# The relationship between US macroeconomic variables and the Swedish stock market:

*An empirical study using multiple linear regression.*


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# Abstract

The endogenous nature of international economies and stock markets returns has led to an immense interest in predicting stock prices. Research on the topic of macroeconomic variables and stock market returns is thus relevant. This paper is set out to analyse the direct impact macroeconomic variables from the United States have on the Swedish stock market (OMXS30) during 2000-2020. This study's theoretical model is based on the discounted dividend model, which argues that for a macroeconomic variable to affect an equity asset's price, it needs to affect its discount factor or its expected cash flows and thus affect its expected discounted dividends. The author implement Ordinary Least Squares to estimate the impact of US macroeconomic variables on OMXS30. The findings were that US Money Supply (M2) and Federal Funds rate are significant in explaining OMXS30.


**Keywords**: Ordinary Least Squares, OMXS30, Macroeconomic variables, Economies, Discounted Dividend Model

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# 1 Introduction

## 1.1 Background

Investors and businesses consolidate to invest or speculate in various assets in the stock market (Delmon, 2021). It is a crucial part of any developed or developing economy since this allows allocation and redistribution of capital between entities, individuals and the government promoting liquidity, competitiveness and economic growth (Mohamadieh, 2021). Investors looking to increase their wealth invest their money in businesses that are believed to be profitable (Rustagi, 2021). This business receives capital who can then invest and thus create value for their shareholders and the economy. This also creates more significant tax revenue for the government who can then further develop the economy. The stock market and the economy is thus endogenous in such a way that changes in macroprudential-, monetary- and fiscal policies will change the landscape in which businesses and individuals are operating (Caporale et al., 2005). This, in turn, will change the valuation of the securities that form the stock market (Arthur et al., 1996). Over the years, the financial markets have also witnessed ever-larger internationalisation of companies and financial institutions, which has increased cross-border capital flows. With capital flowing from institutions to investors across borders, policies implemented in one country might affect the purchasing power or the overall economic landscape, thus affecting stock market valuations (Capasso, 2008). Due to this endogenous nature of economic forces and the stock market, investors and speculators need to understand how the macroeconomic landscape impacts valuations of stocks (Bosworth et al., 1975).

Factors that affect the valuation of stocks are substantial. For this reason, there have been many models developed throughout the years to determine a fair value of a business (Fernández et al., 2007). What is consistent across all of the valuation models is that there will always be external forces affecting one or several variables in the equation and thus change the future expected value of the stock (Meitner, 2006). For example, changes in macroprudential, monetary and fiscal policies affect how investors and businesses can access and allocate capital. This will, in turn, affect the valuations of stocks. This particular paper will be considering the expected discounted dividend model developed by Chen et al. (1986) and the most cited in the literature (Damodaran, 2000).

Due to the endogenous nature of the economy and stock markets and the immense interest in predicting stock prices, research on the topic of macroeconomic variables and stock market returns is quite substantial (Song et al., 2021). Therefore, this paper aims to add value to the existing literature by exploring relationships previously not considered. We will be focusing on how the Swedish stock market reacts to changes in US macroeconomic variables. This is because there seem to be gaps in the literature on the direct relationship between US macroeconomic variables and the Swedish stock market (Hermansson et al., 2021). Furthermore, Swedish companies and the Swedish economy are largely exposed to international markets and cross-border capital flows (Box et al., 2021), whose macroeconomic variables effects are yet to be explored (Hilmersson et al., 2021). As is in line with previous literature (Ljungstedt, 2015) (Talla, 2013) (Pettersson, 2013)(Pfeffer and Fyhn, 2014), this paper will be considering the OMX Stockholm 30 (OMXS30) as a proxy for the Swedish stock market as the dependent variable. To achieve the goals of this paper, which is "to add value to the existing literature on macroeconomic forces and their effect on the Swedish stock market", this paper will be considering independent variables not yet fully explored in the literature. The independent variables considered for this thesis are SEK/USD, US industrial production, US Gross Domestic Product, US money supply, Federal Reserve Funds rate and US Unemployment rates, and they are all analysed in monthly data from 2000 - 2020. For explanations of the choice of variables, see Chapter 2 and Section 3.1.

To answer the central question of this research paper, "How do US macroeconomic variables affect the Swedish stock market during the period 2000-2020", the author is implementing a multiple linear regression analysis by estimating Ordinary Least Squares (OLS) (Lokshin and Sajaia, 2004).

## 1.2 Structure

The paper is organised as follows. Section 2 presents a literature review under two broad classifications, including the Swedish stock market and internationally. We detect the gap in the research on which this research is based. In Section 3, we explain the method adopted and the main variables included in the econometric specification. We also include a model validation to evaluate the validity of our econometric framework. In Section 4, we present our empirical results. In Section 5, we discuss the results, and it's practical implications. In section 6, we exhibit the main conclusions, express limitations to the study and present ideas for further research areas.

# 2 Literature Review

Fama and Schwert (1977) provide early research on the relationship between macroeconomic variables and the stock market. They set out to discover which asset classes would be considered hedges against unexpected and expected inflation during 1953-71. They found a negative relationship between common stock returns and (1) expected inflation and (2) unexpected inflation, although the latter was less consistent in their test. This was unexpected considering the long-held theories; however, it proved consistent with other empirical studies conducted at the time. They also conclude that its relation with inflation could explain only a tiny portion of the variation in the common stock returns. Similarly, Chen et al. (1986) provide some rather early research on the topic of stock market returns as a result of changes in economic state variables. They implement an approach where they measure expected stock returns due to changes in US economic state variables, real consumption per capita, and oil pricing. Their findings were that neither oil pricing nor real consumption per capita had a statistically significant relationship, whereas several economic state variables did. The most notable were industrial production, changes in the risk premium and changes in the yield curve. Similarly to Chen et al. (1986), Schwert (1990) provided additional research on the relationship between US industrial production and US stock markets. Schwert (1990) used industrial production as a proxy for real activity and found that real stock returns and real future activity have a significant relationship with evidence for over 100 years. In addition to this, Jareño and Negrut (2016) provided relatively recent research on the relationship between US macroeconomic variables and the US stock market. They implement an approach where they use Pearson's correlation analysis to measure the relationship between a set of independent variables to the Dow Jones Industrial Average (DJIA) and the Standard & Poor's 500 (S&P 500). These independent variables were industrial production, gross domestic product (GDP), consumer price index (CPI), unemployment rates and long-term interest rates. They were able to conclude a statistically significant relationship between all of their variables except for CPI. In line with previously mentioned studies, Jareño and Negrut (2016) provided evidence of a recent relationship between domestic variables and the stock market in the US. However, they used a different statistical model than this study.

