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Unveiling the Predictive Power

A Thesis Examining the Predictive Ability of Macroeconomic Factors and its Causal Effect on the Returns of the Swedish Stock Market

Authors

Alex Lundvall

Gabriel Ahonen

Supervisor

Claudio Daminato

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Abstract

To obtain excessive returns on the stock market, investors should be able to effectively forecast what drives the fluctuations of the stock market. The usage of macroeconomic factors as indicators for stock market performances has been utilized more profoundly in recent times. However, the implications of the efficient market hypothesis suggests that such macroeconomic factors cannot be used to predict stock market returns. This thesis investigates the predictive power of different selected macroeconomic variables on the returns of the Swedish stock market during the period from January 2002 until December 2019. The relationship between the Swedish stock market index OMXS30 and the inflation rate, repo rate, STIBOR rate, unemployment rate and the industrial production index are being analyzed by utilizing the Vector Autoregression model and the Granger causality test. The results from this study suggest that inflation has some predictive power on the returns of the Swedish stock market and that the unemployment rate shares a positively associated relationship with the returns.

1. Introduction

In more recent years, the returns of the stock market are increasingly used as an indicator of the prosperity and the performance of the overall economy. By using the realization of some macroeconomic variables and their relationship to the returns of the stock market, one can use the perception of the relationship to predict the future performance of the stock market and control for their individual risk exposure. However, the theoretical framework of stock market efficiency is still of great importance when evaluating potential correlations because a statistical relationship would dispute the theories of efficiency and unpredictability in stock market prices.

In this study, we will investigate the causal effects on the returns of the Swedish stock market index OMXS30 together with some macroeconomic factors between January 2002 and December 2019. More precisely, we will use the inflation rate, repo rate, STIBOR rate, unemployment rate and the industrial production index to test if each of the macroeconomic determinants can be used as predictors when forecasting the stock market return. To be able to obtain an adequate sample, all of the data has been collected and recorded with monthly observations. In order to test for stationarity among the variables, the augmented Dickey-fuller test has been used along with the Akaike Information Criterion (AIC) to find the optimal lag selection. Furthermore, we have performed the Breusch-Godfrey (LM) test in order to check for model misspecification. Lastly, we have conducted the Vector Autoregression model and the Granger causality test in order to examine if our macroeconomic variables have predictive power on the stock market returns.

1.1 Purpose

The main purpose of this study is to examine if the returns of the Swedish stock market index OMXS30 can be explained by some macroeconomic variables during the period of 2002-2019. That is, if such macroeconomic variables can help in predicting the future performance of the stock market and if the relationship is either positive, negative or non-existing. With this in minds, we hope to be able to answer the following research question:

Do macroeconomic variables have predictive power on the returns of the Swedish stock market?

By using the framework of a Vector Autoregression model together with a Granger causality test, we will be able to examine the statistical significance between the macroeconomic variables and the stock market return as well as the predictive power in each of the variables. We acknowledge that similar studies and methodologies on the subject have been studied earlier but there exists a great consensus arguing that the results from such studies differ in terms of macroeconomic variable usage and the chosen time series. Furthermore, the results from these studies display different results depending on which country-specific stock market that has been utilized. For the time being, the studies conducted in Sweden, on the Swedish stock market are fairly limited and those conducted are performed with similar approaches in their respective methodology. By using the inflation rate, repo rate, STIBOR rate, unemployment rate and the industrial production index to examine their individual relationship with the stock market return in Sweden, we hope to contribute to the research field of the Swedish stock market. With this in mind, we furthermore hope to facilitate knowledge about whether the theoretical framework of stock market efficiency and unpredictability is sufficient in a small and open economy.

1.2 Results

Our empirical findings from the Vector Autoregression model and the Granger causality test suggest that inflation has some predictive power on the returns of the Swedish stock market.
The output from the Vector Autoregression model shows that unemployment has a positively associated relationship with the Swedish stock market return. However, the findings from the Granger causality test suggests that unemployment does not Granger cause the returns. Both the Vector Autoregression model and the Granger causality test provides evidence that the repo rate, STIBOR rate and the industrial production index does not have any predictive power on stock market returns. Similarly, no causal effect has been identified for these variables on the returns of the stock market

2. Previous studies

Numerous investigations from various papers, financial analysts and articles have in recent decades attempted to forecast the relationship between the stock market returns and different macroeconomic determinants. Through empirical studies and different methods they have analyzed the impact of macroeconomic variables on stock prices, focusing on one single variable or the relationships between several. However, the results of these studies have yielded varying conclusions, depending on the combination of variables, methodologies and what kind of test that has been utilized. In this section, we will examine past research papers and their respective empirical findings. These findings will be used at the end of our analysis to discuss if our statistical results are consistent with the previous studies or not.

Chen, Roll, and Ross (1986) investigated the influence of macroeconomic variables on stock market returns and how innovations in the variables may affect future performances of the stock market. The nine variables of interest in their study were inflation, treasury bill rate, long-term government bonds, industrial production index, low-grade bonds, equally weighted equities, value-weighted equities, consumption and oil prices. These variables were used to evaluate the multifactor model within the United States with monthly observations during 1958-1984 and the innovation of the variables were estimated by using the residuals of a Vector Autoregressive model. According to the findings in their paper, the consumption and oil prices were not linked to the financial market. Instead, industrial production, the change in long-term government bonds and low-grade bonds were all found to have a significant relationship with the U.S. stock market returns.

Another study by Fifield et al. (2002), examined how global and local economic factors affected the returns of emerging stock markets (ESMs). The authors used data from a range of emerging markets to find evidence that the local economic factors that could cause a significant relationship are GDP, inflation, money and interest rate. At the same time, the selected global economic factors such as the industrial world production and world inflation can be considered sufficient to capture the essence of the macroeconomic conditions on a global scale. The chosen methodology by the authors was to conduct a principal component analysis using these factors to explain the index returns of 13 emerging stock markets between 1987 and 1996. The study suggested that both global and local economic factors play a significant role in explaining the stock market returns. However, the local and global factors should not be seen as equally inducers because they prevail differently in each country and the authors argue that this should be considered by investors when making investment decisions in emerging markets.

Gan et al. (2006) aimed to investigate the interaction between macroeconomic variables and the stock market in New Zealand. To accomplish this, the authors used seven different macroeconomic variables and performed two cointegration tests, Johansen and the Granger causality test. The variables used in their study are the inflation rate, exchange rate, GDP, money supply, long- and short-term interest rate and finally the domestic retail oil price. Furthemore, the authors used the innovation accounting analysis to examine the short-term relationships between the stock market index NZSE40 and the seven different macroeconomic factors. The study revealed that interest rates, money supply and real GDP consistently influenced the NZSE40, but there was no empirical evidence to suggest that the New Zealand stock index serves as an economic indicator for fluctuations in macroeconomic variables from January 1990 to January 2003.

In a study conducted by Samveg (2012), eight different macroeconomic variables are investigated as determinants for the performance of the Indian stock market. The variables used for estimation are the interest rate, inflation, exchange rate, industrial production index, money supply and the price of silver, oil and gold. Furthermore, the author examined these variables on two stock market indices that represent the Indian stock market and the data is recorded by using monthly observations from Januari 1991 until December 2011. By using the augmented Dickey-fuller test for unit root together with the Johansen Cointegration, the Granger causality test and lastly the Vector Error Correction Model (VECM) the author discovered that inflation and money supply have a long-term relationship with the Indian stock market.

The relationship between the stock market returns and macroeconomic variables is also commonly studied within universities as bachelor or master theses. One such bachelor thesis from Nordenberg and Shaqiri (2019) examined the relationship between the return of three different Swedish stock market indices and some macroeconomic variables during the time series of 2003-2019. In their study, they use the interest rate, the inflation rate, the exchange rate, the yield curve, and the unemployment rate as macroeconomic factors when investigating the return on the Swedish stock market. The methodology in their thesis is to utilize a Vector Autoregression model to examine the relationship between the macroeconomic variables and the stock market return in Sweden. Their findings suggest that on each of the three stock market indices, the variables have some differences in their respective causal relationship but they acknowledge that the repo rate seems to have a consistent causal relationship for all of the three indices.

2.1 Variable literature review

Inflation

To what extent the inflation rate affects the OMXS30 index will be crucial in our analysis because as Fama (1981) discussed, stock returns tend to be negatively correlated with inflation. To exemplify this contention, it means that stock returns tend to be higher when the economy is growing and lower when inflation is high. Fama (1981) examined the relationship between stock returns and inflation in the mid 1950s and found that the relationship is negative due to the fact that higher inflation induces a more moderate and less profound real economic activity which leads to lower returns. This finding will be of interest in our study because with the negative correlation between stock return and inflation in mind, we will examine if the same result holds in more recent years.

