	(0.44102)	(0.10439)	(0.06955)
	[1.73549]	[1.26048]	[-1.09782]	[1.24285]	[-1.50784]
D(IP FIN(-3))	0.387754	-0.001051	0.189237	-0.020894	0.100033
	(0.19494)	(0.00900)	(0.43425)	(0.10279)	(0.06848)
	[1.98914]	[-0.11678]	[0.43578]	[-0.20327]	[1.46079]
C	0.001320	0.001318	-0.033604	0.003473	-6.63E-05
	(0.00566)	(0.00026)	(0.01260)	(0.00298)	(0.00199)
	[0.23328]	[5.04416]	[-2.66692]	[1.16444]	[-0.03338]
R-squared	0.139307	0.095798	0.166557	0.091949	0.196022
Adj. R-squared	0.069046	0.021985	0.098521	0.017823	0.130391
Sum sq. resids	0.856014	0.001826	4.247855	0.238001	0.105636
S.E. equation	0.066086	0.003052	0.147217	0.034847	0.023215
F-statistic	1.982715	1.297855	2.448064	1.240437	2.986731
Log likelihood	285.3011	940.3152	114.7006	421.6226	508.1302
Akaike AIC	-2.519259	-8.669627	-0.917376	-3.799273	-4.611551
Schwarz SC	-2.250987	-8.401354	-0.649104	-3.531001	-4.343279
Mean dependent	-0.000391	0.001162	-0.023099	0.001442	0.000388
S.D. dependent	0.068493	0.003086	0.155053	0.035161	0.024895

Determinant resid covariance (dof adj.)	5.41E-16
Determinant resid covariance	3.57E-16
Log likelihood	2276.930
Akaike information criterion	-20.53456
Schwarz criterion	-19.11429
Number of coefficients	90

Table 19 VECM for Sweden

Error Correction:	D(OMX_STO)	D(CPI_SWE)	D(INT_SWE)	D(EX_SWE)	D(IP_SWE)
CointEq1	-0.047791	0.004897	0.018996	0.000829	-0.001383
	(0.01452)	(0.00108)	(0.04756)	(0.00115)	(0.00677)
	[-3.29142]	[4.54437]	[0.39942]	[0.72045]	[-0.20437]
D(OMX_STO(-1))	0.001843	0.001370	0.292534	0.008395	0.041018
	(0.07143)	(0.00530)	(0.23396)	(0.00566)	(0.03330)
	[0.02580]	[0.25835]	[1.25033]	[1.48358]	[1.23177]
D(OMX_STO(-2))	-0.057361	-0.003194	0.291085	-0.011972	0.042445
	(0.07098)	(0.00527)	(0.23250)	(0.00562)	(0.03309)
	[-0.80811]	[-0.60636]	[1.25200]	[-2.12914]	[1.28270]
D(OMX_STO(-3))	0.030274	-0.003559	0.007035	0.010046	0.033033
	(0.07248)	(0.00538)	(0.23740)	(0.00574)	(0.03379)
	[0.41769]	[-0.66161]	[0.02963]	[1.74973]	[0.97764]
D(OMX_STO(-4))	-0.011931	-0.003417	0.129867	-0.003643	0.039475
	(0.07179)	(0.00533)	(0.23514)	(0.00569)	(0.03347)
	[-0.16619]	[-0.64125]	[0.55229]	[-0.64055]	[1.17950]
D(CPI_SWE(-1))	-1.246653	-0.197799	4.151559	0.018382	0.670023
	(0.95503)	(0.07088)	(3.12812)	(0.07565)	(0.44522)
	[-1.30535]	[-2.79075]	[1.32717]	[0.24298]	[1.50493]
D(CPI_SWE(-2))	-0.349347	-0.259954	-0.504672	-0.127878	0.225405
	(0.94029)	(0.06978)	(3.07984)	(0.07449)	(0.43835)
	[-0.37153]	[-3.72520]	[-0.16386]	[-1.71683]	[0.51422]
D(CPI_SWE(-3))	-1.108476	-0.296095	-1.705041	0.013034	-0.259480
	(0.93150)	(0.06913)	(3.05105)	(0.07379)	(0.43425)
	[-1.18999]	[-4.28312]	[-0.55884]	[0.17664]	[-0.59754]
D(CPI_SWE(-4))	-2.775076	-0.325098	-2.725701	0.028048	-0.310123
	(0.93748)	(0.06957)	(3.07064)	(0.07426)	(0.43704)
	[-2.96014]	[-4.67267]	[-0.88767]	[0.37768]	[-0.70960]
D(INT_SWE(-1))	0.030539	-0.002913	0.251354	0.002513	-0.008133
	(0.02347)	(0.00174)	(0.07687)	(0.00186)	(0.01094)
	[1.30128]	[-1.67271]	[3.26991]	[1.35193]	[-0.74338]
D(INT_SWE(-2))	-0.008720	0.001087	-0.110405	-0.000436	-0.000455
	(0.02433)	(0.00181)	(0.07970)	(0.00193)	(0.01134)
	[-0.35839]	[0.60178]	[-1.38533]	[-0.22615]	[-0.04014]
D(INT_SWE(-3))	0.040832	-0.000583	0.130968	0.004839	0.009328
	(0.02394)	(0.00178)	(0.07840)	(0.00190)	(0.01116)
	[1.70584]	[-0.32809]	[1.67046]	[2.55187]	[0.83593]
D(INT_SWE(-4))	-0.031314	-0.001564	-0.133384	-0.003162	0.001871
	(0.02347)	(0.00174)	(0.07686)	(0.00186)	(0.01094)
	[-1.33441]	[-0.89828]	[-1.73535]	[-1.70107]	[0.17101]
D(EX_SWE(-1))	0.058024	0.128212	1.651076	0.133648	0.318005
	(0.92460)	(0.06862)	(3.02844)	(0.07324)	(0.43103)
	[0.06276]	[1.86848]	[0.54519]	[1.82474]	[0.73778]
D(EX_SWE(-2))	0.119429	0.168984	2.679553	-0.020653	0.134619
	(0.90599)	(0.06724)	(2.96750)	(0.07177)	(0.42236)
	[0.13182]	[2.51323]	[0.90297]	[-0.28777]	[0.31873]
D(EX_SWE(-3))	0.643266	0.121633	-0.939413	-0.099109	0.388991
	(0.89726)	(0.06659)	(2.93888)	(0.07108)	(0.41828)
	[0.71692]	[1.82663]	[-0.31965]	[-1.39440]	[0.92997]
D(EX_SWE(-4))	-0.823337	0.095987	-1.635343	0.146028	0.757941
	(0.89522)	(0.06644)	(2.93222)	(0.07092)	(0.41734)
	[-0.91970]	[1.44476]	[-0.55772]	[2.05919]	[1.81614]
D(IP_SWE(-1))	0.178792	0.013880	0.708478	0.022041	-0.463940
	(0.15593)	(0.01157)	(0.51074)	(0.01235)	(0.07269)
	[1.14660]	[1.19945]	[1.38715]	[1.78435]	[-6.38218]
D(IP_SWE(-2))	0.309728	0.006218	0.058685	0.019822	-0.145172
	(0.17094)	(0.01269)	(0.55989)	(0.01354)	(0.07969)
	[1.81193]	[0.49011]	[0.10481]	[1.46387]	[-1.82175]
D(IP_SWE(-3))	0.106126	-0.000315	-0.826096	0.004176	0.017413
	(0.17033)	(0.01264)	(0.55789)	(0.01349)	(0.07940)
	[0.62308]	[-0.02494]	[-1.48076]	[0.30948]	[0.21930]
D(IP_SWE(-4))	0.079568	-0.003433	-0.770830	-0.003505	0.150045
	(0.15338)	(0.01138)	(0.50237)	(0.01215)	(0.07150)
	[0.51877]	[-0.30159]	[-1.53438]	[-0.28846]	[2.09849]
C	0.009385	0.002131	-0.019560	0.000188	-0.000739
	(0.00444)	(0.00033)	(0.01455)	(0.00035)	(0.00207)
	[2.11340]	[6.46575]	[-1.34473]	[0.53390]	[-0.35699]
R-squared	0.196977	0.273146	0.187755	0.178849	0.258231
Adj. R-squared	0.108221	0.192810	0.097980	0.088090	0.176245
Sum sq. resids	0.480029	0.002644	5.149894	0.003012	0.104322
S.E. equation	0.050264	0.003730	0.164635	0.003982	0.023432
F-statistic	2.219324	3.400029	2.091404	1.970593	3.149727
Log likelihood	344.7774	896.1477	93.25171	882.3223	506.5717
Akaike AIC	-3.045070	-8.246677	-0.672186	-8.116248	-4.571431
Schwarz SC	-2.696745	-7.898352	-0.323861	-7.767923	-4.223106
Mean dependent	0.002920	0.001081	-0.021792	6.30E-05	-7.76E-05
S.D. dependent	0.053227	0.004152	0.173346	0.004170	0.025817