Research provided on the relationship between macroeconomic variables and the Swedish stock market is somewhat extensive. Larsson and Johansson Prakt (2013) researched how macroeconomic variables affect the banking sector of Sweden from March 2005 to April 2012. They used a set of 7 independent macroeconomic variables to determine a relationship, and similar to previously mentioned literature, they apply a set of domestic variables to do so. As opposed to previously mentioned literature, they also include some variables with international exposure but none from the US. In line with previous literature, they concluded a statistically significant relationship between some domestic variables and the Swedish banking sector. However, they were also able to find a statistical relationship with exchange rates to the EURO. As opposed to this study, Larsson and Johansson Prakt (2013) don't include variables deriving strictly from the US. They implement an approach where they analyse a specific proportion of the Swedish stock market. Similarly to this research, Larsson and Johansson Prakt (2013) include OMXS30 as a proxy for the Swedish stock market; however, they use it as an independent variable instead of this research which will be using it as the dependent variable. Talla (2013) also investigated the relationship between macroeconomic variables and the Swedish stock market. Like this research, Talla (2013) uses macroeconomic variables to explain variations in the OMXS30 as a proxy for the Swedish stock market. Talla (2013) also uses domestic variables along with exchange rates to the EURO and interbank rates. He was also able to conclude that exchange rates to the EURO are significant in influencing changes of the dependent variable. Further research on how domestic and international variables can affect the Swedish stock market is Ljungstedt (2015). His research provided variables mainly domestically or from the Eurozone with some exceptions, such as the DJIA and the exchange rate of the Swedish Krona (SEK) towards the US Dollar (USD). He found that SEK/USD had a barely significant positive influence on the OMXS30 as a proxy for the Swedish stock market. He also found that DJIA has a long-term negative influence on the OMXS30. Ljungstedt (2015) applies a framework of using the Johansen test, which is a Vector Autoregression Model (VAR) turned into a Vector Error Correction Model (VECM) to test for Cointegration between the dependent and the independent variables. In contrast, this paper will be using a multiple linear regression model. Pettersson (2013) implements a more international approach where he uses independent variables from both the US and the Eurozone to investigate the effects on the OMXS30. Pettersson (2013) used the Arbitrage Pricing Theory (APT) as his framework for choosing his independent macroeconomic variables. Like this research, Pettersson (2013) also carried out his research by estimating his econometric model through Ordinary Least Squares (OLS). He also tested for Granger-causality by using the Vector Autoregressive (VAR) model. Pettersson (2013) used a short time frame ranging from January 2003 - June 2007. His research suffered from severe multicollinearity, which caused him to remove some of his variables in a second model. This could cause his model to suffer from omitted variable bias (OVB). Further on the research of the Swedish stock market and international forces is Pfeffer and Fyhn (2014) who found a linear relationship between the S&P 500 index and the OMXS30 existed. Similarly, Ljungstedt (2015) also found a significant relationship between DJIA and the OMXS30. However, even though existing literature (Jareño and Negrut, 2016) can explain a statistically significant relationship between US macroeconomic variables to the S&P 500 and DJIA, there is no evidence that US macroeconomic variables have a direct statistical relation to the OMXS30. It is reasonable to assume that many other variables affect S&P 500 and DJIA movements that Jareño and Negrut (2016) didn't include in their models. Similar research to previously mentioned ones also exists in different regions and different economies. Naturally, Sweden is a small open economy and thus differs quite substantially from certain others. Nevertheless, it is interesting to compare and contrast various researches on similar areas. Hunjra et al. (2014) set out to measure the impact of macroeconomic variables on the stock prices in Pakistan. By testing for cointegration and Granger Causality, they found that there exists a strong long-term relationship and an insignificant short-term relationship between inflation, GDP, exchange rates and interest rates to the KSE100. The Pakistani economy is experiencing fiscal imbalances, has a significantly larger population, almost ten times smaller GDP/Capita and the GDP composed of entirely different sectors compared to the Swedish one. All this creates another gap in research that is interesting to examine. Nevertheless, Hunjra et al. (2014) used GDP, exchange rate and inflation; and found a significant long-term relationship to their selected dependent variable, indicating that these are exciting variables to investigate. Further on the topic of macroeconomic forces and their effect on stock markets internationally is that of Gan et al. (2006). They set out to investigate the relationship between the New Zealand Stock Exchange 40 (NZSE40) and a set of macroeconomic variables including inflation (consumer price index), exchange rate, real GDP, long-term interest rate, short-term interest rate, money supply and domestic retail oil prices. Like many other researchers on the topic of macroeconomic forces and their effect on stock markets, they only use domestic independent variables. They found that all of their variables show a long-term relationship with real GDP, interest rate and money supply being the most consistent in determining changes in the NZSE40. Research on macroeconomic forces' effect on stock markets is abundant, taking many different econometric approaches. However, after reviewing the relevant literature for this paper, it is fair to say that there exists a rather large gap in the research on the direct relationship between US macroeconomic variables and the Swedish stock market. As discussed earlier in this section, most existing research uses either domestic variables or foreign indices from the US or Europe as their independent variables which creates a gap in a direct relationship between international macroeconomic variables and the Swedish stock market. This is also consistent with chosen international studies. However, it could be presumed that there would be a direct relationship between the OMXS30 and international macroeconomic variables. The OMXS30 comprises 30 companies with operations exposed internationally, meaning that changes in the international macroeconomic landscape could affect their operations and thus investors perception. As mentioned, previous studies have proven that some domestic macroeconomic variables affect the US stock market (Chen et al., 1986)(Jareño and Negrut, 2016). Other existing studies have proven a relationship between the US stock market and the Swedish stock market (Ljungstedt, 2015)(Pfeffer and Fyhn, 2014). However, that doesn't necessarily mean that there exists a direct relationship between US macroeconomic variables and the Swedish stock market. This is a gap this research is set out to investigate.

# 3 Methodology

The author implements Ordinary Least Squares to estimate the impact of US macroeconomic variables on OMXS30. This chapter first introduces the data chosen and then goes over the econometric model adopted along with a validation of it.

## 3.1 Data

### 3.1.1 Choice of Variables

Chen et al. (1986) developed a theory that argues that for a macroeconomic variable to affect an equity asset's price, it needs to affect its discount factor or its expected cash flows and thus affect its expected discounted dividends. Therefore, they argue that the stock prices and macroeconomic variables that affect the discount factor or expected cash flow inevitably have a long-term relationship. The formula for stock prices is displayed in equation 3.1:

$$p = \frac{E(c)}{k} \tag{3.1}$$

Where *E(c)* is expected cash flows and $k$ is the discount rate. Therefore, the formula for actual returns for any given time is displayed in equation 3.2:

$$\frac{dp}{p} + \frac{c}{p} = \frac{d[E(c)]}{E(c)} - \frac{dk}{k} + \frac{c}{p} \tag{3.2}$$

In addition to the previous empirical framework that will act as a guideline for the choice of the variables, the current paper will also be adding real value to existing research by exploring those independent variables not yet fully explored in the literature.

### 3.1.2 OMXS30

The OMXS30 is a market-weighted price index that consists of the 30 most traded stocks on the Swedish stock exchange. The OMXS30 is the leading price index of the Swedish stock exchange, whose market drivers make it exceptionally liquid compared to other indices on the same market. This also means that it is an appropriate choice as an underlying index for derivatives products (The Nasdaq Group, 2021). Due to its extremely high liquidity and position as the main index of the Swedish stock exchange, it is considered to incorporate the most available information and thus be the best proxy of the entire market. It is also in line with previous literature analysing macroeconomic variables' effect on the Swedish stock market, such as that of Ljungstedt (2015), Talla (2013), Pettersson (2013) and Pfeffer and Fyhn (2014).