Chen (2009) argued that the inflation rate is a very useful predictor when examining the future performance of the stock market. However, the author provided evidence that the inflation rate has a better predictive power for the direction the stock market is heading instead of the absolute value of the stock returns. Nevertheless, Chen (2009) claimed that the inflation rate is one of the most evident macroeconomic variables in explaining the significant relationship with the stock market but exactly where the predictive power is located, is not as clearly. Contrary to this finding, Westerlund et al. (2015) argued that the inflation rate does not in general work as a predictor for stock market returns. However, they showed minor evidence proving that inflation has some predictive power in forecasting stock returns for smaller sized stocks but this result was limited. From these previous studies, it is evident to see that the findings on the relationship between the inflation rate and stock market returns is bisectional. With this in mind, it will be crucial in our study to examine if the statistical relationship exists and if this is the case, to what extent the inflation rate has predictive power on the stock market returns.

Repo Rate

Since the repo rate has such a crucial role for the Swedish economy it will be important to examine if there exists a relationship between the repo rate and the stock market. If this will be the case we should expect that changes in the repo rate may also lead to changes in the stock market returns. Alam and Uddin (2009) investigated the relationship between major interest rates and stock prices, focusing on both developed and developing countries. Their findings in developed countries, which are more relevant for our study, indicated that changes in interest rates can have a significant impact on stock prices. More specifically, they suggested that when interest rates rise, investors may shift their investments away from stocks and towards alternative assets that offer higher yield potential.

STIBOR

Ang and Bekaert (2006) found in their study that interest rates can have predictive power to some extent on the future stock returns. Nonetheless, they argued that this relationship is limited to the short run and that the effect is weak due to inconsistency of results across various samples and different time periods. The reason behind these findings is that the relationship between interest rates and stock returns could be highly dependent on other macroeconomic variables that affect the market economy in its entirety.

Unemployment

In a study conducted by Boyd, Hu, and Jagannathan (2005), the authors examined the effects of unexpected changes in the unemployment rate on stock returns. Their study focuses on how the news of unemployment affects the stock market. According to their findings, during periods of economic expansion, an announcement of increased unemployment tends to be beneficial for stock returns, whereas it is likely to be detrimental during economic contractions. With this in mind, it may be important to consider the state of the economy and the level of unemployment in our study when analyzing the predictive power of macroeconomic variables on stock returns.

Industrial production index

Chang and Pinegar (1989) examined the relationship between the industrial production index and the return of the stock market on certain seasons during a year. They found evidence that changes in the seasonal industrial production index during growth peaks in the industries tend to be associated with stock market peaks. More precisely, during February and August when firms present their fiscal performances and their real activity, the stock market responds accordingly to the accomplishments of the industries. The authors acknowledge that this goes in line with the hypothesis that stock market returns reflect real economic activity. Chang and Pinegar (1989) argued that the stock return of large firms Granger causes future economic growth in the industrial production industries. This means that the seasonal stock returns of individual large firms can predict future performance and when the industrial production increases, the seasonal stock market return tends to increase. As previously mentioned, Chen, Roll, and Ross (1986) also investigated whether industrial production has a significant effect on the stock market return in the United States. They found strong evidence proving that industrial production affects the expected stock return.

The industrial production index will be of profound interest when we examine the relationship between the variable and the Swedish stock market index. The above mentioned findings alleged that the stock market return tends to follow the performance of the large industries in the economy and would therefore suggest larger returns when the industrial production increases. It will be of interest to examine whether these findings are consistent with the Swedish data that will be used in our study and we will investigate if the industrial production index in Sweden has predictive power on the returns of the stock market.

2.2 Short subject discussion

From the above listed previous studies, it is straightforward to conclude that the subject already is well studied. Therefore, in this subchapter we will briefly explain how our study will differ from other studies. Some of the macroeconomic variables and tests that have been constructed previously will be used in this study as well. This includes the augmented Dickey-fuller test for unit root and the Granger causality test that has been previously used by Samveg (2012). However, the author used a Vector Error Correction Model (VECM) whereas we will use a Vector Autoregression model (VAR) to conduct the analysis. In a study by Gan et al. (2006), they investigated the effect of different macroeconomic variables including inflation and interest rate and the same two variables will be used in our analysis, however, we will examine the stock market return with respect to a Swedish stock market index. Their study found evidence of a strong relationship between the stock market and several of the examined macroeconomic variables when using a VAR model. Similarly, we will be using a VAR model when constructing our analysis and examining the significance of the Swedish stock market return because of the models adequacy in the subject. Considering the historical impact of inflation rates on various economies, it is likely that a long-term relationship exists between inflation and the returns of the Swedish stock market.

Nordenberg and Shaqiri (2019) investigated if there exists a causal relationship between the returns of the Swedish stock markets and some macroeconomic variables by using a Vector Autoregression (VAR) model. In our analysis, we will use a similar approach but we will not use the exchange rate and the yield curve as macroeconomic determinants because these variables are commonly studied when investigating the relationship with the stock market return. Instead, we will use the industrial production index together with the inflation rate, Swedish repo rate, STIBOR rate and the unemployment rate. Nordenberg and Shaqiri (2019) investigated the relationship during the period 2003-2019 with monthly observations for the stock returns using three stock market indices. We will also examine the relationship with monthly observations to obtain adequate data but instead during the time series of 2002-2019 and with respect to one large single stock market index, the OMXS30. By doing this, we will be able to capture a larger share of the total stock market value which we believe will give us more efficient results because our chosen index represents the largest money circulation each traded day on the Swedish stock market. We acknowledge the similarity in the time frame and the chosen methodology, however the final result of the analysis will be highly dependent on the chosen variables and the possibilities that the variables may influence each other. In our study, we will therefore expect to see different results and explanations which we believe will contribute to the overall research field of the Swedish stock market because it can potentially highlight that small variable changes can cause large outcome deviations.

3. Theoretical framework

In this section, we will present the theoretical framework that we will use in our analysis. We have decided to start from the efficient market hypothesis as the fundamental reasoning behind this thesis together with the random walk theory. Both theories will be used as a benchmark when conducting our research.

3.1 Efficient Market Hypothesis

The efficient market hypothesis (EMH) is a hypothesis which suggests that financial markets are efficient and that prices reflect all available information in the market. The implications of the EMH asserts that it is unfeasible for traders to buy stocks at undervalued or inflated prices because the offered market price on exchanges always reflects the true valuation of the stock. Consequently, it is impossible to outrank the overall market through specialist stock selections or market timing, hence the only means for an investor to attain higher returns is by purchasing stocks with higher risk (Investopedia, 2022).

Fama (1970) discusses the three forms of the efficient market hypothesis. The first one is the weak form, which suggests that prices reflect all past prices and trading volume information, but does not include public or insider information. The second form is the semi-strong efficient, which suggests that prices reflect all publicly available information, including different financial statements, news, articles and economic data. The third is the strong form, which implies that prices reflect all information available, including both public and insider information.

The concept of efficient markets is central for our analysis and has been extensively studied by economists and academics in relation to the capital market. The efficient market hypothesis is a major area of research and is frequently used when discussing the effect on the stock market return but there are divergent views on its validity. While some reject the EMH, others support it. According to Grossman and Stiglitz (1980), the criticism surrounding the EMH is that it assumes that all market participants have access to and uses the available information in an unbiased manner. However, in reality, information is not always distributed equally or interpreted in the same way by all market participants. As a result, some participants may have an informational advantage, allowing them to attain higher returns without purchasing stocks with higher risk. A more recent article written by French, K.R. (2008) provides evidence in favor of the EMH by examining the cost of active investing. French´s findings support the idea behind the EMH which suggests that it is difficult for investors to consistently outperform the market, as stock prices already incorporate all available information.

The efficient market hypothesis will be used as an efficiency benchmark in this study. Bearing in mind the theoretical concept behind the EMH, the three different forms explained by Fama (1970) will be used when discussing and interpreting the results of the relationship between the stock market returns and the different macroeconomic variables. Since the validity behind the EMH is double-barreled, it will be of interest in our study to see whether the recorded data for the Swedish stock market holds within the framework of the efficient market hypothesis. If the EMH holds, our results should indicate that the macroeconomic variables used in this study should not affect the returns of the OMXS30 stock market index.

3.2 Random Walk Theory

The random walk theory states that prices of various assets on the stock market move unpredictably. This means that previous trends or movements of the stock market price cannot be used to predict future prices and therefore, makes it impossible to precisely time the market. The above assertion is also a key assumption from the efficient market hypothesis, thus the EMH and random walk theory are frequently used together. By acknowledging this, the understanding of the random walk theory becomes evident; Stock market prices are both unpredictable and efficient. This means that all available information is incorporated into the stock prices and when new information arrives, the market adjusts quickly to this making it impossible to use fundamental analysis or past trading prices as an indicator for future prices (Investopedia, 2023a).

