The effects of macroeconomic factors on the frequency of IPOs in Finland

Lappeenranta–Lahti University of Technology LUT

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Examiner: Post-doctoral researcher Timo Leivo

ABSTRACT

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The effects of macroeconomic factors on the frequency of IPOs in Finland.

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Macroeconomic factors have been found to influence firms' decisions to list. However, most of the previous studies have focused on non-Nordic countries. The aim of this thesis was to investigate the relationship between three macroeconomic factors - gross domestic product (GDP), 3-month interbank rate, and market index (OMXH25) - and the initial public offering (IPO) in Finland over the period 2001-2021, and thus to extend the research to the Nordic region. Six different regression models using the least-squares method were created to examine whether the relationship between macroeconomic factors and IPO activity is positive and whether the factors have a direct effect on IPO activity.

No statistical significant relationship was found between the GDP and the frequency of listings in Finland. The relationship between the interest rate and IPO activity appeared to be negative and the interest rate shock to IPO activity delayed. The link between IPO activity and OMXH25 was positive and the impact of the index on IPO activity immediate. This finding is consistent with previous research findings that when the market index rises, the number of companies going public rises as well.

Companies can benefit from these results to assess their listing decisions, that is, whether a macroeconomic factor and its change is clearly driving companies' listing decisions. In addition to the identified links between macroeconomic factors and IPO activity, future research should focus on the causal relationships between these factors to clarify the true causal relationships.

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Makrotaloudellisten tekijöiden on todettu vaikuttavan yritysten listautumispäätöksiin. Useimmissa aiemmissa tutkimuksissa on kuitenkin keskitytty muihin kuin pohjoismaihin. Tämän tutkielman tavoitteena oli tutkia kolmen makrotaloudellisen tekijän - bruttokansantuotteen (BKT), kolmen kuukauden pankkienvälisen koron ja markkinaindeksin (OMXH25) ja listautumisannin (IPO) välistä suhdetta Suomessa vuosina 2001–2021 ja siten laajentaa tutkimusta Pohjoismaihin. Pienimmän neliösumman menetelmää käyttäen luotiin kuusi erilaista regressiomallia, joiden avulla tutkittiin, onko makrotaloudellisten tekijöiden ja listautumisannin välinen suhde positiivinen ja onko tekijöillä suora vaikutus listautumisaktiivisuuteen.

BKT:n ja listautumistiheyden välillä ei havaittu merkittävää yhteyttä Suomessa. Korkotason ja listautumisaktiivisuuden välinen suhde näytti olevan negatiivinen ja koron shokki listautumisten määrään näytti tapahtuvan viiveellä. Listautumisannin aktiivisuuden ja OMXH25-indeksin välinen yhteys oli positiivinen ja indeksin vaikutus listautumisaktiivisuuteen välitön. Tämä havainto on yhdenmukainen aiempien tutkimustulosten kanssa, joiden mukaan markkinaindeksin noustessa myös pörssiin listautuvien yritysten määrä kasvaa.

Yritykset voivat hyödyntää näitä tuloksia arvioidessaan listautumispäätöksiään eli sitä, ohjaako jokin makrotaloudellinen tekijä ja sen muutos selvästi yritysten listautumispäätöksiä. Makrotaloudellisten tekijöiden ja listautumisaktiivisuuden välillä havaittujen yhteyksien lisäksi tulevissa tutkimuksissa olisi keskityttävä näiden tekijöiden välisiin syy-yhteyksiin todellisten syy-yhteyksien selvittämiseksi.

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1 Introduction

Initial Public Offerings (IPOs) are an important mechanism for companies to raise capital from the public markets. Companies benefit from an IPO in two ways: they receive greater liquidity and better access to capital (Berk J. & Demarzo P., 2013, 812). Even though IPOs are widely used and are important part of financial markets, their success rate is not always guaranteed. In addition to internal or company-specific factors (e.g., need for funding), several external or macroeconomic factors (e.g., interest rate) may influence the outcome of the offering and, thus, listing decisions. Concerning the external factors, the world around us is changing all the time. Therefore, it is important for the company seeking funding to have an idea of the timing of the funding and, in addition to internal factors, whether certain external factors are important to consider.

Over the past decades, there has been major economic events. For instance, there was the birth of the internet and the resulting dot-com bubble which caused a lot of controversy, especially for IPOs with average under-pricing of up to 80% in some years (Ljungqvist A. & Wilhelm W.J., 2003). Then there was the financial crisis, followed by a period of low interest rates and the corona crisis. During these times, concerning IPOs, the research has been very scarce on how the different macroeconomic factors are influencing listing decisions. Anglenini and Foglia (2018) conducted a first modern study utilizing contemporary datasets to explore the fundamental mechanisms of IPO variation from a macroeconomic perspective in UK between 1996 and 2016. Their research shed new light between IPOs and external factors, adding to the growing body of knowledge on this topic. They found out that especially in the UK stock volatility, industrial production and interest rates are strongly correlated with the IPO activity. It is also known that the variation in the number of IPOs is explained also by the state of the market. (Ritter J.R., & Welch I, 2002). All in all, macroeconomic factors certainly have some bearing on IPO decisions. However, as said research is relatively scarce and limited to very small area in terms of region. Further research with modern datasets is needed.

The present study aims to contribute to the existing body of research on IPOs by examining the impact of macroeconomic factors on the volume of IPOs in Finland, a region that has been underexplored in previous studies. By focusing on this specific region, the study seeks to provide novel insights into the interplay between macroeconomic factors and IPO activity, which could have implications for our understanding of IPO behaviour in more detail.

1.1 Research aims and questions

The purpose of this study is to analyse how the macroeconomic factors explain IPO frequency in Finland. To achieve these objectives, the following research question will be addressed:

- How the macroeconomic factors affect on the frequency of IPOs in Finland?