Determinant resid covariance (dof adj.)	6.90E-18
Determinant resid covariance	3.99E-18
Log likelihood	2742.633
Akaike information criterion	-24.78899
Schwarz criterion	-22.96820
Number of coefficients	115

Table 20 VECM for Norway

Error Correction:	D(OSE_ALL)	D(CPI_NOR)	D(INT_NOR)	D(EX_NOR)	D(IP_NOR)
CointEq1	-0.049100	0.000852	-0.039023	0.000236	0.004964
	(0.01074)	(0.00092)	(0.03832)	(0.00096)	(0.00290)
	[-4.57234]	[0.92140]	[-1.01835]	[0.24521]	[1.71282]
D(OSE_ALL(-1))	0.067865	0.000739	0.445705	0.004945	0.025500
	(0.07052)	(0.00607)	(0.25165)	(0.00631)	(0.01903)
	[0.96235]	[0.12161]	[1.77115]	[0.78394]	[1.33970]
D(OSE_ALL(-2))	-0.041842	0.002785	0.196517	-0.003974	0.031154
	(0.06769)	(0.00583)	(0.24154)	(0.00605)	(0.01827)
	[-0.61815]	[0.47768]	[0.81358]	[-0.65636]	[1.70521]
D(CPI_NOR(-1))	-2.125224	0.073668	4.407226	-0.035577	0.062234
	(0.81174)	(0.06992)	(2.89667)	(0.07261)	(0.21910)
	[-2.61810]	[1.05361]	[1.52148]	[-0.48995]	[0.28405]
D(CPI_NOR(-2))	-0.121931	-0.060802	-2.234969	-0.119900	0.012650
	(0.83088)	(0.07157)	(2.96495)	(0.07432)	(0.22426)
	[-0.14675]	[-0.84957]	[-0.75380]	[-1.61320]	[0.05641]
D(INT_NOR(-1))	0.054275	-0.000482	0.050190	0.003136	-0.003767
	(0.02042)	(0.00176)	(0.07285)	(0.00183)	(0.00551)
	[2.65843]	[-0.27411]	[0.68891]	[1.71739]	[-0.68365]
D(INT_NOR(-2))	-0.000186	-0.000676	-0.064550	0.000616	-0.008485
	(0.02033)	(0.00175)	(0.07256)	(0.00182)	(0.00549)
	[-0.00917]	[-0.38588]	[-0.88963]	[0.33891]	[-1.54601]
D(EX_NOR(-1))	0.822341	0.070386	-0.284787	0.050342	0.176980
	(0.80987)	(0.06976)	(2.89000)	(0.07245)	(0.21859)
	[1.01540]	[1.00899]	[-0.09854]	[0.69489]	[0.80963]
D(EX_NOR(-2))	1.536809	0.017591	1.850651	0.010206	-0.033795
	(0.80738)	(0.06954)	(2.88109)	(0.07222)	(0.21792)
	[1.90346]	[0.25294]	[0.64234]	[0.14131]	[-0.15508]
D(IP_NOR(-1))	0.853799	-0.015578	2.180381	0.013231	-0.465108
	(0.25846)	(0.02226)	(0.92229)	(0.02312)	(0.06976)
	[3.30346]	[-0.69975]	[2.36409]	[0.57229]	[-6.66727]
D(IP_NOR(-2))	0.447737	-0.009229	1.522381	0.016416	-0.176667
	(0.26375)	(0.02272)	(0.94117)	(0.02359)	(0.07119)
	[1.69760]	[-0.40624]	[1.61754]	[0.69578]	[-2.48170]
C	0.011138	0.001632	-0.031527	0.000394	1.79E-05
	(0.00436)	(0.00038)	(0.01556)	(0.00039)	(0.00118)
	[2.55351]	[4.34378]	[-2.02556]	[1.00924]	[0.01520]
R-squared	0.207879	0.025835	0.090100	0.052573	0.207610
Adj. R-squared	0.164744	-0.027213	0.040551	0.000981	0.164460
Sum sq. resids	0.597185	0.004431	7.604493	0.004779	0.043506
S.E. equation	0.054372	0.004683	0.194026	0.004864	0.014676
F-statistic	4.819237	0.487012	1.818412	1.019011	4.811359
Log likelihood	325.6682	850.3616	53.43149	842.2723	605.9369
Akaike AIC	-2.931478	-7.835155	-0.387210	-7.759554	-5.550812
Schwarz SC	-2.742732	-7.646409	-0.198464	-7.570808	-5.362066
Mean dependent	0.007121	0.001698	-0.020654	7.77E-05	0.000506
S.D. dependent	0.059493	0.004621	0.198084	0.004866	0.016055
Determinant resid covariance (dof adj.)		1.07E-17			
Determinant resid covariance		8.02E-18			
Log likelihood		2693.766			
Akaike information criterion		-24.56790			
Schwarz criterion		-23.54553			
Number of coefficients		65			

4.6 Granger causality results

In this chapter, the results from the pairwise Granger causality tests are presented for each of the countries. With these results, in combination with earlier VECM results, we can draw conclusion about the short-term relationships between the market indices and macroeconomic variables. The Granger causality is used with the earlier VECM to give more insight about the short-term relationships and give robustness to the conlcusions drawn. In each of the Granger causality tables, the pairs of stock market indices and macrovariables are presented, while the pairs between macrovariables are left out of the tables for clarity and as they are not in the interest of this study. Amount of lags utilized for each of the tests are per the above mentioned and earler used for the cointegration tests and VECM.