The data has been retrieved from Investing.com (FusionMediaLimited, 2021), a financial markets platform that provides real-time financial data and other financial services (Hernández-Nieves et al., 2020). The data has been retrieved and presented as the monthly-ending price of the OMXS30 index, and the timeframe covered is 2000/01/01 - 2020/12/01.

### 3.1.3 SEK/USD

The first independent variable will be the bilateral exchange rate of the Swedish Krona to one US Dollar. This is due to the US being one of Sweden's largest trading partners, accounting for a large portion of all exports and imports, and in 2020 accounting for a large trade surplus (Bussière et al., 2020)(SCB, 2021a)(SCB, 2021b). If the exchange rate were to depreciate, meaning the purchasing power of the Swedish Krona would go down, there would be higher domestic demand, and Sweden could experience demand-pull inflation. Following the framework developed by Chen et al. (1986), an increase in inflation would inevitably affect the expectations of cash flows along with the discount factor. This means that the value of the stocks constituting the OMXS30 would change. SEK/USD is included in previous literature such as Ljungstedt (2015) and Pettersson (2013) despite being analysed over a different time frame and using another econometric framework.

This data has been retrieved from Investing.com (FusionMediaLimited, 2021). The data has been retrieved and presented as the monthly-ending price of the SEK/USD exchange rates, and the timeframe covered is 2000/01/01 - 2020/12/01.

### 3.1.4 US Industrial Production

The second independent variable for this research will be Industrial Production in the US. Industrial production is a measurement of the amount of productive output from the industrial sector. It will be measured through the Industrial Production and Capacity Utilization Index (G.17 IPCU), which is presented by the Federal Reserve of the US (FED). Many pieces of research have analysed the relationship between industrial production and stock markets, including Chen et al. (1986), Schwert (1990) and Jareño and Negrut (2016). Previous literature has found significant statistical relationships between industrial production and stock market returns in the US. Industrial production is considered a good indicator of an economy's real economic growth. Since most financial markets´ indicators are endogenous, US industrial production might affect the purchasing power of Swedish companies and thus the expected cash flows of companies that comprise the OMXS30.

The G.17 IPCU Index is a capacity utilisation index measured in 2012=100 and is retrieved and presented as the monthly-ending percentage. The historical data for the G.17 IPCU index has been retrieved from the FederalReserve (2021).

### 3.1.5 US Gross Domestic Product

The third independent variable will be the Gross Domestic Product (GDP) of the US. GDP is a measurement of the value of all total products and services in an economy (Wesselink et al., 2007). Compared to industrial production, the GDP takes into account all the different sectors in an economy, the secondary market of what is produced, along with all of the services in the economy. While GDP is a lagging indicator of an economy and the stock market tends to be future speculation of how companies will be performing, following the framework of Chen et al. (1986), the GDP is likely to affect the stock market. An increase in GDP would typically mean more production and spending amongst consumers and companies, which inevitably affects the expected cash flows of companies. GDP has also been studied by various pieces of research such as that of Jareño and Negrut (2016), Al-Abedallat and Al Shabib (2012) and Paramati and Gupta (2011), where the findings vary. Considering that this research will be including both industrial production and GDP as independent variables, there might be a risk for multicollinearity since both are supposed to represent economic growth. However, they might also produce very different results for this study, considering that private goods-producing industries only accounted for less than a fourth of the total US GDP in 2019, which in large was dominated by private services-producing industries (BEA, 2021). The variance inflation factor (VIF) test will be conducted to check for multicollinearity among the independent variables (Craney and Surles, 2002).

The Bureau of Economic Analysis in the US typically measures GDP on a quarterly basis. The US Monthly GDP (MGDP) Index from IHSMarkit (2021) has been used to make GDP comparable by monthly measures. The MGDP index is leveraging aggregation and calculation methods to produce a monthly index based on the quarterly data from the Bureau of Economic Analysis. The data is presented in trillions of dollars.

### 3.1.6 US Money Supply

An increase in money supply typically leads to a rise in stock market prices (Pícha et al., 2017). When the supply of money increases, it stimulates the economy that can invest, manufacture, and spend, which will lead to increased sales for companies; this will, in turn, increase the revenue of companies that inevitably affects their expected cash flows. An increase in the money supply also leads to dilution of existing money, which could cause inflation (Palmer, 1970). Inflation could also affect interest rates which would affect companies' discount factors. Therefore, the money supply could affect both of the variables that would affect equity valuation according to the framework of Chen et al. (1986). Money Supply is included in existing literature such as that of Talla (2013) but is measured in the domestic currency Swedish Krona (SEK), whereas this research considered money supply in USD.

The money supply in the US will be observed through M2, a measure of all cash and "near money" in an economy such as savings deposits and the like. This has been retrieved from the Federal Reserve Bank of St. Louis (FRED, 2021b) and is presented and used through monthly measurements in billions of dollars.

### 3.1.7 Federal Funds Rate

Another independent variable that is expected to influence the stock market is the Federal Funds Rate, the interbank interest rate for reserve balances in the US. As this rate increases, it becomes more expensive for banks to borrow money which makes them keep their funds and build up their reserves. If the rate is low, it is cheap to borrow, which stimulates the economy through more lending to the public, leading to increased spending and, thus, presumably, higher stock prices (Alam and Uddin, 2009). Interest rates are considered in previous research (Larsson and Johansson Prakt, 2013) but are only measured domestically.

The effective federal reserve funds rate is also measured through monthly measurements and is retrieved from the Federal Reserve Bank of St. Louis (FRED, 2021a). The rate is presented in the effective percentage that is charged.

### 3.1.8 US Unemployment Rate

The unemployment rate will be the last independent variable that will be used for this paper. Unemployment rates are generally a good indicator of how an economy is performing (Diener and Seligman, 2004). In times of economic expansion, employment is high, and thus spending on goods and services is increased. This contributes to an increase in sales for companies that can spend and invest. On the contrary, in times of economic contraction, inflation is generally rising, and as goods and services are becoming more expensive, their demand decreases. Because of this, companies are laying off workers, and unemployment rates are increasing. In both of the above-described scenarios, the expected cash flows of companies are changing and thus changing the company's equity value according to the expected discounted dividend model (Chen et al., 1986). Both these scenarios are indicative of a negative correlation between the two variables (unemployment and OMXS30). Unemployment rates are analysed in previous literature, such as that of Jareño and Negrut (2016).

The Federal Reserve constantly measures unemployment rates, and the data has been retrieved from the Federal Reserve Bank of St. Louis (FRED, 2021c). The data is presented in monthly percentages of the total population.

### 3.1.9 Descriptive Statistics

A summary of the main variables used is provided in Table 3.1. The main statistics related to these variables over 252 monthly observations are displayed in Table 3.2. Finally, Table 3.3 summarises the correlation between the datasets.