To complement the objectives of the thesis and the research question, the following sub-questions was developed:

- What are the long-term relationships between macroeconomic factors and IPO frequencies?
- What is the shock effect of macroeconomic factors on IPO frequencies?

To answer these questions, the study uses regression analysis to examine the relationship between the selected macroeconomic factors and IPO volume over time.

1.2 Constraints

The study will be conducted over a period of 20 years, from 2001 to 2021, and will focus on IPOs listed on the main market of the Nasdaq Nordic Helsinki and listings to First North. The decision to focus on Finland was made since no such study has been conducted in Finland and the overall research is very scarce in Northern Europe.

The study will focus on explanatory factors that are believed to have an impact on IPO volume and will ignore other possible influencing factors. The independent variables selected for the study are gross domestic product of Finland, stock market index (OMXH25) and interest rate (3-month interbank rate). The dependent variable is frequency of IPOs listed in Nasdaq Nordic Helsinki and First North. More precise analysis of these variables is in the data section.

It is important to acknowledge that examination of a limited region and exclusion of other macroeconomic factors that may influence IPO frequency may limit the generalizability of the findings. It should also be noted that the number of independent variables is limited by the small number of observed values. This is since IPOs frequency data for this study is only available on an annual basis.

1.3 Structure

The structure of the thesis consists of six parts. The first is an introduction. After introduction is a literature review and hypothesis section where we first provide an overview of the research done on macroeconomic factors and after that we form three different hypotheses through the old studies. The third section discusses the selected macroeconomic factors more precise. The fourth section covers methodology. In this section, we review the statistical tests and modelling methods used in this study. This section is followed by a presentation of the results. After results we analyse the results and draw conclusions on whether the results obtained support the hypotheses formulated. The last section contains the limitations encountered in the thesis, suggestions for future research and a summary, which summaries the main finding of the study.

2 Literature review and hypothesis

Little research has been done on the impact of macroeconomic factors on IPOs, and most of the research that has been done dates back twenty years. However, despite this, research have shown that external macroeconomic factors are associated with IPOs. Research identifies one external factor in particularly that explains companies' IPO activity which is the market index. The impact of the other two external factors selected for the study, interest rates and GDP, on IPO activity is less clear.

In the case of interest rate, the relationship is unclear to the extent that the results of the study differ from each other. For example, Tran et al. (2011) in their US study concluded that there was a negative relationship between interest rates and IPO volume. In practice, this would mean that as interest rates rise, IPO activity would fall in relation to volume. The study covers the period 1970-2005. The same conclusion has been reached by Jenssen and Johnson (1993) in a US study. This study is slightly older and covers the period 1962-1991. One of the most recent studies on the relationship between interest rate and IPO frequencies is the study by Mehmood, Mohd-Rashid and Ahmad (2020), in which they examine macroeconomic factors including the impact of interest rate on IPO activity in Pakistan. They concluded that there would be a negative relationship between interest rate and IPO frequency. The opposite finding of a negative correlation between the variables, i.e., a positive correlation, has been made by Brau et al. (2003) and Frank and Goyal (2007). The Brau et al. study is also from the USA. The Frank and Goyal study did not focus on any particular country but included 2,691 companies from around the world. Among these findings on the relationship between interest rates and IPO activity is the study by Jovanovic and Rousseau (2004), where they found an inverse U-shaped relationship between the two variables. This would mean that when the interest rate is very low or very high, IPO activity decreases, but if the interest rate is somewhere in between, IPO activity relative to volume increases.

The link between GDP and IPO activity is also contradictory in the light of the older research results. Korajczyk and Levy (2003) found a relationship between GDP and IPO activity as their study focused on the impact of macroeconomic factors, such as GDP, on the capital structure of companies. The same positive association between variables was found by Choe et al. (1993) who examined the relationship between IPO volumes and business cycle fluctuations. The same conclusion of positive correlation between the two variables is reached by Angelini and Foglia (2018), whose study was conducted in the UK. The opposite conclusion was reached in a Nordic study by Rydvist et al. (1995), who concluded that there was no correlation between business cycle fluctuations and companies' IPO decisions. They compared 11 European countries over the period 1980-1989 and family-owned companies in Sweden over the period 1970-1991.

However, as said the findings on the relationship between the market index and IPO activity are consistent. One study is that of Ameer (2012) in Malaysia, which found a significant positive relationship between market index and IPO volume. The time span of the study was 1990-2008. The findings of Ameer are also supported by studies by Loughran et al. (1994) and Rees (1997), whose findings suggest a positive relationship between market index and IPO volume. The study by Loughan et al. included 25 countries from different parts of the globe and the time span of the study was 1959-1992. The Rees study was conducted in the UK and examined the extent to which different macroeconomic factors explain the incentives for companies to list.

The effects of other variables on IPO activity have also been studied over the years. For example, underpricing has been shown to play a significant role in companies' IPO decisions. Underpricing is the main source of uncertainty that influences companies' decisions to list (Bruce & Thilakaratne, 2014; Latham & Braun, 2010; Lowry et al., 2010). The same conclusion was reached by Ritter (1987) in his study which claimed that the incentives for companies to IPO are very much related to underpricing. Political stability has also been seen to have a positive impact on economic growth and thus during periods of high political instability the number of IPOs decreases (Colak et al., 2017).

All in all, previous research data would suggest that of the external factors selected for this study, at least the market index and IPO activity would be positively correlated. For GDP and interest rates, the relationship is less clear. The hypotheses for these variables are therefore as follows:

1. Hypothesis:

There is a positive correlation between GDP and the frequency of IPOs. The general idea is that as the real economy grows, and through shocks, the amount of investment increases, and hence the amount of funding raised through IPOs also increases. The positive relationship is supported by previous research evidence (Korajczyk R. & Levy A., 2003; Choe et al., 1993)

2. Hypothesis:

There is a positive correlation between interest rates and the frequency of IPOs. This hypothesis is supported by the intuition that as interest rates rise, companies' incentives to seek funding through equity financing increase. The positive correlation is partly supported by older research (Brau J. et al., 2003).