Table 21 Pairwise Granger Causality Tests for Finland

Sample: 2000M07 2018M07
Lags: 3

Null Hypothesis:	Obs	F-Statistic	Prob.
DIF_CPI_FIN does not Granger Cause DIF_OMX_HEL	213	1.11271	0.3450
DIF_OMX_HEL does not Granger Cause DIF_CPI_FIN		0.57519	0.6319
DIF_INT_FIN does not Granger Cause DIF_OMX_HEL	213	0.16420	0.9204
DIF_OMX_HEL does not Granger Cause DIF_INT_FIN		1.82266	0.1441
DIF_EX_FIN does not Granger Cause DIF_OMX_HEL	213	0.22008	0.8824
DIF_OMX_HEL does not Granger Cause DIF_EX_FIN		2.62206	0.0517
DIF_IP_FIN does not Granger Cause DIF_OMX_HEL	213	2.74606	0.0440
DIF_OMX_HEL does not Granger Cause DIF_IP_FIN		6.24977	0.0004

Table 21 presents the Pairwise Granger Causality test for Finland's model. The tests include three lags for each variable pair of market index and macroeconomic variable. From the table we can see, that there is a bidirectional causality between differences of industrial production and market index with 5% significance level. The null hypothesis of no Granger causality over the other variable can be rejected for both tests as the given p-values for IP not Granger causing OMX is 0.0440 and only 0.0004 with opposite test. Almost significant with 5% confidence level, and clearly with 10%, is the rejection of null hypothesis in case of OMX_HEL Granger causing the EX_FIN with p-value of 0.0517. This means, that there is a unidirectional causality running from stock index to exchange rate according to the test.

Observing unidirectional causality from DIF_OMX_HEL to DIF_EX_FIN and bidirectional causality between DIF_IP_FIN and DIF_OMX_HEL are aligned with the findings observed from the VECM presented earlier in this study. The bidirectional causality findings are supported by the observed bidirectional causality between the stock market development and economic growth in the eurozone in study by Kajurová and Rozmahel (2016, 1931-1933). Similar relationship is also found for Canada (Sawhney et al. 2006, 592), while only unidirectional causality is found for United States. Other supporting findings have already been presented in the case of observed bidirectional relationship with the VECM (e.g. Dritsaki 2005; Wongpangpo & Sharma 2012; Kwon & Shin 1999). Result of market index Granger causing exchange rate is supported by Tsagkanos & Siripoulos (2013, 114-117) as well as by Kollias et al. (2016) for eurozone countries in a period after the financial crisis.

Table 22 Pairwise Granger Causality Tests for Sweden

Sample: 2000M07 2018M07
Lags: 4

Null Hypothesis:	Obs	F-Statistic	Prob.
DIF_CPI_SWE does not Granger Cause DIF_OMX_STO	212	4.77920	0.0011
DIF_OMX_STO does not Granger Cause DIF_CPI_SWE		0.15356	0.9612
DIF_INT_SWE does not Granger Cause DIF_OMX_STO	212	1.99432	0.0967
DIF_OMX_STO does not Granger Cause DIF_INT_SWE		1.39766	0.2361
DIF_EX_SWE does not Granger Cause DIF_OMX_STO	212	0.72121	0.5783
DIF_OMX_STO does not Granger Cause DIF_EX_SWE		3.09954	0.0167
DIF_IP_SWE does not Granger Cause DIF_OMX_STO	212	0.44892	0.7731
DIF_OMX_STO does not Granger Cause DIF_IP_SWE		2.68588	0.0325

Pairwise Granger Causality test results for Sweden's system are presented in the Table 22, where we can see that these results closely resemble the observations made about short-term relationships from VECM. With 5% level, the null hypothesis of no granger causality from consumer price index to stock market index can be rejected. This means, that there is unidirectional causality from the CPI to the OMX index. This finding is supported by the findings from the earlier VECM as well as studies by Dritsaki (2005) for Greece's economy and by Kalyanaraman (2015) for multiple different sectors in Saudia Arabia. However, some contradicting findigs are noted by Ahmed et al. (2017), who observe a opposite unidirectional causality running from stock index to the inflation rate and by Gan et al.

(2006) as they do not find any significant short-term causality between CPI and stock markets for New Zeland's economy. The unidirectional Granger causality from stock index to exchange rate is also found to be significant with 5% level, also supporting the earlier observation from the VECM. This is supported by the findings by Kollias et al. (2016), while contradicting, opposite, causal relationship is observed by Gan et al. (2006) and bidirectional Granger causality is observed by Kwon & Shin (1999).

With 10% significance level, the null hypothesis of no Granger causality from interest rate to stock index can be rejected, thus unidirectional causality between the two is observed. This is again inline with the earlier findings from VECM and supporting evidence is presented by Dritsaki (2005). Opposite unidirectional causality is presented in the study by Acikalin et al. (2008). Last found Granger causal relationship is between industrial production and the market index. This time, the unidirectional relationship is observed to be from the stock index to the industrial production, which is contrary to the observed opposite unidirectional relationship from the earlier VECM. Supporting findings for this observation is presented by Plíhal (2016) from the Germany's economy and markets, while contradicting conclusion are made by Sawhney et al. (2006) and Acikalin et al. (2008) as both observe unidirectional causality running from real economic activity (GDP/GDP growth) to stock indices.

Table 23 Pairwise Granger Causality Tests for Norway

Sample: 2000M07 2018M07
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
DIF_CPI_NOR does not Granger Cause DIF_OSE_ALL	214	3.56682	0.0300
DIF_OSE_ALL does not Granger Cause DIF_CPI_NOR		0.18968	0.8274
DIF_INT_NOR does not Granger Cause DIF_OSE_ALL	214	2.59835	0.0768
DIF_OSE_ALL does not Granger Cause DIF_INT_NOR		3.82326	0.0234
DIF_EX_NOR does not Granger Cause DIF_OSE_ALL	214	0.66754	0.5141
DIF_OSE_ALL does not Granger Cause DIF_EX_NOR		1.41047	0.2463
DIF_IP_NOR does not Granger Cause DIF_OSE_ALL	214	4.60577	0.0110
DIF_OSE_ALL does not Granger Cause DIF_IP_NOR		2.22568	0.1105

In the Table 23 are presented the Granger Causality tests for Norway's system. A unidirectional causality can be observed between the CPI and OSE_ALL index, with the causality running from the CPI to the index. This finding is aligned with the earlier findings of VECM in this study and also observed to exist for Sweden's system. This means that supporting findings from earlier studies are same as for Sweden's Granger causality test: Dritsaki (2005) and Kalyanaraman (2015). However, this observation contradicts the findings of Gjerde & Sættem (1999, 68) for Norway's stock returns and inflation rate, as they do not find any causality between the two from their VAR model. These contradicting findings are most likely due the different time periods used in the studies, as we have noted earlier that over time the fundamentals between different variables can shift.