Table 3.1: Regression Variables.

| Variable Type | Full Name | Model Name |
|---|---|---|
| Dependent | OMXS30 | OMX_30 |
| Independent | SEK/USD | SEK_USD |
| Independent | US Industrial Production | IPCU |
| Independent | US Gross Domestic Product | GDP |
| Independent | US Money Supply | M2 |
| Independent | US Unemployment Rate | Unem |
| Independent | Federal Funds Rate | Ffunds |

Table 3.2: Summary of the variable statistics for 2000-2020.

| Variable | Median | Mean | St. Dev. | Min | Max |
|---|---|---|---|---|---|
| OMX_30 | 1107 | 1142 | 356 | 446 | 1918 |
| SEK_USD | 0.128 | 0.129 | 0.0193 | 0.0922 | 0.168 |
| IPCU | 100 | 99.8 | 5.78 | 86.4 | 112 |
| GDP | 15014 | 15546 | 3422 | 9921 | 22009 |
| M2 | 8592 | 9510 | 3551 | 4662 | 19391 |
| Unem | 5.4 | 5.99 | 1.99 | 3.3 | 14.4 |
| Ffunds | 1.04 | 1.72 | 1.90 | 0.05 | 6.54 |

Table 3.3: Pearson's Correlation Matrix for 2000-2020.

| | OMX_30 | SEK_USD | IPCU | GDP | M2 | Unem | Ffunds |
|---|---|---|---|---|---|---|---|
| OMX_30 | 1 | −0.190 | 0.709 | 0.826 | 0.826 | −0.219 | −0.098 |
| SEK_USD | −0.190 | 1 | 0.076 | −0.037 | −0.144 | 0.398 | −0.200 |
| IPCU | 0.709 | 0.076 | 1 | 0.743 | 0.633 | −0.495 | 0.021 |
| GDP | 0.826 | −0.037 | 0.743 | 1 | 0.968 | −0.038 | −0.460 |
| M2 | 0.826 | −0.144 | 0.633 | 0.968 | 1 | 0.042 | −0.501 |
| Unem | −0.219 | 0.398 | −0.495 | −0.038 | 0.042 | 1 | −0.584 |
| Ffunds | −0.098 | −0.200 | 0.021 | −0.460 | −0.501 | −0.584 | 1 |

## 3.2 Econometric Model

### 3.2.1 Multiple Linear Regression

The econometric model adopted in this paper is the multiple linear regression that attempts to explain how much of the movements in the dependent variable Y can be explained by the independent variables X (Ge and Wu, 2019). The multiple linear regression is a continuation of the simple linear regression model that only uses one independent variable to predict the outcome of the dependent variable. By adding more independent variables, a more nuanced understanding of the dependent variable could be explored. The formula for the multiple linear regression is displayed in equation 3.3:

$$y = \beta 0 + \beta 1x1 + \beta 2x2 + \ldots + \beta pxp + \epsilon \tag{3.3}$$

Where $\beta 0$ is the y-intercept which is constant and where $\beta 1$ is the slope coefficient for the first independent variable *x1*, and where $\beta 2$ is for the second independent variable *x2*, etcetera, the $\epsilon$ is the error term of the model. The use of multiple linear regression in this research is to analyse the relationship between several independent variables to the OMXS30. As it is almost impossible to account for every possible independent variable that affects the dependent variable, those will be included in the error term $\epsilon$. When conducting multiple regression, you try to predict the value of the dependent variable y based on a change in any of the independent variables $x$ when keeping the other independent variables constant. This is done by estimating ordinary least squares (OLS), which by definition is the process of minimising the sum of squared residuals and fitting a regression line to it. The residuals are the measurement of the smallest distance from that regression line to each actual data point. A real error term is something incalculable since it is the difference between the sample dataset and the population. However, in multiple regression, the residuals that are used to estimate the regression line are calculated based on the sample datasets actual values. Since a multiple regression model aims to understand a population based on a sample, the residuals will act as the error term $\epsilon$ for the population data in the formula above. This means that if the actual value of the OMXS30 is higher than the predicted values, i.e. the regression line, the price of the OMXS30 is being underestimated by OLS and vice versa. OLS is used in previous literature, such as that of Talla (2013) and Larsson and Johansson Prakt (2013).

### 3.2.2 Model Validation

#### 3.2.2.1 Omitted Variable Bias

As mentioned in section 3.2.1, when conducting a multiple linear regression analysis, it is almost impossible to include all the independent variables to determine the values of the dependent variable hence why an error term is included in the formula to account for the unknown fluctuation. When estimating the error term $\epsilon$ it is assumed that the unknown variables not included in the model are uncorrelated with the model's independent variables (Clarke, 2005). The model becomes biased if the omitted variables have an impact or a relationship with the dependent variable. Assume a model that tries to predict movements in OMXS30 based on changes in money supply, that being a simple linear regression. It is safe to say that movements in the OMXS30 can't only be explained by money supply. We have thus omitted variables that most likely are correlated with the money supply. If we omit a variable that is negatively correlated with money supply and affects OMXS30, the model will be negatively biased. This stems from the fact that when the money supply goes up, OMXS30 tends to go up. Because it is always assumed that the error term $\epsilon$ is uncorrelated with the independent variables, when we have an omitted independent variable that is positively correlated with OMXS30, and that is negatively correlated with money supply, it would mean that we overspecify the effect of money supply in the model since it also captures the impact of the unknown independent variable. This could thus drive a negatively biased model. On the contrary, if the omitted unknown variable would be negatively correlated with OMXS30 and negatively correlated with money supply, we would have a positively biased model.

#### 3.2.2.2 Multicollinearity

Another potential problem that might arise with a multiple linear regression is multicollinearity. When two or more independent variables in the model are perfectly correlated, we get perfect multicollinearity which is outside the scope of this paper since the variables observed for this research have no possible way of being perfectly correlated (Alin, 2010). Imperfect multicollinearity is when there are signs of significant correlation between two or more independent variables $x$ in the model. Here a problem arises since they are essentially, in the measurement of the model, accounting for the same movement in the dependent variable $y$. This means that it is almost impossible to distinguish which of the variables account for the movements in the dependent variable. When including two highly correlated independent variables, it is hard for the model to determine the correct value for the slope coefficients due to its high variance. This means that dropping one independent variable highly correlated to another can significantly change the slope coefficients of the other independent variables since it becomes easier for the model to estimate the variance. What can be done to mitigate this problem and create a more robust model is to increase the sample size since this will decrease the variance. If that is not possible, you can be faced with something called bias-variance trade-off, which is when you have to choose whether to remove the variable at the expense of a potential omitted variable bias. To test for imperfect multicollinearity, we will be using a Variance Inflation Factor (VIF) test to compute in any statistical tool pack (Mansfield and Helms, 1982). The author of this paper relied on R-Studio for this research. If imperfect multicollinearity with a high VIF is detected among the independent variables, such variables will be removed to avoid violating the model validation and damaging the interpretation of the results.