3. Hypothesis:

There is a positive correlation between the market index and the frequency of IPOs. The idea behind the hypothesis is that companies should list when the general market sentiment is good, i.e., when the market is rising. The positive correlation is also supported by previous research evidence (Loughan et al., 2018; Ameer, 2012).

3 Variables and methodology

In this section, we will go deeper into the historical development of the variables selected for the study over the last twenty years.

3.1 Data

A market index is a portfolio of investments representing a specific segment of the financial markets. Typically, equity indices are market value weighted indices, i.e., the weight of a company in the index is determined by its market value. The weights are used to adjust the individual impact of the index items (Puttonen V. & Knupfer S., 2014, 43).

For this study, as said stock market indice (OMXH25) has been chosen as an explanatory variable to measure market performance. The index is a market value-weighted index of the 25 most traded stocks in Helsinki. The stock market index data was collected through the Investing.com website. It covers stock market indices for Finland (OMXH25) for the period of 2001-2021.

The OMX Helsinki has grown slowly over the past twenty years. Figure (5) shows the historical variation of the given time series over the period considered. An interesting highlight is the upswings in the 2008 financial crisis and the strong response of the index before and after the crisis, and the relatively steady growth of the index from 2012 to 2021, but the peak during the financial crisis was not reached until ten years after the crisis.

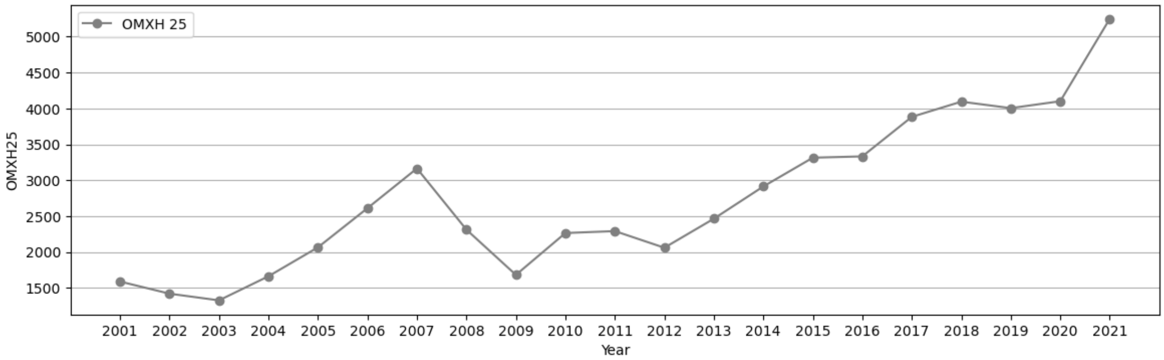

Figure 1: Stock index (OMXH25) over the studied period 2001-2021.

The three-month interbank rate is the rate at which banks deposit and lend to each other with a maturity of three months. The choice of interest rate for this study is supported by the idea that the interest rate measures the long-term financing costs in liabilities. The rate is collected from the Federal Reserve Bank of St. Louis for the period of 2001-2021.

The three-month interbank rate in Finland has been negative for a long time over the past twenty years. Figure (2) shows how the three-month interbank rate before the financial crisis in Finland peaked at up to 4% and reached a low of around 2%, but after the major drop during the financial crisis the rate has not started to rise, but has remained mainly below 1%, even falling into negative levels.

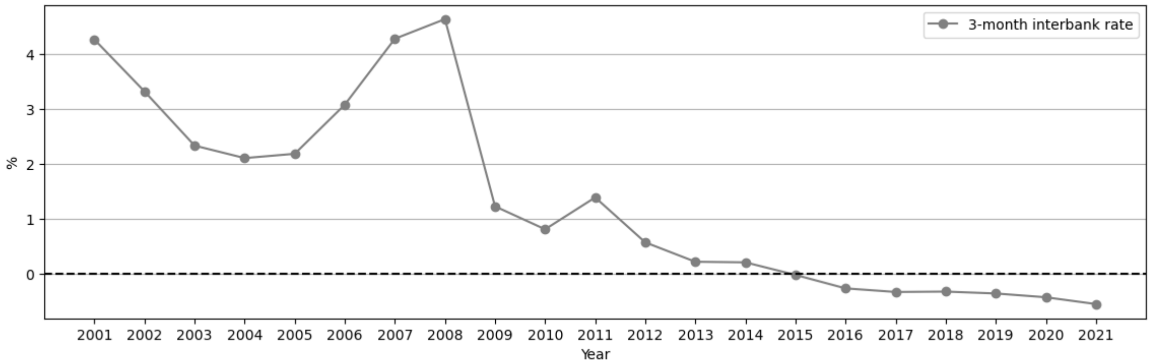

Figure 2: 3-month interbank rates (%) in Finland for the period 2001-2021.

Gross domestic product describes the value of each country's monetary output over a given period and is usually calculated quarterly or annually. Comparability is included by calculating values in US dollars and by calculating GDP at 2015 constant prices, which takes inflation into account. This is important because, when comparing years with each other, it is important to consider the removal of inflation from GDP.

GDP is one of the three independent variables chosen for this research and reflect changes in the real economy. GDP data is collected from the World Bank for the period of 2001-2021.

GDP follows to some extent the same slow growth rate as the stock market index. When looking at the figure (3), it is interesting to note how Finland's GDP growth has been very strong between 2001 and 2008, before the financial crisis. However, the post-financial crisis period has been more volatile, and it took almost ten years for GDP growth to reach the same level as before the financial crisis.