Second observed unidirectional causal relationship from the pairwise Granger causality test is the causality from industrial production to the stock index. This contradicts somewhat the earlier noted bidirectional causality from the VECM as the acceptance of the null hypothesis, that there is no Granger causality from OSE_ALL to the IP is just above the 10% significance level. Gjerde & Sættem (1999, 68) observe similar unidirectional causality from their study on Norway's system thus supporting this finding. Other supporting evidence are presented by Sawnhey et al. (2005) and Acikalin et al. (2008) while contradicting findings are concluded by Plíhal (2016). While the other two observed Granger causal relationship are significant with 5% level, a bidirectional relationship can be observed for interest rate and stock market index with 10% level. This is supported by the findings from the VECM. This finding is also supported by the study of Wongbangpo & Sharma (2002) but contradicted by the study of Gjerde & Sættem (1999).

5 CONCLUSIONS

The purpose of this master's thesis is to study the long-term and short-term relationships between market indices and selected macroeconomic variables for selected three Nordic countries: Finland, Sweden and Norway. For each country, a stock index is selected, that reflects the overall markets in said country most efficiently. For Finland, index OMX Helsinki All-Share index (OMXHPI) is selected as it includes all of the shares listed in the Helsinki's stock market. OMXSPI, the OMX Stockholm All-Share index, is used for the same purpose for Sweden, which also includes all the shares traded in the Stockholm's stock exchange. Lastly, for Norway, the Oslo Bors All-Share index (OSEAX) is used as it too tracks the all shares traded in the Oslo's stock exchange. For each country, four different macroeconomic variables are chosen. These variables are the consumer price index, long-term interest rate (10-year government bond yield), exchange rate and industrial production index. Exchange rates used are EUR/USD, SEK/USD and NOK/USD, while the industrial production index for Finland includes the total industrial production and for Sweden and Norway the manufacturing industrial production. Variables of market index, consumer price index and industrial production are natural logarithm transformed for each country. The data is in monthly format and the data period consist of 217 months from the July of 2000 to July of 2018.

The methodology used in this study includes the Johansen's cointegration test, vector error correction models and Granger causality test, which are widely used in earlier studies for different countries and sets of macroeconomic variables. Before using these methods to analyse the relationships between variables, Augmented Dickey-Fuller and Phillips-Perron tests are implemented and from these it is observed that on level all of the variables contain one unit root (I(1)) and on first differences in none of the variables unit roots are present. Multiple different lag length criteria are examined, alongside with residual autocorrelation test, to determine the optimal lag length to be used for each country. For Finland, three lags are used, while for Sweden four lags and for Norway two lags are used.

In the beginning of this study two main research question were presented alongside with three different supporting research questions. Next, the findings for each of these questions are presented.

Is there long-term relationship between stock indices and selected macroeconomic variables in the selected Nordic countries?

As hypothesized in the beginning of this study, a cointegrating relationship is observed to exist between the market indices and macroeconomic variables for each of the countries. From Johansen's cointegration test we can observe, that one cointegrating equation are found for each of the countries. These found relationships tell us, that there is a long-term equilibrium between the stock markets and macroeconomic variables in these Nordic countries and deviations from this equilibrium are corrected in the economies, thus meaning that these variables evolve and move together over time. These found cointegrating relationships are supported by numerous different studies, such as Mukherjee & Naka (1995) for Japan's economy, Nasseh & Strauss (2000) for six different European economies and Sawhney et al. (2006) for both USA and Canada. From the cointegration results, we can conclude that the stock markets in Finland, Sweden and Norway are grounded in the macroeconomic fundamentals and in long-term influenced by the macroeconomic factors (Nasseh & Strauss 2000, 242).

Which macroeconomic variables are significant to the market indices in long-term?

To analyse these found long-term relationships further, the cointegrating equations are analysed from the vector error correction models. From these equations the significance of each macroeconomic variable can be assessed. From Finland's cointegrating equation, all of the chosen macroeconomic variables (CPI, interest rate, exchange rate and industrial production) are found to be significant in the long-run. From Sweden's cointegrating equation, we can conclude that, all of the four macroeconomic variables are significant in the system, same as Finland's system. Only one, out of the four macroeconomic variables, is found to be significant in the long-term for Norway's system. This macroeconomic variable is the long-term interest rate.

Are found significant long-term relationships between market indices and macroeconomic variables positive or negative?

For Finland, the relationship between market index and consumer price index is found to be positive, which is opposite of what was hypothesized earlier in this study. The explanation behind this observed positive relationship is most likely caused by the increase in consumer prices signalling a boost in economic activity, thus having a positive effect on stock markets (Maysami et al. 2004, 54). Interest rates are also found to have a positive relationship for the stock index, which is also differing from the hypothesized findings. This observation is also most likely explained by simultaneous increase in both interest rates and stock markets, as the both experienced a period of increasing after the financial crisis and a period of decreasing during the crisis. The found negative long-term relationship between market index and exchange rate is as hypothesized and this means, that while the domestic currency depreciates, there is an increase in stock market index. This finding is supported by Mukherjee & Naka (1995) as well as by Liu & Shrestha (2008). Lastly for Finland, we can observe a positive long-term relationship between industrial production and market index. This is aligned with the hypothesized finding and is supported by the research of Fama (1981), Mukherjee & Naka (1995) and Nasseh & Strauss (2000).

For Sweden, consumer price index is found to have a negative relationship with stock index as hypothesized. Supporting evidence is presented by, for example, Fama (1981) and Geske & Roll (1983) as well as by Mukherjee & Naka (1995). The negative relationship between the long-term interest rate and market index confirms the hypothesized finding and evidence supporting this has been presented by Nasseh & Strauss (2000) and Humpe & Macmillan (2009). Against the hypothesized findings, is the found positive relationship between exchange rate and market index in Sweden. Few reasons are presented, why this relationship might be. Firstly, Swedish companies might have advantage on the cheaper imported goods triumphing over the decrease in demand for the domestic goods abroad, as hypothesized by Maysami et al. (2004). Secondly, the strengthening of domestic currency might signal a positive outlook of the future for the markets, thus having a positive effect on the stock markets. Most curious is the observed negative long-term relationship between industrial production and market index. This found relationship has very limited support from previous research, with the exception of study by Brahmasrene & Jiranyakul (2007). In Swedish system, this relationship is hypothesized to be caused by the period of stock market growth, while the manufacturing industrial production index decreased, most likely due other sectors driving the growth in Swedish markets.