During the period of 1919-1990, Frennberg and Hansson (1993) tested if Swedish stock prices followed a random walk. In contradiction to the theory, they found that Swedish stock market prices did not follow a random walk pattern during their observed time because they identified profound evidence that stock returns were positively autocorrelated for shorter investment periods up to one year. Jennergren and Korsvold (1974) also examines the random walk theory and the assumption of the EMH on the Norwegian and Swedish stock markets. As in line with the random walk theory, they acknowledge that changes in the stock market prices are independent and identically distributed (IID) random variables. The authors found similar results as Frennberg and Hansson (1993), mainly that in shorter time periods the result indicates some evidence of positive autocorrelation in stock returns. However, Jennergren and Korsvold (1974) also found that both the Norwegian and the Swedish stock markets tend to follow a random walk for longer investment periods, indicating that the markets are efficient and that the theory behind a random walk holds.

The theory of a random walk will be of interest in our analysis because the evidence to which extent the random walk theory has proven to hold in reality is bisectional. For shorter investment periods, the result from previous studies is in contradiction with the theory, but for longer periods, the result is proven to be in line with the theory. In our analysis, we will use the random walk theory as a benchmark when conducting our regressions with a time period of one month between the observations.

4. Definitions, data and methodology

In the following chapter, we will define our variables and present how the data for the variables have been retrieved. We will also explain the methodology behind this study and why the chosen methodology is sufficient for this analysis.

4.1 Variable definitions

This subchapter explains in more detail each of the variables that will be used in our study. Our variable of interest will be the return of the Swedish stock market index OMXS30 and its relationship to the inflation rate, the Swedish repo rate, the STIBOR rate, the unemployment rate and the industrial production index.

4.1.1 OMXS30

OMXS30 is a stock market index consisting of the 30 most traded stocks on the Swedish Stock Exchange. The index is a market-weighted price index which means that the underlying stocks affect the value of the index with a weight that is proportional to the asset's total market value (Nasdaqomxnordic, 2023). In this study, the closing price of the OMXS30 index will be used when evaluating the stock market returns. The index suits the purpose of this analysis because it consists of large firms from various sectors across the whole Swedish stock market such as industry, finance and energy which enables us to capture a large share of the total market value. This assumption is also based on the reasoning that the index is the most used and recognized index that represents the Swedish stock market. As of 2023-03-28, the OMXS30 index consists of the 30 underlying stocks presented in appendix table A1 (Avanza Bank, 2023).

4.1.2 Inflation rate

Inflation is a macroeconomic phenomena in which the general price level in the economy increases and as a consequence, the purchasing power of the household could potentially decrease. The rise in prices means that the cost of the same basket of selected goods and services increases over time, making money less valuable because one unit of currency buys less than in previous periods. In Sweden, the usage of the Consumer Price Index (CPI) is the most common way to measure inflation. More precisely, the monthly changes in the CPI is used to account for the inflation rate. The CPI measures the price of the average basket of goods or services in the economy which is then used as a proxy for the rate of inflation under a certain time period. The target for the Swedish inflation rate is set by the Riksbank at a 2% rate increase on a yearly basis (Riksbanken, 2022a).

4.1.3 Repo rate

The Swedish repo rate, more commonly named the policy rate, is used by the Swedish central bank called the Riksbank to determine at which rate different banks can lend and deposit money from the central bank. The repo rate is also used to control the inflation target and stabilize the economy by either an increase or a decrease in the repo rate. Higher interest rates make borrowing money more expensive for individuals and for businesses which can lead to reduced spending. As a consequence, saving becomes more attractive due to the higher interest rates offered by banks. Reduced spendings can also lead to lower demand for goods and services which could be traced to a decrease in the inflation rate. Similarly, the opposite happens with a lower repo rate, the increased affordability that comes with lower interest rates leads to an increased spending, which then can result in a higher inflation (Riksbanken, 2022b).

4.1.4 STIBOR

STIBOR, also known as the Stockholm Interbank Offered Rate, is the most commonly used reference rate for financial contracts, loans and floating interest rates for Swedish kronor. It is the main interest rate at which Swedish banks offer to lend money from each other on the money market without collateral. The rate is also used as a benchmark when formulating the interest rates offered by the leading banks to households and corporations in Sweden. The STIBOR rate comes in different forms with durations ranging from one day to 6 months and it is regulated by the Swedish Financial Benchmark Facility (SFBF, 2023).

We also want to mention that there are other reference rates used in the Swedish economy such as the Swestr, which is a new reference rate that is used for shorter maturities such as day to day. The main difference between STIBOR and Swestr is that the latter is transactions-based and therefore less dependent on future estimations which STIBOR rely on (Riksbank, 2021). We have decided not to use Swestr because we want to analyze the reference rate with maturities on a monthly basis and therefore, Swestr will not be suitable for our analysis. This decision is also based on the fact that STIBOR is well established and that it is the most used reference rate by financial actors while Swestr is still in its initial running phase. With this in mind, we will use the one month STIBOR as a representative measurement for the interest rate in the Swedish economy that reflects the average interest rate at which banks are willing to lend to each other during a one month period.

4.1.5 Unemployment

The impact the unemployment rate might have on the stock market returns is not as commonly studied in Sweden in contrast to some of the other variables being used in this analysis. However, the reason behind the usage of the macroeconomic determinant is because of the effect the unemployment rate may have on the overall economy. For example, high unemployment rates suggest that the economy is not generating enough jobs which can lead to a decline in productivity as fewer individuals are in fact working. While a low unemployment rate often signifies a thriving economy. This is evident in the stock market as investors are more feasible to invest in prosperous companies (Forbes, 2022).

4.1.6 Industrial production index

This index is an economic indicator for industry-level data that measures the real output in the manufacturing, mining, electric and gas sectors. The industrial production index (IPI) is measured relative to a base year and the index is commonly used by investors and economists as an macroeconomic indicator for certain industries and for overall economic growth. The index is presented on a monthly basis and since it measures the real output in each industry, it encompasses both the total level of production and capacity which makes the index a useful tool when forecasting future economic performances. Furthermore, the industrial production index is a vital indicator for policymakers to stimulate the economy with fiscal and monetary policies. The capacity utilization displayed in the index indicates the demand in the industrial sector and a low capacity utilization is a signal for overcapacity with weak demand, whereas a high capacity utilization could be a sign of the economy overheating with increasing prices. In that sense, the index is a sufficient indicator for policymakers to intervene and stimulate the economy to avoid a boom bust business cycle (Investopedia, 2021).

4.2 Data

The data in this study will be time series data that contains a total of 216 observations for each variable. All of the observations have been recorded on a monthly basis starting in January 2002 until December 2019, which covers 18 years of observations. The reason behind the chosen timeline is that we want to provide valuable insight into how our specific variables affect the returns of the Swedish stock market over an extended period, different market conditions and during major global events. The period from January 2002 to December 2019 covers both the global financial crisis and the European debt crisis. We believe that it is interesting to analyze the impact of macroeconomic variables during these events because it can provide insights into how these variables affect the stock market returns during times of crisis. Even though more recent data is available for the variables, we have chosen to delimit our study to 2019 as we want to exclude the COVID-19 crisis from our analysis. The main reason is because of the lack of historical data compared to the global financial crisis and the European debt crisis. By excluding the COVID-19 crisis we can focus on a more established period, which we believe will provide more robust and reliable results.

The data has been collected from numerous sources that are commonly used and recognizable as sources with good credibility. The closing price of the stock market index OMXS30 has been collected from Investing.com. Data for the Consumer Price Index (CPI), the unemployment rate and the industrial production index has been retrieved from Statistics Sweden (SCB). The data for the Swedish repo rate and the STIBOR rate has been gathered from the Swedish Riksbank. All of the data will be applied to the statistical software program STATA where we will conduct the econometric analysis.

Before we perform our analysis, we need to assure that the data is in a suitable format to avoid skewness and estimation errors. The retrieved data is stored in both percentage and index values and to combine these in our estimations could lead to interpretation problems because they represent different scales of measurement. We will start by transforming indices, more precisely the OMXS30 stock market index and the industrial production index, into natural logarithmic values. The reason behind this is to partly adjust for the possibility of capturing data that is non-linear because both the indices may be subject to volatility and fluctuations over time. Consequently, not taking the logs of the indices could potentially cause a less accurate response in the relationship between the variables making the data more likely to present varying results. This transition is also made because we want to make sure to prevent a skewed distribution in the dataset and impede extreme values that could potentially affect the final outcome of the estimation. We will however not transform the values for the inflation, repo rate, STIBOR and the unemployment rate since they are already stored in percentage and take values close to zero with a small standard deviation.