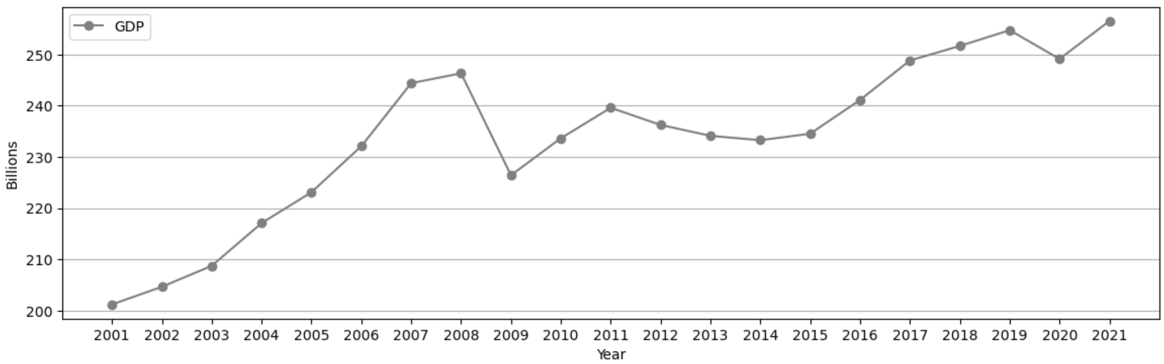

Figure 3: Absolute GDP in Finland for the 2001-2021 period (Billions).

For the study, the volume of IPOs is measured by calculating the annual IPO frequency in the target country. Another way would be to calculate the annual cumulative capital raised by IPOs per year. However, IPO frequencies were chosen for this study because reliable data were limited to IPO frequencies. IPO frequencies have been collected from the website of the Pörssisäätiö. The frequency includes Nasdaq Nordic listings and listings to First North. Nasdaq OMX First North is a multilateral trading facility owned by OMX. The differences between First North and the main list are First North's lighter requirements for companies to be listed (Inderes, 2021).

IPO activity has clearly increased in Finland over the last ten years. Figure (4) shows how the IPO activity before the financial crisis (2001-2008) is clearly lower than in the post-financial crisis period (2011-2021). In the post-financial crisis period, IPO activity has been clearly higher. The most striking increase has been in 2021, when the IPO activity in Finland has been several times higher than in the previous year’s having a total amount of 29 IPOs in Finland.

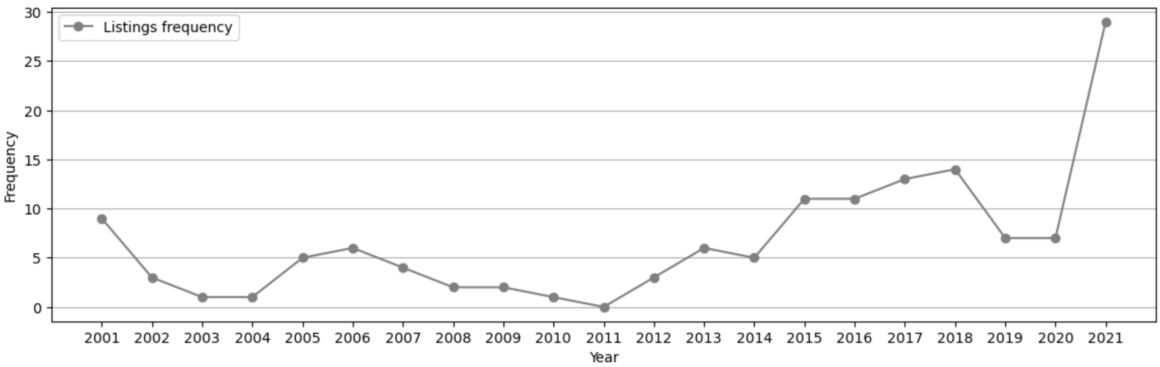

Figure 4: IPOs frequency in Finland for the 2001-2021 period.

Table (1) reports the number of observations, means, variances, minimum and maximum values of the macroeconomic factors between the 2001-2021 period. The mean and standard deviation of the IPOs frequency is about seven. The minimum frequency of IPOs is zero and the maximum value is 29. The mean and standard deviation of GDP is around 234 billion and 16 billion respectively. Between 2001 and 2021, the minimum GDP was around 201 billion and the maximum was around 257 billion. The three-month interbank rate averages 1.35% with a standard deviation of 1.73 percentage points. The lowest rate was -0.55% and the highest was 4.63%. The average of the market index is around 2753 and the standard deviation is around 1040. The lowest value of the market index is around 1328 and the peak is around 5248.

Table 2. Summary of data for the period 2001-2021

Variable	OBS	MEAN	STD	MIN	MAX
IPO	21	6.66	6.56	0.00	29.00
GDP (Billion)	21	234.16	15.95	201.22	256.53
3-Month Interbank Rate (%)	21	1.35	1.73	-0.55	4.63
OMXH25	21	2753.01	1040.07	1327.78	5247.65

3.2 Methodology

In econometric studies and in the definition of models, it is important to consider factors that affect the reliability of the models and thus the reliability of the results. In time series analyses, in order to choose the best model for regression, certain statistical tests must be carried out. The purpose of this section is to review the various statistical tests that are carried out to achieve a robust model and the model itself.

When modelling relationships between different variables using regression analysis, it is important to identify the data used and its nature when building the model. In general, in economic research, data are divided into two different categories – cross-sectional data and time series data. Time series data are characterised by a natural order (Hill R. Carter et al., 2011, 336). Natural order refers to a situation in which the order of observations does not matter. If the natural order of time series data is changed, the dynamic relationships between variables are lost. For example, the GDP of a given country is likely to affect the GDP of the coming year, in which case the order of observations matters. This implies another typical property of time series data, which is that observations are also often independent (Hill R.

Carter et al., 2011, 336). The data selected for this study fulfils the typical characteristics of time series data and as such requires further statistical analysis.