The only significant macroeconomic variable in Norway's system is the long-term interest rate and the relationship is observed to be negative. This finding is in line with the hypothesized and similar findings are noted for Sweden and in studies by Nasseh & Strauss (2000) and Humpe & Macmillan (2009). Only one found significant long-term relationship might signal, that the economic fundamentals between the Nordic countries are different and in bottom line, Norway's economy is the most different from the two, as it is not part of the EU and the industrial landscape is different, heavily focusing on oil. Study by Gjerde & Sættem (1999) also found that in the long-term, only one macroeconomic variable (industrial production) is significant in Norwegian economy. This might give us indication, that indeed Norway's economy and markets do not follow the same fundamentals, as other well developed and open economies such as other Nordic and European countries.

Are there short-term causal relationships between the market indices and macroeconomic variables?

Short-term relationships and causalities in this thesis are studied with vector error correction models and Granger causality tests both. For Finland, two short-term causal relationship are observed. These relationships are between stock index and exchange rate as well as between stock index and industrial production. For Sweden, short-term relationships are observed between all of the four macroeconomic variables and the stock index. Similarly, for Norway, a relationship with causality tests can be observed to exist between each macroeconomic variable and market index.

Are found short-term causal relationships unidirectional or bidirectional?

For Finland, unidirectional causality from stock index to the exchange rate and bidirectional causality between market index and industrial production is observed from both VECM and Granger causality tests. Similar causalities are observed by Tsagkanos & Siripoulos (2013). This finding of unidirectional causality from stock index to exchange rate is speculated to be caused by the power of European stock market interconectedness. As stock markets change in bigger European economies, such as Germany and France, these effects are closely reflected in Finnish stock markets and as these bigger economies have effect on the euro exchange rate, so appears Finland’s markets have. The other causal relationship found from both VECM and Granger causality tests is the bidirectional causality between industrial production and market index. This is also somewhat contradictory to the expected finding as unidirectional causality from industrial production to the market index was expected to be observed. However, supporting evidence for this observation is presented by Dritsaki (2005) and Kwon & Shin (1999).

For Sweden’s system, a unidirectional causality is noted from consumer price index to the market index by both VECM and Granger causality tests, which is supported by the findings of Dritsaki (2005). Also, from both causality tests we can see, that there is a unidirectional causality from the long-term interest rate to the stock index. This observation is also supported by Dritsaki (2005) and Kwon & Shin (1999). From both VECM and Granger causality tests, similarily to Finland, a unidirectional causality from exchange rate to the market index is found. In Sweden’s case, this causality is not expected to be caused by the same factors as for Finland as Sweden operates with its own national currency but as Kollias et al. (2016) explain, the similar causality to be caused by the stock market policies spilling over to the exchange rate in countries with national currencies. From the VECM, a unidirectional causality from the industrial production to the market index is observed, while a opposite unidirectional causality is observed from the Granger causality tests. Supporting evidence for both causal relationships can be found and this might indicate, that there exists a bidirectional causality between the two, but drawing this conclusion is somewhat weak.

From the VECM used for Norway, we can observe a unidirectional causality from exchange rate to the market index, supported by Kwon & Shin (1999) and Kollias et al. (2016). A unidirectional relationship between consumer price index and market index is also observed from both VECM and Granger causality test. Bidirectional causality is found from both methods to exist between the interest rate and market index, which contradicts the hypothesized unidirectional causality from interest rate to the market index. However, similar bidirectional causalities are observed by Wongbangpo & Sharma (2002). Also, a bidirectional causality is observed between the industrial production and market index from the VECM, while a undirectional relationship is noted from the Granger causality test, although the Granger causality test can just bearly accept the hypothesis of no bidirectional causality between the two variable, thus we can conclude, that there is indeed a bidirectional causality supported by the findings by Dritsaki (2005) and Kwon & Shin (1999).

Alongside the two main research questions and three supporting questions, some other observations and conclusions can be drawn from the findings of this study. From the cointegration tests, VECM and Granger causality tests, it can be seen, that the results can differ quite drastically for set of very similar variables for closely resembling countries and markets. Comparing the results of the different countries, we can see that common factors of being small and open economies do not guarantee, that the economic fundamentals are the same for these countries. These observed differences are most likely due the different structures in the industrial and market enviroment of each country as well as by the notion, that Finland is part of the eurozone while on the other hand Norway is not even part of the EU. We can also conclude that, over time economic fundamentals seem to change and develop depending on the overall economic and market situations. Good example of this from this study is the greatly different results, when comparing a similar study done by Gjerde & Sættem (1999) for Norway's economy. These fundamentals tend to change during market booms and busts as investors and consumers tend to change their behaviour most. Similar conclusions are made by Maysami et al. (2004), Wong et al. (2006) and Peiró (2016) for multiple different countries and time periods.

From results of this study, it can be seen, that the markets show a degree of efficency in these Nordic countries and thus they are not weakly market efficent as information from macroeconomic variables determine the development of stock markets. Also arguing that overall markets are most likely semi-strongly efficient, are the studies by Fama (1991) and Mukherjee & Naka (1995) as from both studies conclusions are made, that relationships with macroeconomic variable does not necessarily indicate existance of arbitrage opportunities in the market.

There are several implications and conclusion that can be drawn from this study that may be in the interest for policymakers, companies and investors alike. Overall, this study can help all the operators in the markets to better understand the economic fundamentals and the relationships between stock markets and macroeconomics. More specifically, these results can give policymakers insight on how their decisions affect the markets in both long and short-term. This could give valuable infromation for economic decision making, while keeping the future and development of markets in mind. One example could be that, when deciding about increasing or decreasing interest rate, policymakers could examine from these results, what these planned changes would have on markets both in short-term and long-term. For both companies and investors, findings from this study gives valuable information as understanding how changes in the macroeconomic landscape affects the markets. These results help these operators to understand what is to come from actions and announcements of policymakers. This infromation helps companies to plan proper actions to secure their operations in light of upcoming changes in macroeconomic variables and investors to plan ahead in short and long-term.

Although this study gives good contribution to understanding the long-term and short-term relationship between the markets and macroeconomic environment in Nordic countries, there still are number of limitations that could be taken into account in future research. Firstly, one limitation of this study is the macroeconomic variables used. These variables do not cover all the aspects of macroeconomic variables and in future other variables, such as short-term interest rates and other production indices, should be taken into account as this would shed more light on the fundamental relationships between the markets and macroeconomic enviroment. Another limitation is the time period used in this study, as it contains many periods of economic increases and decreases. As it has been noted in this study, economic fundamentals tend to change over time, depending on the overall market situation. From this it would be beneficial to examine the same market from different time periods and compare the results, for example before and after the financial crisis of 2008. Also one factor that could be considered a limitation of this study, is the methodology used to study these relationships. In the future, to test the robustness of these results, different econometric methods could be implemented, such as impulse response analysis and variance decomposition. Interesting in future research would also be to examine the different market sectors more closely and how they are affected by the macroeconomic variables. One way this could be achieved, would be dividing the market variable to set of different market indices covering specific sectors, such as manufacturing, finances and technology. From this sort of divide a better understanding of how macroeconomic variables affect different parts of the markets in both short-term and long-term could be achieved.