It would be possible to directly use the returns of the stock market, without taking the natural logarithm of the value. As will be discussed later in this chapter in section 4.3.1, when taking the first difference of the natural logarithmic value of an index, one receives the returns of the index. The reason behind the transformation into natural logarithmic values is that we want to analyze the relationship between the stock market return and the several macroeconomic variables by a percentage increase or decrease, instead of the absolute value increase or decrease (Claret Asset Management, 2022).

The following table is a summary description of our statistics for each of the variables in this study. As table 1 shows, it includes the variables that have been transformed into natural logarithmic values and the variables that have not been transformed. The two transformed variables are defined as follows; “Ln_OMXS30” is the natural logarithmic value of the Swedish stock market index and “Ln_IPI” is the natural logarithmic value of the industrial production index in Sweden. For further information about the variable definitions, see table 2 below.

Table 1 - Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Ln_OMXS30	216	6.964	0.342	6.1	7.48
Inflation	216	1.262	1.192	-1.9	4.4
RepoRate	216	1.357	1.552	-0.5	4.67
STIBOR	216	1.529	1.654	-0.729	5.13
Unemployment	216	7.448	1.033	5.4	10
Ln_IPI	216	4.655	0.063	4.511	4.792

Source: Investing.com, SCB, Sveriges Riksbank

Table 2 - Variable description

Variable	Definition	Source
Ln_OMXS30	The monthly natural logarithmic value of the Swedish stock market index OMXS30	Investing.com
Inflation	The percentage change in the inflation rate on a monthly basis	Statistics Sweden (SCB)
RepoRate	The percentage change in the repo rate on a monthly basis	Riksbanken
STIBOR	The percentage change in the STIBOR rate on a monthly basis	Riksbanken
Unemployment	The percentage change in the unemployment rate on a monthly basis	Statistics Sweden (SCB)
Ln_IPI	The monthly natural logarithmic value of the industrial production index (IPI).	Statistics Sweden (SCB)

4.3 Methodology

In this study, we will be using a Vector Autoregression (VAR) model to analyze the relationship between the returns of the OMXS30 index and the numerous macroeconomic variables stated in section 4.1 to examine the stock market return over time. Similarly, we will also be using the Granger causality test together with the VAR model to examine if there exists some predictive power in the macroeconomic variables. The following subchapters describe in more detail each part of the models and the tests as well as the preparatory work that has to be conducted before we perform our final estimation.

4.3.1 Stationary or Non-stationary time series

The first step in a time series analysis is to determine if a time series is stationary or non-stationary as it can impact the choice of model and method used to analyze the data. A stationary time series is one whose statistical properties remain constant over time. Dougherty (2016) writes that a time series is said to be stationary if it follows these three conditions:

> “1. The mean of the distribution is independent of time
> 2. The variance of the distribution is independent of time
> 3. The covariance between its values at any two time points depends only on the distance between those points, and not on time“ (p.481).

Any violation of these three conditions is described as a non-stationary time series. The issue with analyzing non-stationary time series is a problem called spurious regressions. This occurs when two non-stationary variables are regressed against each other, resulting in a high coefficient of determination that suggests a strong relationship between the variables, even though there may not be any meaningful causal relationship between them (Dougherty, 2016).

In order to determine if our time series is stationary or not we have conducted the augmented Dickey-fuller (ADF) test. The ADF test allows for higher-order autoregressive processes in comparison with the ordinary Dickey-fuller test and the formula for the ADF test is written as following:

$$\Delta y = \alpha + \beta t + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + \delta_2 \Delta y_{t-2} + ... + \delta_j \Delta y_{t-j} + \epsilon_t$$

$$H_0 : \delta = 0$$
$$H_a : \delta < 0$$

We want to test the null hypothesis $H_0 : \delta = 0$ against the alternative $H_a : \delta < 0$. Rejecting H_0 implies that the stability condition holds, hence we have stationarity and this means that the variable is integrated of order zero I(0). If we however fail to reject the null hypothesis then the outcome of the test is that the variable is non-stationary. If this is the case we then take the first differences of the series and perform the ADF test once more on the transformed series. This process is repeated until we can reject our null hypothesis (Dougherty, 2016).

Taking the first difference of the natural logarithmic value of the stock market index OMXS30 is crucial in this study. The reason behind this is because when the natural logarithmic value of OMXS30 becomes integrated of order one, it becomes stationary which means that it highlights the return of the stock market index which is the main variable of interest in this study. The result of this I(1) natural logarithmic OMXS30 variable and its causal effect with the other macroeconomic variables will then be examined with the results from the VAR model and the Granger causality test.

4.3.2 Lag selection

Determining the appropriate lag length is a crucial aspect of specifying a Vector Autoregression (VAR) model. The number of lags included in a VAR model affects both the model's performance and accuracy as well as its ability to capture the dynamics of the underlying system. Braun and Mittnik (1993) illustrated that estimates of a VAR with an incorrect lag length are unreliable, resulting in the model showing false impulse response functions and variance decompositions. Overfitting by selecting a higher lag order than required can lead to a higher mean-square forecast errors, as noted by Lütkepohl (1993), while using too few lags may lead to autocorrelated errors.

In this study, we have chosen to use the Akaike Information Criterion (AIC) in order to choose the optimal lag selection. Akaike (1973) first explained the criterion in his paper and concluded that the basic formula for the AIC takes the following form:

$$\text{AIC} = -2\log(L)+2k,$$

where L is the likelihood of the data given the model and k is the number of parameters in the model. The AIC penalizes models with a large number of parameters, which tend to overfit the data by adding a penalty term to the log-likelihood.

4.3.3 Breusch-Godfrey LM test for Autocorrelation

The Breusch-Godfrey test (LM test) for autocorrelation is a commonly used method to check for autocorrelation in time series data. The assumption of non-autocorrelation states that the disturbance term in each observation should be independent of its values in all other observations, resulting in:

$$cov(\mathrm{u}_t,\mathrm{u}_{t'}) = 0$$

$$\text{where } t' \neq t.$$

If this assumption is breached, it implies that the presence of autocorrelation or serial correlation exists in the disturbance term. If the outcome of the test results in autocorrelated time series, the consequences could be severe. Autocorrelation can lead to biased estimates of regression coefficients with inconsistent standard errors hence inference cannot be trusted (Dougherty, 2016).

4.3.4 Vector Autoregression model

The Vector Autoregression (VAR) model is an extension of the univariate autoregressive model used for multivariate time series analysis. It has been proven that the VAR model is very useful explaining the interaction and relationship between multiple time series variables over time and the model is especially applicable when forecasting future performances and describing the economic behavior between endogenous variables (Wang and Zivot, 2006). Sims (1980) argued that the reason behind the VAR model's adaptability on complex interactions between multiple variables simultaneously is because the model does not make simplifying assumptions about exogeneity as other traditional macroeconomic models often do. That is, each variable is treated endogenously where past values of the variables will be considered as predictors for the current values with respect to each of the endogenous variables. This means that the variables included in the VAR model will be regressed with ordinary least squares (OLS) on its own lagged values and also on the lagged values of each of the other endogenous variables that are included in the model. Mathematically, the Vector Autoregression model that is stationary takes the following form:

$$Y_t = c + ß_1 Y_{t-1} + ß_2 Y_{t-2} + \ldots + ß_p Y_{t-p} + \varepsilon_t$$
$$\text{where } t = 1,\ldots,T.$$

Y_t is a vector (n*1) of the time series variables in the model and the $ß_p$ are coefficient matrices (n*n). In the model there is also an unobservable zero mean white noise vector (n*1) process, ε_t, that is serially independent or uncorrelated with the time invariant covariance matrix and c denotes a constant (Wang and Zivot, 2006). Lastly, we want to point out that the VAR model does not explicitly make any assumption about the direction of the potential causality between the observed variables. However, the reason behind the usage of the VAR model is because it enables us to capture the joint dynamics of the variables. This means that with the result from the VAR model, we will be able to see if there exists indications of a statistical relationship between the returns of the stock market and the several macroeconomic factors and if the relationship is positively or negatively associated.