For the empirical part of this study, it has been decided to conduct a regression analysis using the least squares method (OLS-method). The least squares method makes certain assumptions about the variables included in the model and the error terms of the model, such as stationarity of the time series, homoscedasticity of the residuals and the absence of autocorrelation. In addition to the above assumptions, the cointegration of variables must be considered, which contributes to the use of the modelling method. The precise nature of all these factors and the testing methods are discussed in the following paragraphs.

Stationarity means that the time series is constant over time. In other words, a time series is stationary if its mean and variance are constant over time (Hill R. Carter et al., 2011, 447). In practise this means that the properties of the time series do not depend on time. If, on other hand, the properties of the time series depend on time, the time series is said to be non-stationary. The conditions for a stationary time-series are given below.

$$E(y_t) = u \text{ (Constant mean)} \tag{1}$$

$$var(y_t) = \sigma^2 \text{ (Constant variance)} \tag{2}$$

$$cov(y_t, y_{t+s}) = cov(y_t, y_{t-s}) = \gamma_s \text{ (Covariance depends on s, not t)} \tag{3}$$

(Hill, R. Carter et al., 2011, 477)

In general, the stationarity of a time series is first tested visually using the mean of the time series, but to include a robust variable in the model, a more detailed statistical test must be performed. One popular test for stationarity is the Augmented Dickey-Fuller test or unit root test for stationarity (ADF) which also considers the possibility of the autocorrelation. The null hypothesis for the test is that the time-series is nonstationary. The Augmented Dickey-Fuller test is shown in the equation (7).

$$\Delta y_t = \alpha_0 + \gamma y_{t-1} + \sum_{i=1}^{m} a_i \Delta y t_i + v_t \tag{4}$$

Where:

$\Delta y_{t-1} = (y_{t-1} - y_{t-2}), \Delta y_{t-2} = (y_{t-1} - y_{t-2}), \ldots$

(Hill, R. Carter et al., 2011, 485)

A common complicating factor in research is the nature of econometric time series, which are often non-stationary. Such non-stationary time series should not be used in regression models as they may produce a specious regression. However, there is an exception to the rule, cointegration. Cointegration refers to a situation where there is a long-run relationship between time series. In practice, this means that the time series in the model are non-stationary as such, but when the first difference is taken, they become stationary. If the error terms are stationary, of such a model whose variables are I(1) variables (Such variables that become stationary after the first difference are called I(1) variables), the model can be said to be cointegrated, i.e. the variables have a long-run relationship (Hill, R. Carter et al., 2011, 488).

In this study, the cointegration is tested using the Engle and Granger method. The Engle and Granger test assumes that the variables in the model are I(1) variables, i.e. stationary after the first difference. When this assumption is known to be true, the OLS method is used to estimate the model where I(1) variables are as factors. We then test whether the model residuals are stationary using the ADF test.

Heteroskedasticity occurs when the variance of the residuals or error terms in the model are not constant. In practice, heteroskedasticity means that the dispersion of the error terms in the regression model varies widely and systematically as the values of the variable being explained change. The problem is more common in cross-sectional data, but also occurs in time series data (Hill R. Carter et al., 2011, 301). If heteroskedasticity is not considered, the least squares estimator is no longer the best, as there is another estimator with lower variance. Another consideration is that the standard errors calculated for the least squares estimator are incorrect (Hill R. Carter et al., 2011, 302). The opposite of heteroskedasticity is homoskedasticity.

In general, heteroskedasticity is also examined using graphs by plotting the regressors of the model on the graph. However, more detailed statistical tests are usually needed as support. One common statistical test for testing heteroskedasticity is the Lagrange Multiplier test. The Lagrange Multiplier test is based on a variance function, the basic form of which is given in formula (8).

$$var(y_i) = \sigma_i^2 = E(e_i^2) = h(\alpha_1 + \alpha_2 z_{i2} + \cdots + \alpha_s z_{is}) \quad (5)$$

(Hill, R. Carter et al., 2011, 304)

The Lagrange multiplier test also refers to the Breusch-Pagan test. The Breusch-Pagan test uses the same Lagrange multiplier principle, based on the variance function. The null hypothesis of the test is that there is no heteroskedasticity, i.e., the variance of the residuals is constant (Hill R. Carter et al. 2011, 304).

Autocorrelation refers to a situation where the residuals of the model are correlated, i.e., the rule in formula (3) is deviated from. Models' autocorrelation may consist of an error term or of the autocorrelation of an explanatory variable, in a situation where the autocorrelation is not explained by the lags of the explanatory and explanatory terms included in the model.

As with heteroskedasticity, autocorrelation in OLS estimation produces spurious standard errors for the estimated coefficients (Hill R. Carter et al., 2011, 347).

In this study, autocorrelation has been tested using previously mentioned ADF test, which takes account the autocorrelation. If autocorrelation is a problem, a formula that accounts for heteroskedasticity and autocorrelation can be used to calculate fixed standard errors. (Hill R. Carter et al., 2011, 347-354)

After the statistical tests we can form the models. There are three OLS regressions to be estimated in total. The aim is to explain the number of IPOs in Finland by GDP, the 3-month interbank rate and OMXH25. The equations (11-13) are presented below.

$$\text{IPO} = \alpha + GDP_t + e \quad (6)$$
$$\text{IPO} = \alpha + RATE_t + e \quad (7)$$
$$\text{IPO} = \alpha + OMXH25_t + e \quad (8)$$

The impact of macroeconomic factors on the number of IPOs is not necessarily immediate. Thus, after a simple regression, a lagged distribution model is constructed. The assumption of the lag distribution model is that the effect of the independent factor on the dependent factor occurs over time (Hill R. Carter et al., 2011, 337). We use the lag distribution model to examine how the independent power evolves as lags are added to the model. The equations (14-16) of the lag distribution model are shown below.