#### 3.2.2.3 Heteroskedasticity

Heteroskedasticity could also be an issue when computing OLS. When estimating OLS, it is assumed that there is no correlation between the variance of the dependent variable and the movements in the independent variables. This is known as the Gauss-Markov theorem. This means that as an independent variable increase, the variance of the dependent variable $y$ would still stay the same. If the Gauss-Markov theorem is violated, the regular standard errors produced by OLS are not good predictors of our data, and the results of the hypothesis testing would be misleading. If this theory is violated, OLS will no longer be the best model for the selected data even though the model is unbiased. There will potentially be other models that can produce a lower variance. To test if heteroskedasticity is present, we will be conducting a Breusch-Pagan (BP) test. It is done by testing the following hypothesis:

$$H_0 = \sigma^2 = 0 \tag{3.4}$$

$$H_1 = \sigma^2 \neq 0 \tag{3.5}$$

Where the null hypothesis (3.4) assumes homoskedasticity and the alternative hypothesis (3.5) assumes heteroskedasticity. If the p-value of the BP-test is within the significance level of 0.05, the null hypothesis will be rejected, and heteroskedasticity will be assumed. Assuming that heteroskedasticity is present, there are different alternatives to deal with it. One would be to change the model that fits the data better. However, if a model contains a large number of observations, OLS can still produce quite precise estimators as the variance decreases as the number of observations increases. In order to deal with the issue of regular standard errors produced by OLS no longer being good predictors of the data, you can conduct a robust standard errors test to produce unbiased standard errors when there is heteroskedasticity.

#### 3.2.2.4 Autocorrelation

When computing time-series data in econometric models, a problem commonly found is autocorrelation. When using stock market data, the current value is always a function of its previous value. Yesterday's closing price of a stock will be today's opening price, and today's closing price will be tomorrow's opening price. This would cause the error term of the model to be correlated with its lagged versions, and autocorrelation would exist. This would mean that the assumption of OLS that error terms are uncorrelated is violated. When this assumption is violated, the variances produced by OLS are no longer estimated as minimal, and thus the model could be replaced by a model that is a better minimum variance estimator. When assumptions of OLS are violated, the results produced by the model will be inaccurate, which could cause a researcher to unjustly reject the null hypothesis. To test for autocorrelation, this paper will compute a Durbin-Watson test where the following hypothesis test is executed:

$$H_0 \neq Autocorrelation \tag{3.6}$$

$$H_1 = Autocorrelation \tag{3.7}$$

When the null hypothesis (3.6) is rejected and heteroskedasticity is present, regular heteroskedasticity-robust (HC) standard errors are rendered misleading. If your model suffers from heteroskedasticity and autocorrelation, you can account for both in OLS by using heteroskedasticity/autocorrelation robust standard errors (HAC).

### 3.2.3 Interpretation of Results

The interpretation of the results of a multiple linear model is done through a hypothesis test. The hypothesis test for this particular model is as follows:

$$H_0 = P > \alpha \tag{3.8}$$

$$H_1 = P < \alpha \tag{3.9}$$

Where $P$ represents the p-value for the multiple regression and $\alpha$ represents the significance levels. For this test, we will be using a significance level of 0.05 which means a 5% risk of concluding that there is a statistically significant relationship between the variables when there isn't any.

The null hypothesis (3.8) represents a scenario where the p-value is more significant than the significance level of 0.05, which means that there isn't any significant relationship between the independent variables and the dependent variable. If this is the case, we would fail to reject the null hypothesis and would therefore have to remove variables that aren't significant. The alternative hypothesis (3.9) is when the p-value is either less than or equal to the significance level of 0.05. This means that there is a significant relationship at a 0.05 significance level, and we would reject the null hypothesis. It is essential to keep in mind that even though tests could prove to have a lower p-value than 0.05, issues like multicollinearity could increase the slope coefficients of the variables and lead to wrong p-values. It is, therefore, necessary to mitigate as many problems as possible before we conclude that the model is valid; only then can we determine whether the interpretation of the model is correct.

# 4 Empirical Results

After running a multiple linear model test, the initial findings of how US macroeconomic variables impact OMXS30 are summarised in Table 4.1. The regression output and t-test show that the overall relationship is significant. In particular, Money Supply (M2) and Federal Funds rate (Ffunds) are significant in explaining OMXS30.

Table 4.1: Regression output of the initial unrestricted model.

| | Estimate | Standard Error | T-Value | P-Value |
|---|---|---|---|---|
| SEK_USD | 260.928 | 869.987 | 0.300 | 0.764 |
| IPCU | 3.433 | 4.875 | 0.704 | 0.482 |
| GDP | 0.014 | 0.017 | 0.809 | 0.419 |
| M2 | 0.087 | 0.015 | 5.790 | 2.15e-08*** |
| Unem | 0.915 | 10.617 | 0.086 | 0.931 |
| Ffunds | 75.317 | 8.225 | 9.157 | < 2e-16*** |
| Intercept | −407.596 | 375.178 | -1.086 | 0.278 |
| Observations | 252 | | | |
| $R^2$ | 0.820 | | | |
| Adjusted $R^2$ | 0.816 | | | |
| Residual Std. Error | 153.073 | (df = 245) | | |
| F Statistic | 185.952*** | (df = 6; 245) | | |

*Note:* *p<0.01; **p<0.001; ***p<0

A VIF test was conducted to validate if this model suffers from multicollinearity. The results summarised in Table 4.2 shows that the variances of the estimated coefficients for GDP, M2 and IPCU are incredibly high. The variable with the highest variance (GDP) was thus removed.

Table 4.2: Summary of the initial Variance Inflation Factor (VIF) Test.

| SEK_USD | IPCU | GDP | M2 | Unem | Ffunds |
|---|---|---|---|---|---|
| 3.008 | 8.517 | 35.532 | 30.489 | 4.779 | 2.612 |

Another VIF (see Table A1.1) test was computed, showing high variance in IPCU, which was also removed (Becker et al., 2015). Summarised in Table 4.3 is the result of the third VIF test, which indicates low collinearity amongst the remaining variables. With the removal of GDP and IPCU, multicollinearity no longer poses a problem for the model.

Table 4.3: Summary of the last Variance Inflation Factor (VIF) Test.

| SEK_USD | M2 | Unem | Ffunds |
|---|---|---|---|
| 1.233 | 1.584 | 1.888 | 2.331 |

A residual analysis was performed to validate further the appropriateness of the econometric model adopted (see figure 4.1).