4.3.5 Granger Causality test

In combination with the framework of the Vector Autoregression model, we will perform a Granger causality test to see if a stationary time series Granger causes another time series. That is, to examine whether past values of a variable can predict the future values of one variable. Granger (1969) described the causality interpretation and argues that if variable Y is causing the development of variable X, then the causality condition holds if one is better off predicting X when using all the past available information on Y, as against if the information on Y would not have been used. Granger (1980) defined the causation as a probability statement and concludes that Y_n is Granger causing X_{n+1} if:

$$\text{Prob}(X_{n+1} \in A \mid \Omega_n) \neq \text{Prob}(X_{n+1} \in A \mid \Omega_n - Y_n).$$

X_{n+1} is a random variable at time $n+1$, Ω_n denotes all the information that is available and A is the current set for the variables. Ω_n - Y_n is all the information available minus the information set contained in Y_n at time n.

With this in mind, the Granger causality test enables us to examine in more detail if there exists a causal effect on the returns of the stock market. More specifically, by looking at the direction of the causality we can interpret exactly which variable is Granger causing the OMXS30 index, and the other way around.

5. Results

In this section the result from our findings will be presented. In accordance with the methodology, each result will be presented with a table explaining the estimations. Note that the tables is featured either in this chapter, or in the appendix.

5.1 Augmented Dickey-Fuller test

To check if the variables that are being used in this study are stationary or not, we have performed the augmented Dickey-fuller test. The result of the test can be read from the tables below, where table 3 shows the result from the ADF-test without taking the first difference, and table 4 shows the result from the ADF-test while taking the first difference from the non-stationary variables. The null hypothesis H_0 : $\delta = 0$ "there is a unit root" can be rejected on different critical values as stipulated in both table 3 and 4. We have decided to use the $\alpha = 0,05$ significance level with a lag selection of two when conducting the analysis and if the null hypothesis cannot be rejected in the first ADF-test, the first difference has been conducted in the second ADF-test.

As presented in table 3, the test reveals that the OMXS30, repo rate, STIBOR and the industrial production index are non-stationary integrated at order zero I(0). Furthermore, the test shows that inflation and unemployment is stationary when performing the ADF-test the first time without taking the first difference. When performing the ADF-test again, excluding the already stationary variables and taking the first difference of the rest of the non-stationary variables, they become stationary as first order integrated I(1) variables which is presented in table 4. The first differenced variables are rebranded as follows: d.Ln_OMXS30, d.RepoRate, d.STIBOR and d.Ln_IPI where "d." represents the first difference according to the formula:

$$d.Variable_t = Variable_t - Variable_{t-1}.$$

Table 3 - ADF result without first differences

Variables	Test statistics	1% Critical value	5% Critical value	10% Critical value	P-value for Z(t)
Ln_OMXS30	-0.808	-3.468	-2.882	-2.572	0.8167
Inflation	-2.938	-3.468	-2.882	-2.572	0.0411*
RepoRate	-2.229	-3.468	-2.882	-2.572	0.1960
STIBOR	-1.825	-3.468	-2.882	-2.572	0.3682
Unemployment	-3.215	-3.468	-2.882	-2.572	0.0191*
Ln_IPI	-1.652	-3.468	-2.882	-2.572	0.4559

Note: * = stationarity

Table 4 - ADF results with first differences

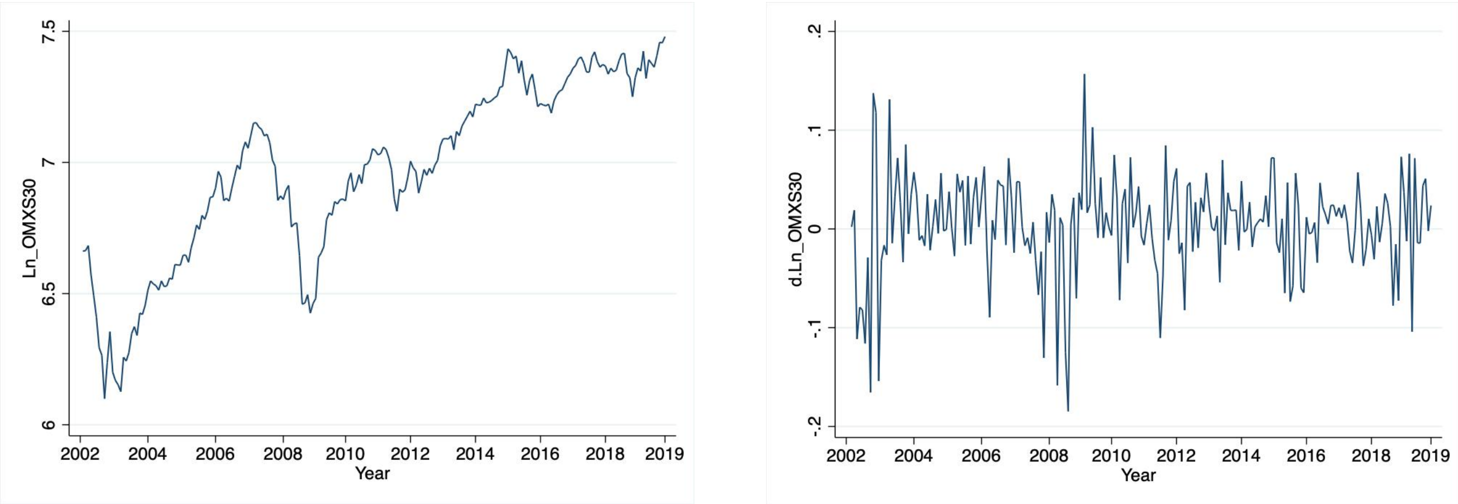
Variables	Test statistics	1% Critical value	5% Critical value	10% Critical value	P-value for Z(t)
d.Ln_OMXS30	-6.794	-3.468	-2.882	-2.572	0.0000*
d.RepoRate	-5.460	-3.468	-2.882	-2.572	0.0000*
d.STIBOR	-5.740	-3.468	-2.882	-2.572	0.0000*
d.Ln_IPI	-9.214	-3.468	-2.882	-2.572	0.0000*

Note: * = stationarity

Graph 1 below represents the variable Ln_OMXS30 before and after the transformation of the first difference graphically. In consent with table 3 and 4 above, the stationarity properties for the rest of the variable are presented graphically in the appendix under the caption "graphs".

Graph 1 - stationarity properties of the Ln_OMXS30 variable

Ln_OMXS30 *d.Ln_OMXS30*



5.2 Akaike Information Criterion and the Breusch-Godfrey LM test

In order to find the optimal lag length in our model, we have as mentioned before decided to use the Akaike Information Criterion (AIC). The result of the test is presented in table A2 in the appendix. The table shows us the AIC as well as three additional tests for lag selection; Final Prediction Error (FPE), Hannan-Quinn information criterion (HQIC) and Schwarz information criterion (SBIC). The AIC suggests that the optimal lag selection for our data is two lags, and therefore two lags is what we have used in our analysis.

The result of the Breusch Godfrey test is presented in table A3 in the appendix. The result from the table tells us that we fail to reject the null hypothesis " no serial correlation" at both lag 1 and lag 2, hence we have no sign of model misspecification and we can proceed accordingly with the rest of the analysis.

5.3 Vector Autoregression Model

By using the VAR model, we have examined if there exists indications of a significant relationship between the returns of the stock market and the several other macroeconomic variables. This has been done by observing the *p*-values and coefficients that are associated with the lagged values for each of the variables and when looking at the output, we can interpret if the potential relationship between the variables is positive, negative or non-existing.

The result is presented in the appendix as table A4. From the output of the model's estimation, it is evident that unemployment has a significant relationship with the return of the stock market index OMXS30. The *p*-values presented in the output indicate the statistical significance of the estimated coefficient for each variable and the regressed lags. A lower *p*-value indicates a higher significance and as observed in table A4 in the appendix, the *p*-value for unemployment at lag 1 is 0,039 which means that the statistical significance is profound on a 95% confidence level in the short-run. The positive coefficient at lag 1 indicates that unemployment is positively associated with the returns of the stock market in the short run. The other variables do not show a evident significant relationship with the stock market return in either the short- or the long-run because the estimated *p*-values for both lag 1 and 2 is above the 5% confidence level on all of the variables.

5.4 Granger Causality Test

The last part of our analysis is to perform the Granger Causality test. As previously mentioned, we want to determine whether our variables can be used to predict the stock market return of OMXS30. We have performed the test with a significance level of 5% and with a lag number of two as the result of the Akaike Information Criterion (AIC) suggested. The result of the test is presented in table 5 below. If the *p*-value is less than 5%, the conclusion is that the excluded variable Granger causes the stock market return.

The result of the Granger causality test indicates that we have evidence supporting that inflation Granger causes the stock market returns. Even though the unemployment rate shows a positively associated relationship with the stock market return in the VAR model, the result from the Granger causality test leaves us with the observation that unemployment does not

Granger cause the stock market return. The rest of the variables are in line with the output from the VAR model meaning that the repo rate, STIBOR and the industrial production index does not have any significant relationship with the Swedish stock market return. Furthermore, when examining all the macroeconomic determinants together at the same time, we can observe a *p*-value of 0,004 which clearly indicates that when combining the macroeconomic variables, the predictive power becomes profound.