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APPENDICES

Appendix 1. Descriptive statistics for differenced variables of Finland, Sweden and Norway

	DIF_OMX_HEL	DIF_CPI_FIN	DIF_INT_FIN	DIF_EX_FIN	DIF_IP_FIN
Mean	-0.002352	0.001192	-0.022917	0.001063	0.000558
Median	0.008397	0.001146	-0.040000	0.000725	0.000488
Maximum	0.232834	0.010175	0.440000	0.099300	0.083743
Minimum	-0.285607	-0.007011	-0.480000	-0.128200	-0.119021
Std. Dev.	0.072523	0.003095	0.154086	0.035134	0.024820
Skewness	-0.793188	0.030762	0.214763	-0.223817	-0.699510
Kurtosis	5.214592	2.866667	2.979512	4.183399	7.712318
Jarque-Bera	66.78910	0.194066	1.664208	14.40728	217.4687
Probability	0.000000	0.907526	0.435133	0.000744	0.000000
Sum	-0.507979	0.257484	-4.950000	0.229550	0.120605
Sum Sq. Dev.	1.130809	0.002060	5.104663	0.265399	0.132444
Observations	216	216	216	216	216

	DIF_OMX_STO	DIF_CPI_SWE	DIF_INT_SWE	DIF_EX_SWE	DIF_IP_SWE
Mean	0.002002	0.001108	-0.022222	2.31E-07	0.000254
Median	0.007185	0.001186	-0.030000	-0.000100	0.002363
Maximum	0.119470	0.010213	0.410000	0.010150	0.088570
Minimum	-0.240191	-0.013521	-0.670000	-0.014994	-0.083656
Std. Dev.	0.053827	0.004133	0.171826	0.004170	0.025737
Skewness	-0.940860	-0.481587	-0.171669	-0.219358	-0.085908
Kurtosis	4.840598	3.732315	3.506749	3.218336	4.291013
Jarque-Bera	62.35807	13.17590	3.372088	2.161287	15.26611
Probability	0.000000	0.001377	0.185251	0.339377	0.000484
Sum	0.432343	0.239411	-4.800000	5.00E-05	0.054938
Sum Sq. Dev.	0.622929	0.003673	6.347733	0.003739	0.142412
Observations	216	216	216	216	216

	DIF_OSE_ALL	DIF_CPI_NOR	DIF_INT_NOR	DIF_EX_NOR	DIF_IP_NOR
Mean	0.007585	0.001725	-0.019861	3.81E-05	0.000573
Median	0.017797	0.001235	-0.030000	0.000125	0.000987
Maximum	0.158913	0.023472	0.630000	0.010421	0.068042
Minimum	-0.340412	-0.012837	-0.590000	-0.021435	-0.050581
Std. Dev.	0.059412	0.004630	0.197403	0.004864	0.015996
Skewness	-1.359682	0.520696	0.049162	-0.507639	0.000909
Kurtosis	7.742124	5.438373	3.195157	4.404811	4.607451
Jarque-Bera	268.9441	63.27144	0.429782	27.03856	23.25513
Probability	0.000000	0.000000	0.806629	0.000001	0.000009
Sum	1.638419	0.372616	-4.290000	0.008230	0.123727
Sum Sq. Dev.	0.758904	0.004608	8.378096	0.005087	0.055016
Observations	216	216	216	216	216

Appendix 2. Individual Unit Root tests for Finland on levels and first differences

Null Hypothesis: OMX_HEL has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on AIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.810724	0.0584
Test critical values:	1% level	-3.460739	
	5% level	-2.874804	
	10% level	-2.573917	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(OMX_HEL) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on AIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-14.21656	0.0000
Test critical values:	1% level	-3.460739	
	5% level	-2.874804	
	10% level	-2.573917	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: OMX_HEL has a unit root
Exogenous: Constant
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.411894	0.0116
Test critical values:	1% level	-3.460596	
	5% level	-2.874741	
	10% level	-2.573883	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(OMX_HEL) has a unit root
Exogenous: Constant
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-14.21751	0.0000
Test critical values:	1% level	-3.460739	
	5% level	-2.874804	
	10% level	-2.573917	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: CPI_FIN has a unit root
Exogenous: Constant
Lag Length: 14 (Automatic - based on AIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.588550	0.8691
Test critical values:	1% level	-3.462737	
	5% level	-2.875680	
	10% level	-2.574385	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(CPI_FIN) has a unit root
Exogenous: Constant
Lag Length: 14 (Automatic - based on AIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.376007	0.0130
Test critical values:	1% level	-3.462901	
	5% level	-2.875752	
	10% level	-2.574423	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: INT_FIN has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on AIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.924351	0.7791
Test critical values:	1% level	-3.460884	
	5% level	-2.874868	
	10% level	-2.573951	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: CPI_FIN has a unit root
Exogenous: Constant
Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.059438	0.7317
Test critical values:	1% level	-3.460596	
	5% level	-2.874741	
	10% level	-2.573883	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(CPI_FIN) has a unit root
Exogenous: Constant
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-13.02168	0.0000
Test critical values:	1% level	-3.460739	
	5% level	-2.874804	
	10% level	-2.573917	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(INT_FIN) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on AIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-9.911682	0.0000
Test critical values:	1% level	-3.460884	
	5% level	-2.874868	
	10% level	-2.573951	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: INT_FIN has a unit root
Exogenous: Constant
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.883468	0.7921
Test critical values:	1% level	-3.460596	
	5% level	-2.874741	
	10% level	-2.573883	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(INT_FIN) has a unit root
Exogenous: Constant
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-11.04337	0.0000
Test critical values:	1% level	-3.460739	
	5% level	-2.874804	
	10% level	-2.573917	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: EX_FIN has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on AIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.002156	0.2859
Test critical values:	1% level	-3.460596	
	5% level	-2.874741	
	10% level	-2.573883	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(EX_FIN) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on AIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-13.99422	0.0000
Test critical values:	1% level	-3.460739	
	5% level	-2.874804	
	10% level	-2.573917	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: EX_FIN has a unit root
Exogenous: Constant
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.071749	0.2564
Test critical values:	1% level	-3.460596	
	5% level	-2.874741	
	10% level	-2.573883	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(EX_FIN) has a unit root
Exogenous: Constant
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-13.99476	0.0000
Test critical values:	1% level	-3.460739	
	5% level	-2.874804	
	10% level	-2.573917	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: IP_FIN has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on AIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.882488	0.3402
Test critical values:	1% level	-3.460884	
	5% level	-2.874868	
	10% level	-2.573951	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(IP_FIN) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on AIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-12.54333	0.0000
Test critical values:	1% level	-3.460884	
	5% level	-2.874868	
	10% level	-2.573951	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: IP_FIN has a unit root
Exogenous: Constant
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.286575	0.1773
Test critical values:	1% level	-3.460596	
	5% level	-2.874741	
	10% level	-2.573883	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(IP_FIN) has a unit root
Exogenous: Constant
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-17.97276	0.0000
Test critical values:	1% level	-3.460739	
	5% level	-2.874804	
	10% level	-2.573917	

*MacKinnon (1996) one-sided p-values.