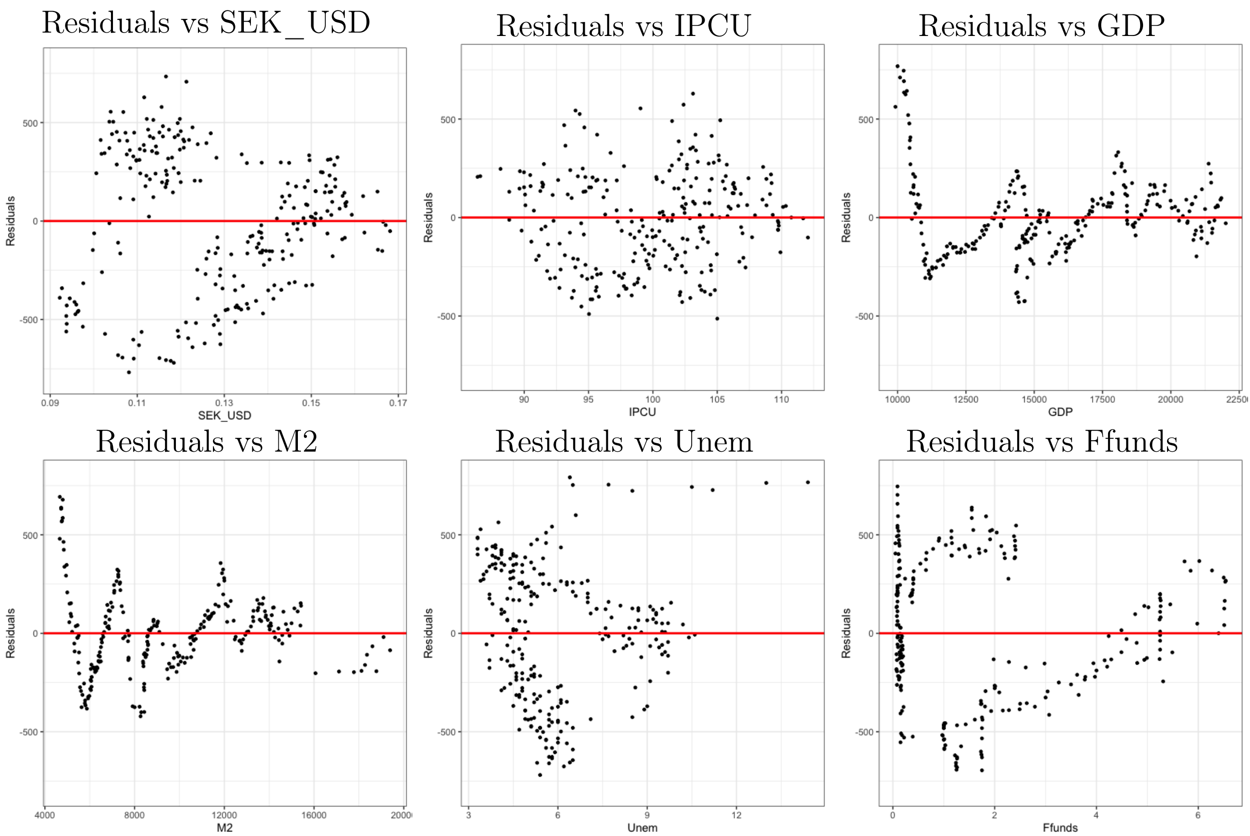


Figure 4.1: Residual vs Predicted Plots.

This was computed to determine whether OLS is a good predictor of the data set at hand. The residual analysis results indicate in all variables included in our current model (after adjustment for multicollinearity) that as our independent variables increase, the variance in our dependent variable (OMX_30) seems to change. This stems from the fact that as our independent variables increase, the residuals get smaller. This indicates that our data might suffer from heteroskedasticity. To test for heteroskedasticity, a Breusch-Pagan (BP) test was conducted (Astivia and Zumbo, 2019). The results from the BP-test indicate that our model suffers from heteroskedasticity (see Table A1.2). Because this model uses stock market returns, tests for autocorrelation were conducted. To test whether the model's error term is correlated with its lagged error terms, a Durbin-Watson (DW) test was conducted as is in line with Larsson and Johansson Prakt (2013). The null hypothesis states that the error term is uncorrelated with its lagged versions. The results from the DW-test (see Table A1.2) show that the p-value is extremely low, which means that we can reject the null hypothesis and assume autocorrelation. A Newey-West robust standard errors test was implemented (Newey and West, 1986) to produce robust standard errors for both heteroskedasticity and autocorrelation (HAC). This is also in line with Larsson and Johansson Prakt (2013). The regression output with HAC standard errors are summarised in Table 4.4.

Table 4.4: Regression output of the final HAC-adjusted model.

| | Estimate | Standard Error | T-Value | P-Value |
|---|---|---|---|---|
| SEK_USD | 1143.027 | 1184.826 | 0.965 | 0.336 |
| M2 | 0.104 | 0.012 | 8.512 | 1.685e-15-*** |
| Unem | −9.154 | 19.772 | −0.463 | 0.644 |
| Ffunds | 76.187 | 32.550 | 2.341 | 0.020-* |
| Intercept | −73.545 | 262.087 | −0.281 | 0.779 |
| Observations | 252 | | | |
| $R^2$ | 0.8185 | | | |
| Adjusted $R^2$ | 0.8156 | | | |
| Residual Std. Error | 153 | (df = 247) | | |
| F Statistic | 278.5*** | (df = 4; 247) | | |