Table 5 - Granger Causality Wald tests

Equation	Excluded	chi2	df	Prob > chi2
d.Ln_OMXS30	Inflation	6.8404	2	**0.033***
d.Ln_OMXS30	d.RepoRate	1.6203	2	0.446
d.Ln_OMXS30	d.STIBOR	1.7827	2	0.410
d.Ln_OMXS30	Unemployment	4.3865	2	0.112
d.Ln_OMXS30	d.Ln_IPI	2.7399	2	0.254
d.Ln_OMXS30	ALL	25.984	10	**0.004***

Note: * = Granger causing is profound

6. Discussion and extensions

In this chapter, each of the examined variables will be discussed in more detail with regards to the findings in the result section as well as some previously evaluated studies on the subject. Furthermore, we will discuss possible explanations to why, or why not the variable of interest show a statistically significant relationship with the stock market return.

6.1 Inflation

From the Granger causality test, we observe that inflation is Granger causing the OMXS30 stock market return. This means that inflation contains valuable information that is useful for forecasting and predicting the value of the stock market return today and in the future. Fama (1981) found a significant relationship in his study and argued that there exists a negative correlation between future stock market returns and inflation. In our study we have discovered with the Granger causality test that there indeed exists a relationship between inflation and the Swedish stock market return. However, since the output from the VAR model shows an insignificant result, we cannot explain if the correlation is negative or positive, but from the Granger causality test we do see that the relationship is significant because inflation is Granger causing the stock market return.

The observed result for the inflation rate and its relationship to the Swedish stock market return is not as straightforward to see as Fama (1981) argued. Our result is instead somewhat in line with the findings of Chen (2009) because we observe the direction of the significance which indicates that the inflation rate does influence the stock market returns and not the other way around. Arguably, since the inflation rate has some predictive power on stock market returns, one could use this perception when making investment decisions and handling risk-exposure. From the results however, we cannot explicitly assert the positive or negative significance of this relationship, which furthermore goes in line with the evidence from Chen (2009).

6.2 Repo rate

From both the Granger causality test and the Vector Autoregression (VAR) model we find no evidence supporting that the repo rate has any long run or short run effect on the Swedish stock market return. Considering Sweden is a developed and open economy similar to the countries Alam and Uddin (2009) discussed in their paper, theories suggest that changes in different countries' interest rates could have an effect in the return of the stock market. Nevertheless, our empirical findings do not provide any support for a relationship between the stock market return and the repo rate. One possible explanation for this insignificant relationship could be due to the implications of market efficiency and the fact that changes in the repo rate is often anticipated beforehand. This means that if the stock market is efficient, fluctuations in the repo rate should be incorporated into stock prices quickly and the effects of the changes in the rate should only be fractional or negligible on the returns.

6.3 STIBOR

Our result indicates that the STIBOR rate does not have a significant relationship and it does not Granger cause the return of the stock market index OMXS30 during the period of 2002-2019. These results are to some extent in line with the empirical findings of Ang and Bekaert (2006) even though they argued that interest rates can have some predictive power on future stock returns. The reason behind this is because Ang and Bekaert (2006) suggested that if there exists a statistical significance, this relationship is often weak and highly dependent on other macroeconomic variables and the chosen sample of the time series. Therefore, our statistical insignificant result may be subject to the performance of other macroeconomic variables or some occasional chocks in the overall economy. We will not discuss further if the insignificant result is related to other variables since the purpose of this study is to examine the returns of the Swedish stock market index OMXS30 and not the relationship between the macroeconomic determinants.

However, one could argue that the increased interest rates prior to the financial crisis 2008 could have disrupted the relationship between the interest rates and the stock market. Similarly, the abruptly decreased interest rates in December 2008 lead to historically low rates and large fluctuations in the offered interest rates during a short time frame (Investopedia, 2023b). These fluctuations can be shown in the graph for the STIBOR rate in the appendix. Such profound shifts in the interest rates could potentially distort its relationship to the stock market which means that the financial crisis of 2008 could be one of the reasons behind the insignificant result from the VAR model and the Granger causality test. Nevertheless, we acknowledge that other factors could also explain the observed result in our study. This is something that could be investigated as further research.

6.4 Unemployment

Our result from the VAR model proves that unemployment has a positively associated relationship with the return of the Swedish stock market on lag 1. However, we observe an insignificant result from the Granger causality test, which means that unemployment does not

Granger cause the OMXS30 returns. The result from the VAR test is somewhat in line with the findings from Boyd, Hu, and Jagannathan (2005), telling us that the announcement of a rise in the unemployment rate has a positive relationship with the stock market during economic expansion and a negative relationship during economic contractions. Even though Boyd, Hu, and Jagannathan (2005) investigated the response of stock prices to the arrival of macroeconomic news, the result from their paper is similar to ours. When the unemployment rate gets higher, the returns of the stock market are shown to eventually increase given the time frame. Such a positively associated relationship could potentially imply that when unemployment rates are increasing, investors could see this as a signal of lower economic activity in the near future. At the same time, it is feasible to suggest that the government would try to stimulate the overall state of the economy by intervening with fiscal or monetary policies which could increase the expectations in the long-run, generating higher stock market returns.

6.5 Industrial production index

When examining the relationship between the industrial production index and the stock market return of OMXS30, we can conclude from the VAR model that there is no underlying significant relationship. Similarly, by observing the results from the Granger causality test in table 5, we can identify that the industrial production index is not Granger causing the returns of the OMXS30. However, when looking in the opposite direction in the Granger causality test presented in table A5 in the appendix, we can conclude that the stock market return is Granger causing the industrial production index. Our main interest with the Granger causality test was to examine if some of the macroeconomic variables Granger causes the stock market return, however in this case, we find that the direction of the statistical significant relationship was the other way around. This result goes in line with the empirical findings from Chang and Pinegar (1989) who found that the stock return of large corporations Granger causes the economic growth of the industrial production index.

6.6 Implications of the Theoretical framework

The efficient market hypothesis (EMH) and the Random Walk theory has been used as a benchmark for the theoretical framework in this study. As mentioned earlier, the theories suggest that the several macroeconomic determinants should not have an effect on the stock market return in Sweden during our chosen time series. This would then imply that all available information is incorporated into the stock prices in the market, as well as the prices of the stocks in the OMXS30 index following a random walk. However, from the results listed above it is clear to see that this is not the case in our study, because some variables share a statistically significant relationship with the stock market return. The inflation rate is shown to Granger cause the stock market return and the unemployment rate has a positively associated relationship with the returns of the Swedish stock market.

These statistically significant results indicate that the stock market is not fully efficient nor does the prices move unpredictable which means that some investors may have more disclosure about the available information than others while making investment decisions. This result is somewhat in line with the findings of Grossman and Stiglitz (1980) who argued that the available information in the stock market is not equally distributed, meaning that some market participants can take advantage of specific circumstances. Similarly, Frennberg and Hansson (1990) observed that the prices on the Swedish stock market did not follow a random walk during 1919-1990 which enabled investors to use past trading information as a prediction for future performance.

It is evident that the Swedish stock market contains some form of inefficiency and that the prices do not move unpredictably. Nevertheless, it is still difficult to give an explicit suggestion to how profound the market inefficiency is because some of our macroeconomic variables show results indicating no statistical relationship with the stock market return. However, recalling the three different forms of the EMH explained by Fama (1970), we would suggest that the OMXS30 index as a representative for the Swedish stock market is somewhat inefficient in the semi-strong form. That is, some macroeconomic data may not be fully incorporated into the stock prices in the sense that it does not follow a random walk which creates some predictive power for certain macro variables to affect the stock market return over time.

6.7 Limitations and further investigation

When we started with this study, we expected to observe a more profound statistical relationship between the stock market return and the several macroeconomic variables than what the result shows. According to some previous studies that we investigated before doing our analysis Chen, Roll, and Ross (1986) found empirical evidence showing that the industrial production index has a significant relationship with the stock market return in the U.S. Similarly, Fifield et al. (2002) suggested that inflation rates and interest rates can share a statistical relationship with the returns of different emerging stock markets. Lastly, Gan et al. (2006) provided evidence from New Zealand, suggesting that interest rates have a relationship with the NZSE40 stock market index.