Appendix 3. Individual Unit Root tests for Sweden on levels and first differences

Null Hypothesis: OMX_STO has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on AIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.525779	0.8824
Test critical values:	1% level	-3.460596	
	5% level	-2.874741	
	10% level	-2.573883	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(OMX_STO) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on AIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-13.48766	0.0000
Test critical values:	1% level	-3.460739	
	5% level	-2.874804	
	10% level	-2.573917	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: OMX_STO has a unit root
Exogenous: Constant
Bandwidth: 6 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.864813	0.7978
Test critical values:	1% level	-3.460596	
	5% level	-2.874741	
	10% level	-2.573883	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(OMX_STO) has a unit root
Exogenous: Constant
Bandwidth: 5 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-13.62040	0.0000
Test critical values:	1% level	-3.460739	
	5% level	-2.874804	
	10% level	-2.573917	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: CPI_SWE has a unit root
Exogenous: Constant
Lag Length: 14 (Automatic - based on AIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.515622	0.8843
Test critical values:	1% level	-3.462737	
	5% level	-2.875680	
	10% level	-2.574385	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(CPI_SWE) has a unit root
Exogenous: Constant
Lag Length: 13 (Automatic - based on AIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.237376	0.0193
Test critical values:	1% level	-3.462737	
	5% level	-2.875680	
	10% level	-2.574385	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: CPI_SWE has a unit root
Exogenous: Constant
Bandwidth: 88 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.910559	0.3271
Test critical values:	1% level	-3.460596	
	5% level	-2.874741	
	10% level	-2.573883	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(CPI_SWE) has a unit root
Exogenous: Constant
Bandwidth: 70 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-15.06292	0.0000
Test critical values:	1% level	-3.460739	
	5% level	-2.874804	
	10% level	-2.573917	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: INT_SWE has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on AIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.030276	0.7425
Test critical values:	1% level	-3.460739	
	5% level	-2.874804	
	10% level	-2.573917	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(INT_SWE) has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic - based on AIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.173884	0.0000
Test critical values:	1% level	-3.461178	
	5% level	-2.874997	
	10% level	-2.574019	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: INT_SWE has a unit root
Exogenous: Constant
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.912983	0.7828
Test critical values:	1% level	-3.460596	
	5% level	-2.874741	
	10% level	-2.573883	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(INT_SWE) has a unit root
Exogenous: Constant
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-10.82737	0.0000
Test critical values:	1% level	-3.460739	
	5% level	-2.874804	
	10% level	-2.573917	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: EX_SWE has a unit root
Exogenous: Constant
Lag Length: 9 (Automatic - based on AIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.926998	0.3194
Test critical values:	1% level	-3.461938	
	5% level	-2.875330	
	10% level	-2.574198	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(EX_SWE) has a unit root
Exogenous: Constant
Lag Length: 8 (Automatic - based on AIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.962928	0.0000
Test critical values:	1% level	-3.461938	
	5% level	-2.875330	
	10% level	-2.574198	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: EX_SWE has a unit root
Exogenous: Constant
Bandwidth: 6 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.995057	0.2890
Test critical values:	1% level	-3.460596	
	5% level	-2.874741	
	10% level	-2.573883	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(EX_SWE) has a unit root
Exogenous: Constant
Bandwidth: 5 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-12.88472	0.0000
Test critical values:	1% level	-3.460739	
	5% level	-2.874804	
	10% level	-2.573917	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: IP_SWE has a unit root
Exogenous: Constant
Lag Length: 5 (Automatic - based on AIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.197652	0.2078
Test critical values:	1% level	-3.461327	
	5% level	-2.875062	
	10% level	-2.574054	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(IP_SWE) has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic - based on AIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.684060	0.0000
Test critical values:	1% level	-3.461178	
	5% level	-2.874997	
	10% level	-2.574019	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: IP_SWE has a unit root
Exogenous: Constant
Bandwidth: 8 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.414372	0.1390
Test critical values:	1% level	-3.460596	
	5% level	-2.874741	
	10% level	-2.573883	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(IP_SWE) has a unit root
Exogenous: Constant
Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-20.57662	0.0000
Test critical values:	1% level	-3.460739	
	5% level	-2.874804	
	10% level	-2.573917	

*MacKinnon (1996) one-sided p-values.

Appendix 4. Individual Unit Root tests for Norway on levels and first differences

Null Hypothesis: OSE_ALL has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on AIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.496416	0.8881
Test critical values:	1% level	-3.460739	
	5% level	-2.874804	
	10% level	-2.573917	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(OSE_ALL) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on AIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-12.33491	0.0000
Test critical values:	1% level	-3.460739	
	5% level	-2.874804	
	10% level	-2.573917	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: OSE_ALL has a unit root
Exogenous: Constant
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.554489	0.8765
Test critical values:	1% level	-3.460596	
	5% level	-2.874741	
	10% level	-2.573883	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(OSE_ALL) has a unit root
Exogenous: Constant
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-12.32908	0.0000
Test critical values:	1% level	-3.460739	
	5% level	-2.874804	
	10% level	-2.573917	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: CPI_NOR has a unit root
Exogenous: Constant
Lag Length: 13 (Automatic - based on AIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		1.182393	0.9980
Test critical values:	1% level	-3.462574	
	5% level	-2.875608	
	10% level	-2.574346	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(CPI_NOR) has a unit root
Exogenous: Constant
Lag Length: 12 (Automatic - based on AIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.407806	0.0004
Test critical values:	1% level	-3.462574	
	5% level	-2.875608	
	10% level	-2.574346	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: CPI_NOR has a unit root
Exogenous: Constant
Bandwidth: 23 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		0.854081	0.9948
Test critical values:	1% level	-3.460596	
	5% level	-2.874741	
	10% level	-2.573883	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(CPI_NOR) has a unit root
Exogenous: Constant
Bandwidth: 25 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-14.72969	0.0000
Test critical values:	1% level	-3.460739	
	5% level	-2.874804	
	10% level	-2.573917	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: INT_NOR has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on AIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.314036	0.6232
Test critical values:	1% level	-3.460596	
	5% level	-2.874741	
	10% level	-2.573883	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(INT_NOR) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on AIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-13.26391	0.0000
Test critical values:	1% level	-3.460739	
	5% level	-2.874804	
	10% level	-2.573917	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: INT_NOR has a unit root
Exogenous: Constant
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.340264	0.6108
Test critical values:	1% level	-3.460596	
	5% level	-2.874741	
	10% level	-2.573883	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(INT_NOR) has a unit root
Exogenous: Constant
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-13.24153	0.0000
Test critical values:	1% level	-3.460739	
	5% level	-2.874804	
	10% level	-2.573917	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: EX_NOR has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on AIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.832266	0.3642
Test critical values:	1% level	-3.460739	
	5% level	-2.874804	
	10% level	-2.573917	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(EX_NOR) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on AIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-13.34791	0.0000
Test critical values:	1% level	-3.460739	
	5% level	-2.874804	
	10% level	-2.573917	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: EX_NOR has a unit root
Exogenous: Constant
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.801871	0.3790
Test critical values:	1% level	-3.460596	
	5% level	-2.874741	
	10% level	-2.573883	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(EX_NOR) has a unit root
Exogenous: Constant
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-13.34448	0.0000
Test critical values:	1% level	-3.460739	
	5% level	-2.874804	
	10% level	-2.573917	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: IP_NOR has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on AIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.973449	0.7627
Test critical values:	1% level	-3.460884	
	5% level	-2.874868	
	10% level	-2.573951	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(IP_NOR) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on AIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-14.07921	0.0000
Test critical values:	1% level	-3.460884	
	5% level	-2.874868	
	10% level	-2.573951	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: IP_NOR has a unit root
Exogenous: Constant
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.262095	0.6472
Test critical values:	1% level	-3.460596	
	5% level	-2.874741	
	10% level	-2.573883	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(IP_NOR) has a unit root
Exogenous: Constant
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-22.65993	0.0000
Test critical values:	1% level	-3.460739	
	5% level	-2.874804	
	10% level	-2.573917	