*Note:* *p<0.01; **p<0.001; ***p<0

# 5 Discussion and Managerial Implications

Following the results of the VIF test and the removal of variables subject to high collinearity, the model is no longer suffering from multicollinearity. The interpretation of the interaction of the independent variables on the dependent variable can thus be considered by studying the coefficients (Yip and Tsang, 2007). After validating the econometric model, results indicate that the US money supply (M2) is significantly positively related to movements in OMXS30. What is interesting to note is that this is the contrary of what Talla (2013) noted. Talla (2013) found that the Swedish money supply is positively related to OMXS30 but without significance. These results indicate that the US money supply has a larger influence on OMXS30 than the Swedish money supply. Sirucek (2012) also found that the US money supply is cointegrated long-term with the DJIA, which further supports the results that US money supply impacts stock prices. Interestingly, Ljungstedt (2015) found a negative long-term relationship between DJIA and OMXS30 which means that as DJIA goes up, OMXS30 goes down. The conclusion from this is that there are other factors not captured by this model that doesn't influence OMXS30 but influence DJIA or that positively influence DJIA and negatively influence OMXS30; or vice versa. This could be an area for further research. As in line with previous literature (Ljungstedt, 2015), the results of this research note a positive relationship between OMXS30 and exchange rates to USD. This is consistent with evidence from a study conducted on YEN/USD in Japan (Mukherjee and Naka, 1995). However, as opposed to Ljungstedt (2015) and Mukherjee and Naka (1995), this research indicates that this positive relationship isn't significant under any significance level. This is in line with research from Pakistan who found that the exchange rate of Pak Rupee to the USD has no significant impact on the KSE-100 (Suriani et al., 2015). Talla (2013) noted a significant negative relationship between SEK/EUR and OMXS30, which indicates that changes in EURO are more likely to influence Swedish stock prices than USD. This is also consistent with the findings of Ljungstedt (2015). For statistical purposes, insignificant variables are typically removed, but it was kept despite the exchange rate being insignificant due to its economic and managerial analysis. One economic and managerial reason for the positive statistical relationship of SEK/USD could be that companies that comprise OMXS30 have trade deficits deriving from USD, which would mean that as the SEK appreciates to the USD, these expenses become smaller. Following the framework of Chen et al. (1986), these decreased expenses affect both the discount factor and the expected cash flows positively and thus affect stock prices positively of the companies that make up OMXS30. Consistent with Jareño and Negrut (2016), unemployment (Unem) had a negative relation to stock prices. They found a negative relationship between the DJIA and US unemployment, so as US unemployment rises, the DJIA decreases. However, similar to the exchange rate, this model didn't provide evidence that US unemployment was significant under any significance levels. This is inconsistent with the findings of Boyd et al. (2005), who found a positive relationship between unemployment and stock prices in economic expansions. This stems from the fact that as the economy expands, interest rates are usually kept low, increasing stock prices (Alam and Uddin, 2009). They also found evidence that as unemployment rises in economic contraction, stocks are affected negatively, which are signs of a recession. This indicates a negative correlation between unemployment and interest rates which is confirmed by a moderate negative correlation between Unemployment (Unem) and Federal Funds rate (Ffunds)(see Table 3.3). From a managerial and economic perspective, it is interesting to note that even though unemployment isn't a good predictor of OMXS30 statistically, it can still act as a guide for future interest rates that are statistically significant. The significant positive relationship of Federal funds rate OMXS30 is somewhat unexpected as it implies that as interest rates in the US rise, OMXS30 will rise. These findings are inconsistent with most existing literature, such as Alam and Uddin (2009). They found that interest rates have a significant negative relationship to stock prices in developing and developed economies. In other words, as interest rates go down, stock prices go up. However, the significant positive relationship found in this research is consistent with Eldomiaty et al. (2019), who documented a significant positive relationship between interest rates and non-financial firms listed in DJIA30 and NASDAQ100. Realistically, higher interest rates would affect the discounted dividend model (Chen et al., 1986) negatively since the discount rate would increase. As interest rates rise, low-risk debt assets such as treasury bonds become attractive, and companies need to produce higher returns to meet investors demands. It will also be more expensive to borrow money. However, this significant positive relationship could stem from a case whereby a rising interest rates in the US increases the value of USD. This could affect Swedish companies in two ways where the first is through the capital markets, where investing in US debt assets could increase their rate of returns. The second is that the purchasing power parity (PPP) of US consumers increases. This means that it would be cheaper to import from Swedish companies as the goods become relatively cheaper. This would increase the revenue of Swedish companies and thus impact their discount factor or their expected cash flows. This suggests that as interest rates in the US increases, a trade surplus to USD is beneficial for Swedish companies. However, this is contrary to the positive relationship of the exchange rate and OMXS30 noted in both this research and Ljungstedt (2015), suggesting that a trade deficit to USD is positive for Swedish companies. However, the findings of exchange rates are not significant in this study. This study considers more recent observations than Ljungstedt (2015), suggesting that a positive relationship between the Federal funds rate and OMXS30 is a more reliable case than that of the exchange rate.

# 6 Conclusions, Limitations and Future Research

This study set out to examine the relationship between US macroeconomic variables and the Swedish stock market. To provide a framework for the set of independent variables chosen, the discounted dividend model developed by Chen et al. (1986) and previous literature was adopted. Multiple linear regression by estimating OLS was adopted to examine this relationship. Highly collinear variables were removed, and HAC robust standard errors were adopted to adjust for problems like multicollinearity, heteroskedasticity and autocorrelation. The empirical results from our model show that both the US money supply and federal funds rate are positively significant in their relationship movements in OMXS30. Literature on the topic of money supply's effect on stock prices generally conforms with the findings of this research.

The increase in Swedish stock prices following an increase in the US money supply can be explained by the scenario where the money supply growth stimulates the US economy by increasing demand for products and services. This increases spending and revenue for US companies that consumes and invests more. The US is one of the largest importing nations of Swedish goods, and thus an increase in US money supply is positive for Swedish companies as US companies spending increases. An increase in the Federal funds rate also positively affects OMXS30 as rising interest rates, ceteris paribus, increases the currency's value. This is due to the capital market where a higher interest rate is attractive for foreign investors who can get higher rates of returns in the US, increasing the demand for USD. This increase in currency value increases the purchasing power parity (PPP) of Swedish goods and services and thus the demand for these products.

The conclusive findings from this empirical study is that two macroeconomic variables out of the ones selected are significant in explaining the relationship with the OMXS30.These are money supply and federal funds rate. The findings are to some extent consistent with previous literature and should thus be considered jointly with other empirical studies to form a larger perspective of how macroeconomic variables affect stock prices, specifically across borders and economies. This research aims to add value to existing literature and answer the main question, "How do US macroeconomic variables affect the Swedish stock market during 2000-2020". By presenting a direct statistical relationship between two US macroeconomic variables and the OMXS30, the goals of this research have been achieved.

In light of the findings of this study, additional questions are raised regarding how monetary policies in the US affect monetary policies in Sweden and how the differential between the two affects Swedish stock prices. The model doesn't capture the response in Swedish macroeconomic variables due to changes in US macroeconomic variables. Over time, differences in macroeconomic variables could be interesting to research considering economic spillovers and the diverse international economic landscape. Consider a scenario where the US raises interest rates that affect the export of Swedish goods. This could cause demand-pull inflation as the demand for Swedish goods and services rapidly increases. To fight inflation, the central bank of Sweden might alter monetary policies, which in turn affects companies in OMXS30. The differential of international macroeconomic variables and Swedish macroeconomic variables over time and its effect on OMXS30 is thus an exciting area for future research. This paper implemented an OLS regression analysis that captures the entire period over which the observations stretch. The period we have observed for this research (2000-2020) includes three financial crises (Dotcom, Subprime Mortgage, Covid), which have impacted US monetary policies and volatility in stock prices in different ways. This raises additional questions regarding how monetary policies affect OMXS30 in specific periods following a financial crisis. It could be interesting for future researchers to research how monetary policies following financial crises compare to each other and how they affect stock prices differently. The dataset at hand could be divided into three different OLS regression tests, where the first is 2000-2008 (Dotcom), the second is 2008-2020 (Subprime Mortgage), and the third is 2020-XXX (Covid) and then compare the results over these different periods. The scope of this paper has been to capture the independent variables from a specific country's effect on the dependent variable. This means a range of variables could affect the OMXS30 that this model doesn't include. These variables could be correlated with the independent and dependent variables, which means that the model could suffer from omitted variable bias. In light of the endogenous nature of financial markets and the ever-changing landscape of the global economy, further research could try to capture other variables. Some exciting variables could be monopolistic movements, climate change, international trading agreements, international allies, financial regulations, macroprudential policies, psychosocial, cryptocurrencies and decentralized finance. Further managerial implications on a practical level with an integrated model that considers different variables, periods and captures macroeconomic differentials are needed. Doing that is not an easy task; however, the results obtained constitute a small but significant step by raising awareness of its importance. This first step can provide a guiding start point for those that want to add value in their research on macroeconomic variables effect on stock prices.