Since our chosen variables show less statistical significance with the stock market return than what we expected to observe initially, this enables us to expand our analysis and give some further reasoning. We were limited to use monthly data in this study because some of the macroeconomic variables, such as the industrial production index, the inflation rate and the unemployment rate could not be recorded in a shorter period. The reason behind the less profound statistical relationship in our analysis could arguably be linked to the chosen time of observation. That is, chocks in the Swedish economy are adjusted in time for the next monthly observations which means that the probability of catching a distinct statistical relationship decreases. We would therefore argue that weekly observations could have improved this study by adding more observations for each variable, however, due to the lack of available weekly data, this was not possible in our study.

We acknowledge that the usage of a different econometric model could have yielded a different result. When performing the augmented Dickey-fuller test we took the first difference of the non-stationary variables in order to ensure stationary. For further investigation, one could use the Vector Error Correction Model (VECM) instead of the VAR model to account for the information loss on the transformed variables. However, the utilization of the VECM model is restricted to scenarios when variables are cointegrated, hence the variables must be stationary as first order integrated I(1). In our study both inflation and unemployment were stationary without taking the first difference, therefore we considered the usage of the VAR model to be a better choice in this study.

When constructing our analysis we chose to use the optimal lag according to the Akaike Information Criterion (AIC). Given the result from the AIC we choosed two lags both when performing the augmented Dickey-fuller test, the Granger causality test and in the VAR model. In order to further investigate our analysis, we have chosen to perform the same methodology using only one lag according to the HQIC and the SBIC from table A2 in the appendix. The result is presented in table A6 in the appendix and it shows us a similar result as when constructing with two lags with the exception that the inflation rate now becomes significant at both the VAR model and the Granger causality test. From the result, we observe that the inflation rate is negatively associated with the stock market return in Sweden. As in line with the findings from Fama (1981), this means that stock returns of OMXS30 tend to be lower when the inflation rate is high and vice versa.

Another factor that could have caused disturbance in our analysis is the financial crisis in 2008. As discussed before and as noted in the graphs in the appendix, the financial crisis could have caused unusual changes in the macroeconomic variables we have chosen in our study. For example, the relationship between our interest rate may have changed due to unprecedented actions taken by the Swedish central bank in order to stimulate the economy. In order to account for the crisis we have constructed the same analysis but for the time series January 2002 until December 2007 to examine if the estimations change. This time, the variables Ln_OMXS30, Inflation, Unemployment and Ln_IPI were found to be stationary as first order I(1) integrated variables, noted as "d.". The STIBOR rate and the repo rate were found to be stationary as second order I(2) integrated variables, noted as "d2". The optimal lag length was again conducted with regards to the Akaike Information Criterion (AIC) which suggests the usage of three lags. To examine if the predictive power of the macroeconomic variables changes on the returns of the stock market, the result of the Granger causality test can be found in table A7 in the appendix. From the Granger causality test, we can observe that the STIBOR rate is Granger causing the stock market return. This result supports our previous discussion in section 6.3 about the insignificant relationship between the STIBOR rate and the stock market returns during times of a financial crisis.

7. Conclusion

In this bachelor thesis, we have examined if different macroeconomic variables have predictive power on the returns of the Swedish stock market. To investigate this research question, we have utilized the Vector Autoregression (VAR) model and the Granger causality test in order to determine if there exists a statistical relationship between the Swedish stock market index OMXS30 and the inflation rate, repo rate, STIBOR rate, unemployment rate and the industrial production index. The results from the VAR model suggest that unemployment is positively associated with the returns of the Swedish stock market.

Nevertheless, the evidence from the Granger causality test is proven to be insignificant for the variable, which concludes that unemployment does not Granger cause the returns. In contrast, the results from the Granger causality test shows that inflation Granger causes the returns of the OMXS30 index which means that inflation has some predictive power on the returns of the Swedish stock market. Our empirical findings in this study show no evidence that the repo rate, STIBOR rate and industrial production index have any predictive power on the returns of the Swedish stock market. However, the direction of the causal effect between the stock market return and the industrial production index was found to be the other way around. That is, the stock market return is Granger causing the industrial production index.

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9. Appendix

Table A1 - Underlying stocks included in the OMXS30 price index.

Firm	Symbol
ABB	ABB
Alfa Laval AB	ALFA
ASSA ABLOY B	ASSA B
AstraZeneca	AZN
Atlas Copco A	ATCO A
Atlas Copco B	ATCO B
Autoliv Inc. SDB	ALIV SDB
Boliden	BOL
Electrolux B	ELUX B
Essity B	ESSITY B
Evolution Gaming	EVOG
Getinge B	GETI B
H&M B	HM B
Hexagon B	HEXA B
Investor B	INVE B
Kinnevik B	KINV B
LM Ericsson B	ERIC B
NIBE Industrier B	NIBE B
Nordea Bank	NDASE
Samhällsbyggnadsbolaget i Norden AB	SBB B
Sandvik AB	SAND

SCA B	SCA B
SEB A	SEB A
Sinch AB	SINCH
SKF B	SKF B
Svenska Handelsbanken AB A	SHB A
Swedbank A	SWED A
Tele2 AB	TELE2 B
Telia Company	TELIA
Volvo B	VOLV B

Table A2 - Lag order Selection criteria

Sample: 6 thru 216 Number of obs = 211

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	460.052				5.4e-10	-4.30381	-4.26528	-4.20849
1	985.199	1050.3	36	0.000	5.3e-12	-8.94028	-8.67058*	-8.27308*
2	1044.93	119.46	36	0.000	4.2e-12*	**-9.16522***	-8.66436	-7.92615
3	1074.78	59.699	36	0.008	4.5e-12	-9.10692	-8.3749	-7.29597
4	1101	52.447*	36	0.038	4.9e-12	-9.01426	-8.05107	-6.63142

* Optimal lag

Endogenous: d.Ln_OMXS30 Inflation d.RepoRate d.STIBOR Unemployment d.Ln_IPI

Exogenous: _cons

Table A3 - Breusch Godfrey LM test for autocorrelation

lags(p)	chi2	df	Prob > chi2
1	0.232	1	0.6298
2	1.072	2	0.5851

H0: no serial correlation

Table A4 - Results of Vector Autoregression model with 2 lags included

	Coefficient	Std. err.	z	P > |z|	[95% conf.	interval]
d.Ln_OMXS30						
d.Ln_OMXS30						
L1	-0.007	0.686	-0.10	0.918	-0.141	0.127
L2	-0.079	0.682	-1.17	0.244	-0.213	0.054
Inflation						
L1	-0.012	0.010	-1.12	0.264	-0.032	0.009
L2	0.002	0.010	0.22	0.825	-0.018	0.022
d.RepoRate						
L1	0.005	0.029	0.16	0.871	-0.053	0.063
L2	-0.064	0.051	-1.27	0.205	-0.163	0.035
d.STIBOR						
L1	0.049	0.037	1.33	0.184	-0.023	0.122
L2	-0.001	0.024	-0.02	0.984	-0.048	0.047
Unemployment						
L1	0.011	0.005	2.06	**0.039***	0.001	0.021
L2	-0.006	0.005	-1.16	0.247	-0.017	0.004
d.Ln_IPI						
L1	0.121	0.169	0.72	0.474	-0.211	0.453
L2	-0.186	0.171	-1.08	0.278	-0.522	0.149
_cons	-0.020	0.339	-0.59	0.554	-0.086	0.046

Note: * = Significance at *p*-value < 5%

Table A5 - Granger Causality Wald test

Equation	Excluded	chi2	df	Prob > chi2
d.Ln_IPI	d.Ln_OMXS30	7.5989	2	**0.022***
d.Ln_IPI	Inflation	10.02	2	0.007*
d.Ln_IPI	d.RepoRate	6.6106	2	0.037*
d.Ln_IPI	d.STIBOR	1.2061	2	0.547
d.Ln_IPI	Unemployment	1.2235	2	0.542
d.Ln_IPI	ALL	49.67	10	**0.000***

Note: * = Granger causing is profound

Table A6 - Results of Vector Autoregression model with only 1 lag included

	Coefficient	Std. err.	z	P > |z|	[95% conf.	interval]
d.Ln_OMXS30						
d.Ln_OMXS30						
L1	-0.028	0.068	-0.41	0.685	-0.161	0.106
Inflation						
L1	-0.008	0.004	-2.26	**0.024***	-0.015	0.001
d.RepoRate						
L1	-0.016	0.028	-0.57	0.566	-0.072	0.039
d.STIBOR						
L1	0.005	0.024	0.22	0.829	-0.042	0.059
Unemployment						
L1	0.006	0.004	1.67	0.096	-0.001	0.014
d.Ln_IPI						
L1	0.188	0.156	1.20	0.228	-0.118	0.495
_cons	-0.034	0.031	-1.09	0.276	-0.096	0.027

Note: * = Significance at *p*-value < 5%

Table A7 - Result of the Granger Causality test with the time series of 2002-2007