$$\text{IPO} = \alpha + \beta_o GDP_t + \beta_1 GDP_{t-1} + \cdots \ \beta_q GDP_{t-q} + e_t \quad (9)$$
$$\text{IPO} = \alpha + \beta_o RATE_t + \beta_1 RATE_{t-1} + \cdots \ \beta_q RATE_{t-q} + e_t \quad (10)$$
$$\text{IPO} = \alpha + \beta_o OMXH25_t + \beta_1 OMXH25_{t-1} + \cdots \ \beta_q OMXH25_{t-q} + e_t \quad (11)$$

The results themselves are interpreted using the r^2 coefficient, the f-test and the standard error of the mean. The r^2 coefficient indicates the explanatory power of the regression model, i.e., the extent to which macroeconomic factors explain the variation in the number of IPOs. The F-test indicates whether the variation in the explanatory variable can be explained by the variables in the regression. Standard error (S.E) measures the standard error of the estimate. The standard error indicates the standard deviation of the residuals of the regression model. The larger the standard error, the larger the dispersion of the residuals and, at the same time, the lower the accuracy of the model, or explanatory power (Tietoarkisto, 2023).

4 Results

This section reviews the results obtained. The first step is to report the results of the unit root tests (stationarity) and cointegration of the time series. In the second step, before the main analysis, the test for heteroskedasticity is reported. In the third step, models are created using regression and a lagged distribution model to examine the explanatory power of macroeconomic factors on IPO frequencies in Finland.

4.1 Stationarity

As said, stationarity is tested using the Augmented Dickey-Fuller (ADF) test. When performing the ADF test, the number of lags must be determined. The Schwert criteria have been used to determine the number of lags. The Schwert criterion, calculated with Stata, determines the number of lags up to even eight. According to Wooldridge (2012), a single lag specification for annual data is preferable, because as the number of lags increases, the number of degrees of freedom increases, and contributes to reducing the number of observations, and since we are dealing with an annual and very small data set, the number of lags is kept to one even though the Schwert criteria claims otherwise.

Table (2) reports the original time series and the first differences of the time series, as well as the test statistics and critical values obtained. The table also shows the number of lags and the p-values for each time series. The null hypothesis of the ADF test is that the time series are non-stationary. As can be seen from the table, each time series as such is not stationary. All have a p-value greater than 0.05, and thus the null hypothesis cannot be rejected.

However, the first differences of the time series all have a p-value below 0.05. The test is therefore statistically significant, and the null hypothesis can be rejected. The time series taken first difference are therefore stationary.

Table 2. Augmented Dickey-Fuller tests, *significant at 5% risk level

Variable	Test statistic	Lag	Critical value (5%)	P-value	First difference test statistic	Lag	Critical value (5%)	p-value
IPO	-2.051	1	-3.60	0.57	-3.215	1	-3.00	0.02*
GDP	-2.638	1	-3.60	0.26	-3.615	1	-3.00	0*
RATE	-3.25	1	-3.60	0.07	-4.232	1	-3.00	0*
OMXH25	-2.338	1	-3.60	0.41	-3.969	1	-3.00	0*

4.2 Cointegration

A condition for using OLS and the lag distribution model is that the time series are cointegrated, i.e., the time series must have a long-run relationship. Testing for cointegration using the Engle-Granger method described earlier starts by first generating regressions for each pair of time series, then testing the residuals of the regressions for unit root using the ADF method. If the residuals have a singular root, the null hypothesis remains valid, i.e., the time series are not cointegrated.

Table (3) shows the pairs of variables tested and the test values given by the test for each regression, as well as the critical values of the test. The results are very similar. The regression residuals for each pair of variables are cointegrated at the specified risk level (0.05). Thus, it can be concluded that the time series have a long-run relationship.

Table 3. Cointegration results. H0 rejected if test statistic < -1.95.

Variables	Test Statistic	Critical value
IPO & GDP	-2.43	-1.95
IPO & RATE	-2.60	-1.95
IPO & OMXH25	-2.27	-1.95

4.3 Heteroskedasticity

To fulfil the robustness of the models, heteroskedasticity should be tested. The heteroskedasticity is tested using the Breusch-Pagan test with the null hypothesis of homoskedasticity.

Table (4) reports the results of the heteroskedasticity test for each separate model with each pair of variables. Models explaining the number of IPOs by GDP and interest rate are not statistically significant at a risk level of 5%, because the p-value is well above 0.05, and the null hypothesis holds. This means that models explaining the number of IPOs by GDP and interest rate are homoscedastic. A model explaining IPO activity by OMX Helsinki25 is statistically significant at the 5% risk level. In other words, the null hypothesis of homoskedasticity of the model is rejected and it can be concluded that the model is heteroskedastic.

Table 4. Heteroskedasticity tests, *significant at 5% risk level

	Variables	p-value
Heteroskedasticity (Berusch-Pagan)	IPO & GDP	0.67
	IPO & RATE	0.70
	IPO & OMXH25	0.01*

Heteroskedasticity is corrected by constructing an equation of the corrected standard errors using the Stata robust command.

4.4 Regression analysis

Table (5a) reports the results of the regression analysis. The explanation rate of GDP is 0.21. The MSE is assigned a value of 5.94. There is no guideline value for the MSE, but in general the closer the MSE is to zero, the better the model. The P-value of the F-test scores 0.09, which exceeds the risk level of 0.05, i.e., the null hypothesis of the F-test holds. The correlation between the two variables is positive.

The next model, which attempts to explain IPO activity by interest rates, gives an explanatory power of 0.21, with an MSE of 5.96. The p-value of the f-test is 0.04, i.e., the null hypothesis of the F-test is rejected. The model can be found to be significant. The interest rate variable is also statistically significant at the risk level of 0.05. The correlation between the two variables is negative.