*MacKinnon (1996) one-sided p-values.

Appendix 6. Serial Correlation test for Finland with two and three lags

VEC Residual Serial Correlation LM Tests
Date: 01/02/19 Time: 12:49
Sample: 2000M07 2018M07
Included observations: 214

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	37.95058	25	0.0468	1.533629	(25, 718.5)	0.0468
2	27.95753	25	0.3098	1.122033	(25, 718.5)	0.3099
3	24.15688	25	0.5103	0.966964	(25, 718.5)	0.5105
4	21.53789	25	0.6623	0.860577	(25, 718.5)	0.6624
5	11.48671	25	0.9902	0.455807	(25, 718.5)	0.9902
6	35.31329	25	0.0827	1.424456	(25, 718.5)	0.0828
7	32.34107	25	0.1484	1.301890	(25, 718.5)	0.1485
8	34.32597	25	0.1011	1.383686	(25, 718.5)	0.1012
9	20.45392	25	0.7226	0.816655	(25, 718.5)	0.7227
10	34.26247	25	0.1024	1.381066	(25, 718.5)	0.1025
11	28.89413	25	0.2684	1.160371	(25, 718.5)	0.2685
12	67.65070	25	0.0000	2.790717	(25, 718.5)	0.0000

*Edgeworth expansion corrected likelihood ratio statistic.

VEC Residual Serial Correlation LM Tests
Date: 02/02/19 Time: 14:51
Sample: 2000M07 2018M07
Included observations: 213

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	36.45363	25	0.0650	1.472038	(25, 696.2)	0.0651
2	24.16252	25	0.5100	0.967213	(25, 696.2)	0.5101
3	31.59047	25	0.1702	1.271247	(25, 696.2)	0.1703
4	17.55206	25	0.8608	0.699310	(25, 696.2)	0.8609
5	16.01331	25	0.9144	0.637307	(25, 696.2)	0.9145
6	31.45367	25	0.1744	1.265619	(25, 696.2)	0.1745

*Edgeworth expansion corrected likelihood ratio statistic.

Appendix 7. Serial Correlation test for Sweden with two and four lags

VEC Residual Serial Correlation LM Tests
Date: 01/02/19 Time: 12:53
Sample: 2000M07 2018M07
Included observations: 214

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	36.05048	25	0.0708	1.454933	(25, 718.5)	0.0709
2	49.08778	25	0.0028	1.999039	(25, 718.5)	0.0028
3	37.15952	25	0.0558	1.500841	(25, 718.5)	0.0558
4	46.41019	25	0.0057	1.886497	(25, 718.5)	0.0058
5	17.53225	25	0.8616	0.698598	(25, 718.5)	0.8616
6	32.16578	25	0.1533	1.294677	(25, 718.5)	0.1534
7	46.04041	25	0.0063	1.870987	(25, 718.5)	0.0064
8	47.89139	25	0.0038	1.948702	(25, 718.5)	0.0038
9	31.33995	25	0.1780	1.260719	(25, 718.5)	0.1781
10	31.01121	25	0.1886	1.247211	(25, 718.5)	0.1888
11	24.00654	25	0.5190	0.960847	(25, 718.5)	0.5191
12	109.6811	25	0.0000	4.659414	(25, 718.5)	0.0000

*Edgeworth expansion corrected likelihood ratio statistic.

VEC Residual Serial Correlation LM Tests
Date: 02/02/19 Time: 15:05
Sample: 2000M07 2018M07
Included observations: 212

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	15.35813	25	0.9326	0.610836	(25, 673.9)	0.9326
2	28.41464	25	0.2891	1.141003	(25, 673.9)	0.2893
3	17.06702	25	0.8793	0.679653	(25, 673.9)	0.8794
4	34.17539	25	0.1042	1.378152	(25, 673.9)	0.1043
5	15.88230	25	0.9183	0.631926	(25, 673.9)	0.9183
6	20.59164	25	0.7151	0.822134	(25, 673.9)	0.7153

*Edgeworth expansion corrected likelihood ratio statistic.

Appendix 8. Serial Correlation test for Norway with two

VEC Residual Serial Correlation LM Tests
Date: 01/02/19 Time: 12:55
Sample: 2000M07 2018M07
Included observations: 214

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	15.97914	25	0.9154	0.636032	(25, 718.5)	0.9155
2	21.12114	25	0.6858	0.843683	(25, 718.5)	0.6859
3	23.67221	25	0.5384	0.947247	(25, 718.5)	0.5385
4	32.12671	25	0.1544	1.293069	(25, 718.5)	0.1545
5	22.44767	25	0.6098	0.897490	(25, 718.5)	0.6099
6	27.89048	25	0.3129	1.119290	(25, 718.5)	0.3130
7	40.62219	25	0.0251	1.644626	(25, 718.5)	0.0252
8	33.15621	25	0.1272	1.335454	(25, 718.5)	0.1273
9	20.80991	25	0.7032	0.831073	(25, 718.5)	0.7033
10	17.10327	25	0.8780	0.681303	(25, 718.5)	0.8781
11	20.24512	25	0.7339	0.808203	(25, 718.5)	0.7339
12	56.31313	25	0.0003	2.304797	(25, 718.5)	0.0003

*Edgeworth expansion corrected likelihood ratio statistic.