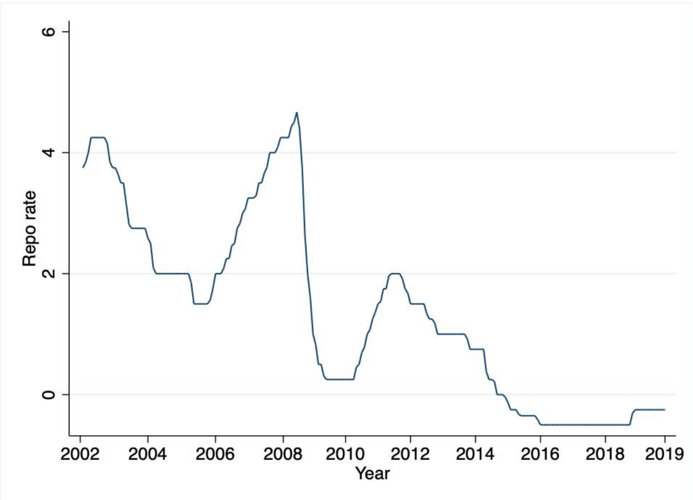
Equation	Excluded	chi2	df	Prob > chi2
d.Ln_OMXS30	d.Inflation	4.3004	3	0.231
d.Ln_OMXS30	d2.RepoRate	4.9085	3	0.179
d.Ln_OMXS30	d2.STIBOR	7.6531	3	**0.048***
d.Ln_OMXS30	d.Unemployment	0.3323	3	0.954
d.Ln_OMXS30	d.Ln_IPI	7.3172	3	0.062
d.Ln_OMXS30	ALL	18.731	15	0.226

Note: * = Granger causing is profound

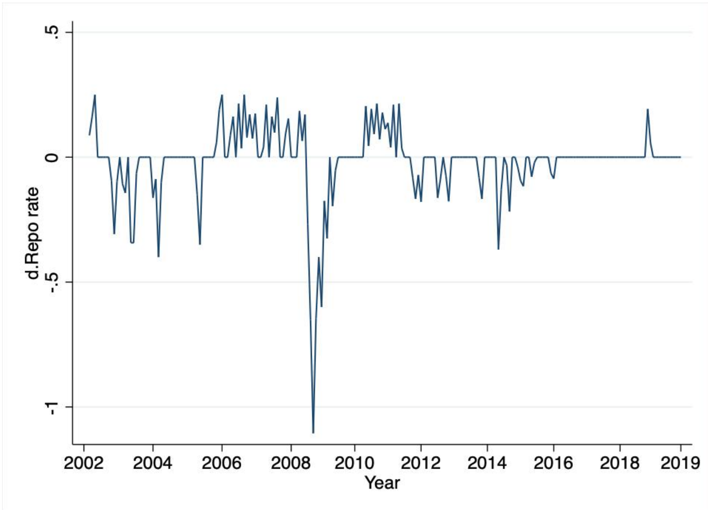
Graphs

Stationarity properties:

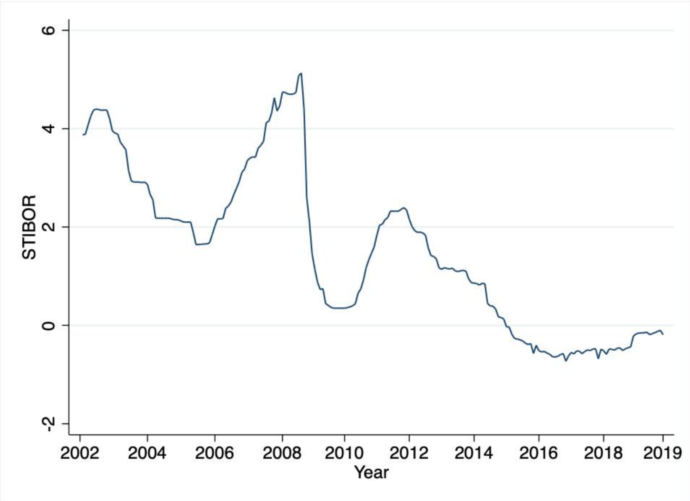
Repo rate



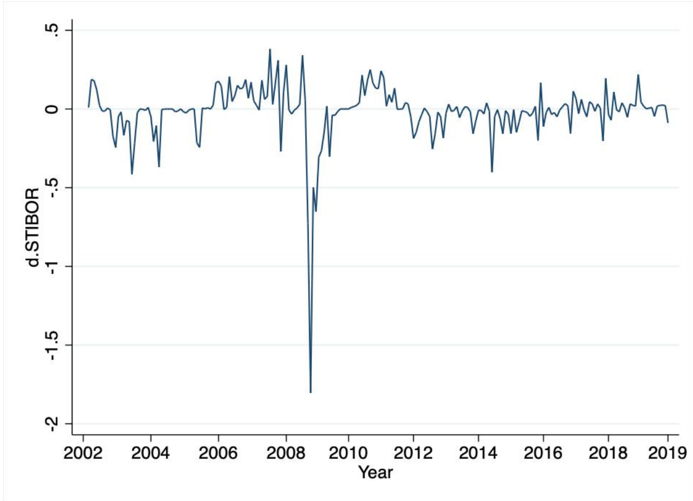
d.Repo rate



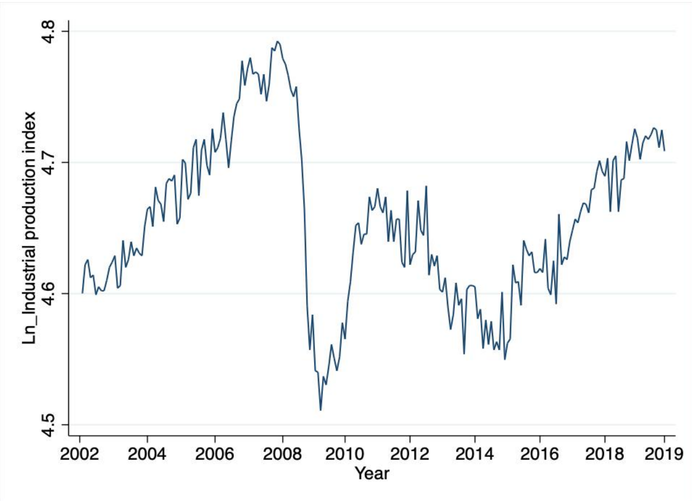
STIBOR



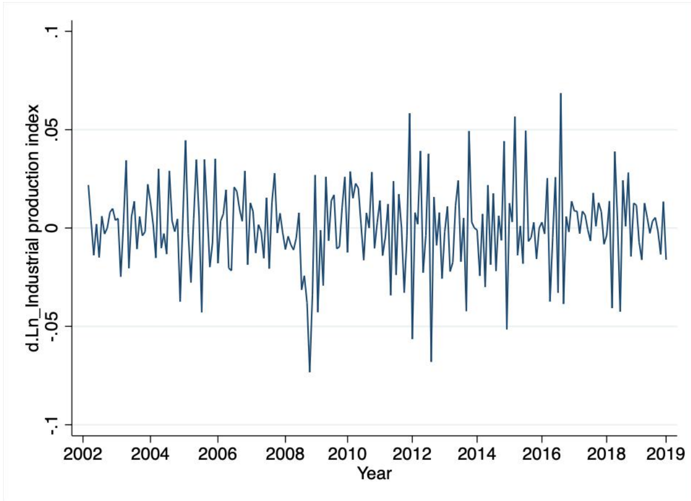
d.STIBOR



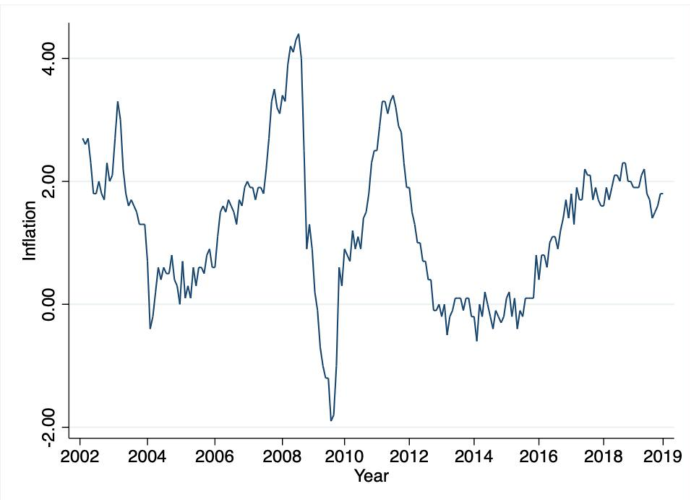
Ln_Industrial production index



d.Ln_Industrial production index



Inflation



Unemployment