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# Appendix

## A1 Additional Tables

Table A1.1: The Second Variance Inflation Factor (VIF) test.

| SEK_USD | IPCU | M2 | Unem | Ffunds |
|---|---|---|---|---|
| 2.832 | 7.150 | 6.198 | 4.728 | 2.493 |

Table A1.2: Summary of BP-test and DW-test.

| | Breusch-Pagan | Durbin-Watson |
|---|---|---|
| P-value | 0.004594 | $< 2.2e\text{-}16$ |
| Test Statistic | 15.052 | 0.14477 |

## A2 Additional Figures

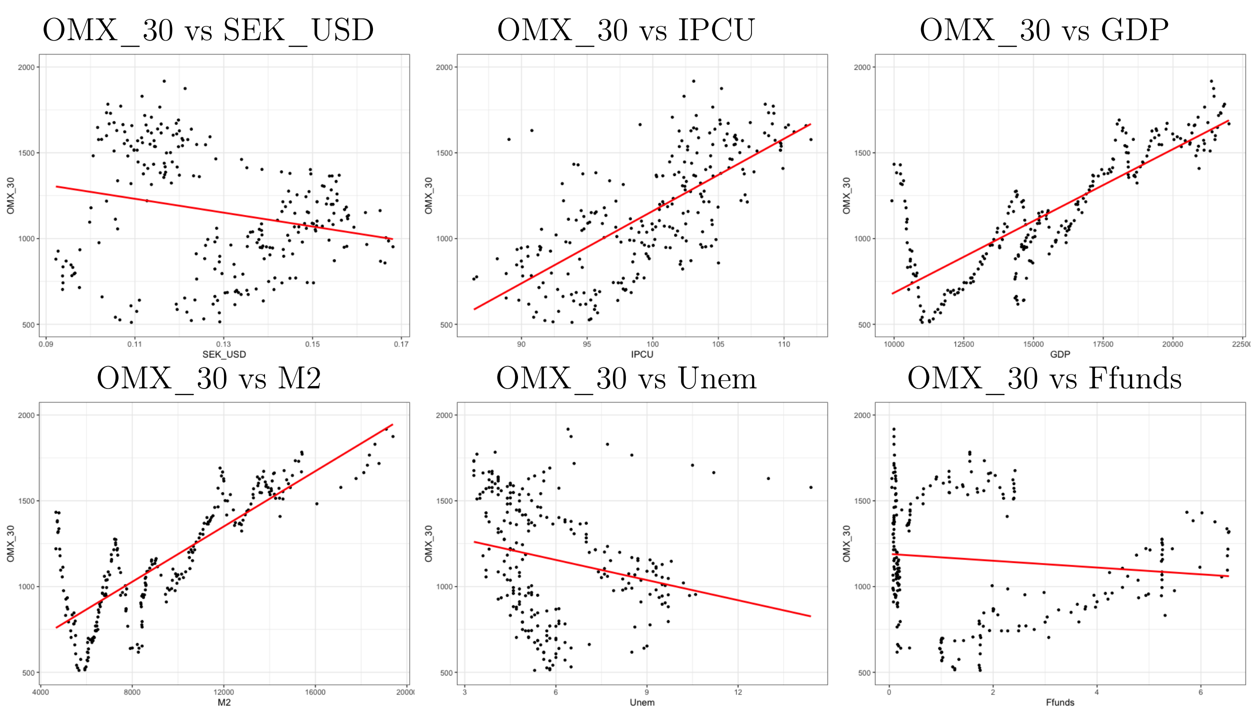


Figure A2.1: Simple Linear Regression Plots.

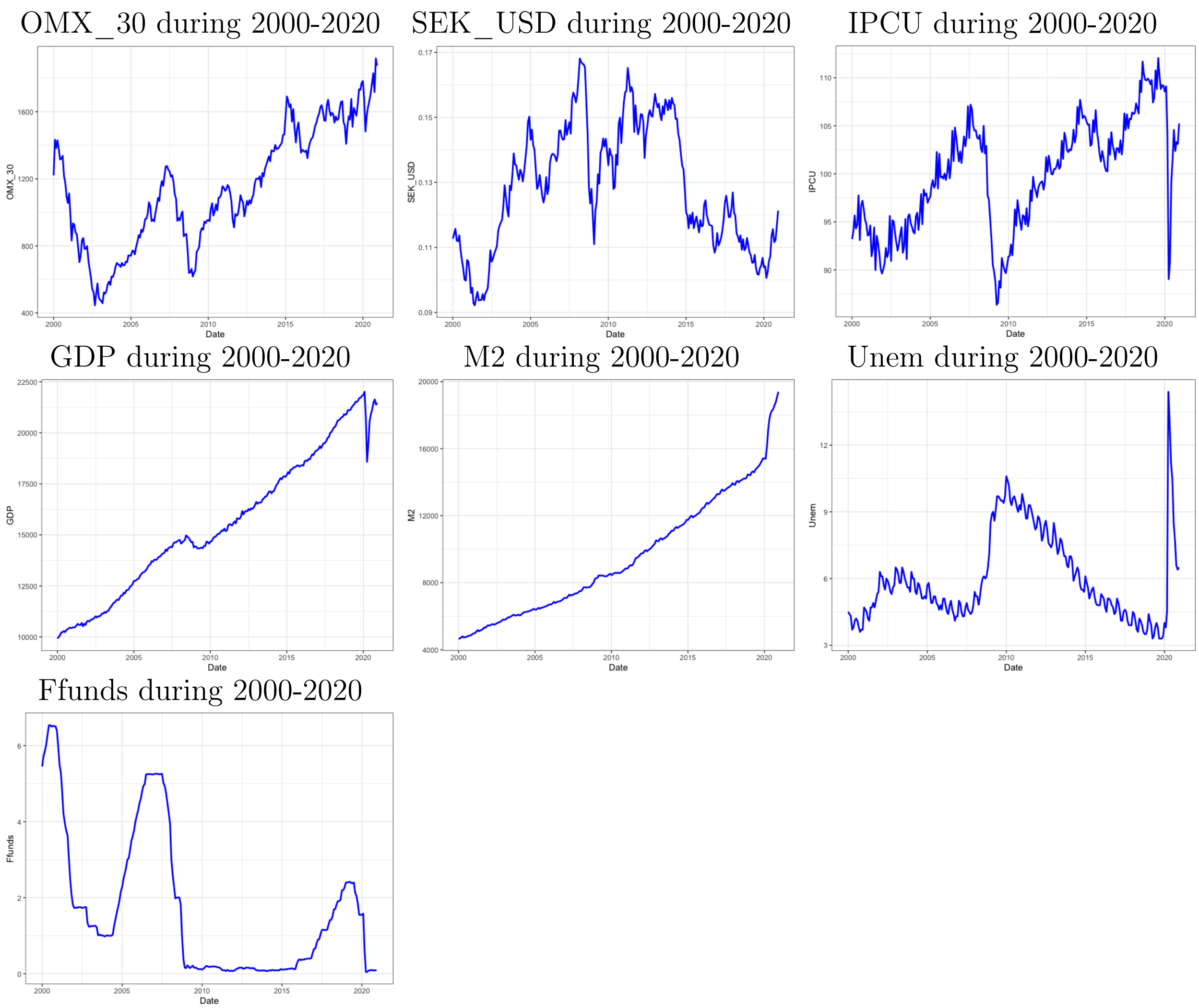


Figure A2.2: Line plots during 2000-2020.