The third model, which attempts to explain IPO activity by index values, gives an explanatory power of 0.53. The MSE is 4.57. The P-value of the F-test is 0.01, i.e., the null hypothesis of the F-test is also rejected in this model. The value of the index as a variable is also statistically significant at the risk level of 0.05. The correlation between the two variables is positive.

Table 5a. Regression analysis results, *significant at 5% risk level

2001-2021	**R-squared**	**MSE**	**F-test**	**p-value**
IPO & GDP (+)	0.21	5.96	3.08	0.09
IPO & RATE* (-)	0.21	5.96	4.92	0.04*
IPO & OMXH25* (+)	0.53	4.57	7.54	0.01*

The models may be affected by the very high observed value of the 2021 IPO frequencies, which is relatively difficult to explain compared to the historical observed values of all variables and the observed values of the 2021 macroeconomic variables. There is no similar sharp change in the interest rate, the value of the index and GDP in 2021 as in the number of IPOs (Figures 1-4), thus the same regressions have been run for table (5b), but now excluding the 2021 observations from the analysis. The same assumptions about the stationarity and cointegration of the I(1) variables hold.

For the period 2001-2020, it can be seen from Table (5b) that the first model explaining listings by GDP, still does not hold as such with an F-test P-value above 0.05.

The second model with interest rate as an explanatory factor now has an explanatory power of 0.20, which is slightly lower than in the regression analysis based on the 2001-2021 data. The model and the explanatory variable are both statistically significant with p-values below 0.05. The MSE is also lower (3.87<4.92) which is a sign that the model is slightly better. The correlation between the two variables is still negative.

The third and final model, which uses index values to explain listings, now has an explanatory power of 0.38. This value is slightly above the value of the 2001–2021-time horizon model. The MSE is 3.4, which is also better than in the previous model. The model and the variable are also statistically significant (p-value < 0.05). The correlation between the two variables is still positive.

Table 5b. Regression analysis results, *significant at 5% risk level

2001-2020	R-squared	MSE	F-test	p-value
IPO & GDP (+)	0.12	4.09	2.18	0.15
IPO & RATE* (-)	0.20	3.87	4.82	0.04*
IPO & OMXH25* (+)	0.38	3.4	6.75	0.02*

4.5 Distributed lag model

Table (6) shows the results of the lag distribution model for the period 2001-2020. It has been decided to exclude the year 2021 from the lag distribution model. The lag distribution model explains the increase in IPOs at a given point in time, by independent variable by a given point in time and one or two lags (Figures 14-16).

When explaining the number of listings by GDP, the p-values of the explanatory factor are above 0.05 for each lag, i.e., the null hypothesis holds. The regression coefficient is positive for the first lag but changes to negative for the second lag. The explanatory power of the model is 0.18 and the MSE is 4.20. The f-test of the model gives a p-value above 0.05, thus the null hypothesis of the f-test also holds. The results are reported in Table (6).

When explaining IPO activity by interest rate levels, the explanatory variable is not statistically significant at the first lag but is statistically significant at the two lags. The signs of the regression coefficients are negative at both lags. The explanatory power of the model is high at 0.56 and the MSE gets a value of 3.03. The model is also statistically significant with an f-test p-value below 0.05. The results are reported in Table (6)

When explaining IPO activity by the OMX Helsinki value, the explanatory factors are all not statistically significant at a p-value above 0.05. The coefficient on the explanatory variable in the model is positive for the first lag and negative for the second lag. The explanatory power of the model is 0.16 and the MSE is 4.22. The model is not statistically significant with a p-value of the f-test 0.16. The results are reported in Table (6)

Table 6. Distributed lag model period 2001-2020, *significant at 5% risk level

2001-2020			
Lag	**IPO & GDP**	**IPO & RATE**	**IPO & OMXH25**
t-1	0.17	-0.35	0.0012
t-2	-0.04	-1.63*	-0.00067
R-squared	0.18	0.56	0.16
MSE	4.20	3.03	4.22
F-test	1.69	9.79	1.44
Prob F-test	0.21	0*	0.16

5 Analysis

The purpose of this study has been to examine the relationship between certain macroeconomic factors and the number of IPOs over the last twenty years. Whether the relationship is potentially negative or positive and whether there is some lag between the variables. A regression analysis has been used to explore the answers, the results of which are reported in Tables (5-6).

The results suggest that the frequency of IPOs and the 3-month interbank rate appear to be related to the number of IPOs and that there is a long-run relationship between the variables. The model was fitted for the time periods 2001-2020 and 2001-2021 (tables 5a and 5b). The explanatory power of the model for the time horizon 2001-2020 (table 5a) was found to be 0.21, which would imply that the interest rate would explain about 21% of the IPO activity in this time horizon. The model was also statistically significant. For the second model fitted to the period 2001-2020 (table 5b), the results were very similar. In this model, only the explanatory power decreased by one percentage point and the MSE was lower, which contributes to a better fit of the model for the time period 2001-2020. As said the correlation between the interest rate and the number of listings was negative. In practice, a negative correlation would mean that as interest rates rise, IPO activity would decrease. This result is the opposite of what was hypothesised and what some of the older studies have found (Brau J. et al., 2003). Also, the lag distribution model results reported in the table (6) are having the same trend with those of the OLS method. The results reported in table (6) show that the correlation was negative for the one lagged and two lagged rate variable, but only for two lags was the variable significant. In effect, this would imply that the shock effect of interest rate is not immediately transmitted to the IPO activity, but it takes at least two years of time for the IPOs to take interest rate into account. A result that is very open to interpretation. As with the OLS model, the lag distribution model was also statistically significant. The MSE for the lagged distribution model was also the lowest of all three models for the lagged distribution model. This effectively means that the lagged distribution model is the most appropriate of these models in terms of MSE.

Overall, the result is very counter-intuitive between the 3-month interbank rate and the number of IPOs because, as we discussed in the hypothesis section, it is intuitive to assume that as interest rates rise, so does IPO activity. But as the literature review showed, the negative correlation result is not unique (Tran et al., 2011; Jenssen & Johnson, 1993). The contradictory relationship can also be seen in Figures 4 and 2, which show the frequency of IPOs and interest rate levels over the last twenty years. Although interest rates have been very low over the last ten years, it appears that the willingness of companies to seek financing through IPOs has been stronger than during periods when interest rates were higher. The link is therefore not unambiguous and based on intuition but is likely to be centred on companies' own visions of optimal capital structures. On the other hand, it is also possible to consider how the incentives of companies to seek financing in different ways are also bound up with the prospects of the period in question. The use of debt increases the volatility of the return on equity. In good times, the use of debt increases returns and in bad times it decreases returns compared to no debt (V. Puttonen & S. Knupfer, 2014,166). The difference between the increase in borrowing activity relative to interest rates before and after the financial crisis would thus be explained by the deterioration in the outlook. Before the financial crisis, the outlook was more positive for companies, which contributed to driving companies to seek debt financing, as the probability of obtaining a better return on equity through debt financing was higher, and on the other hand, the uncertainty after the financial crisis drove companies to seek more equity financing, with less volatility in the return on equity. This would contribute to explain the negative correlation between the number of IPOs and the interest rate over this period. On the other hand, to produce a coherent analysis, information on the change in the debt capital of company's period under review would also be needed.

As with interest rates, the stock index was also correlated with the rate of IPOs and a clear long run relationship was found between the variables. This model was also fitted first for the period 2001-2021 and then for the period 2001-2020 (tables 5a and 5b). The explanatory power of the model was very high, up to 0.53 in the first model fitted between 2001 and 2021 (table 5a). This would mean that the index would explain more than half of the variation in the number of IPOs. The MSE was 4.57, and the p-value of the f-test was 0.01, indicating that the model is statistically significant and as such is robust. The model run between 2001 and 2020 (table 5b) reduced the explanatory power from the previous 0.53 to 0.38, which means that the explanatory power decreased significantly when removing the year 2021 from the model, which was an atypical year for IPO frequencies. The MSE was also lower, which contributes to the fact that the model for the years 2001-2020 performs better. The correlation was positive in both models, supporting the hypothesis that there is a positive correlation between the index and IPO listings. In the lag distribution model, the stock index for the one and two lags were not statistically significant (table 6). Thus, the model itself was also not statistically significant at a p-value of 0.16 for the f-test. Thus, it can be concluded that the impact of the stock index on IPOs is direct and that there is no shock effect, at least on the basis of this data.

While the relationship between interest rates and IPOs is somewhat ambiguous compared to the old results, the relationship between stock price movements and IPO activity seems to confirm the consensus of the older research results. The results of this study point to a clear positive correlation between stock index value and IPO activity and a long-run relationship, which is supported by the studies discussed in the literature review that show a long-run relationship and a positive correlation between market index and IPO activity (Loughran et al., 1994; Rees P., 1997).

In the model where the number of IPOs was explained by GDP, the explanatory power was 0.21 in the first model fitted between 2001 and 2021 (table 5a). The interpretation was that GDP would explain 21% of the variation in IPOs. The MSE was 5.96 and the p-value of the f-test was 0.09, which means that the model is not statistically significant at the 5% risk level and the model as such can be considered as inefficient. The model implemented between 2001 and 2020 reduced the coefficient of explanation from the previous 0.21 to 0.12 (Table 5b). The MSE was also lower, which contributes to a more robust model for the period 2001-2020. The problem with this model was also the p-value of the f-test, which is 0.15 and thus above the 5% risk level. The model as such is therefore not reliable.

In the lag distribution model, the GDP variables with one and two lags were not statistically significant as explanatory factors (table 6). Thus, the model itself was also not statistically significant at a p-value of 0.21 for the f-test.

None of the three models therefore works as such and shows that the link between gross domestic production is not a strong enough explanatory variable on its own. The results suggest that there would be a long-run relationship between the variables, but the correlation between the variables was very weak, and the model that tries to explain IPO activity by GDP did not work as such. Intuitively, one would think that as the real economy grows, the need for investment would also increase, leading to an increase in IPOs, as shown by Lowry (2003) in addition to the studies in the literature review. They found a positive correlation between IPO activity and capital needs (which, for instance, are increased by the growth of the real economy through the multiplier effect). In Finland, however, this relationship was not directly observed between the variables. Thus, the research hypothesis that there is a positive correlation between the frequency of IPOs and GDP was not confirmed by this study and confirms the finding of Rydvist and Högholm (1995b) in Sweden that IPO decisions and GDP are uncorrelated.

In summary all but one of the research hypotheses were rejected. This result partly reflects the contradictory nature of older research findings. Research results vary and no full consensus has been reached on the nature of the relationship (negative or positive) between listings and various macroeconomic factors. The link between the stock market index and IPO activity seems to be clear: the index is positively correlated with IPO activity, but the link between interest rates and GDP seems to be more complex. The contradictions may point to regional differences in the studies, as well as to differences in statistical methods and variables. Whether one studies IPO frequencies or volumes and which factor is used to explain this association may lead to different results. It is also important to delve into the actual causal relationships between variables, in which case it would be important to supplement the study with surveys asking companies what factors they consider when making IPO decisions, in addition to various statistical tests.

6 Conclusions

In this paper, the study focused on the impact of macroeconomic factors on IPOs in Finland over the period 2001-2021. The macroeconomic factors used were gross domestic product, the three-month interbank rate and the OMX Helsinki 25. First, the stationarity of the time series was tested and, with the results obtained, also the cointegration. Each explanatory time series was found to be cointegrated with the time series to be explained. Using this information, a total of six simple models were generated using OLS, three of which used lags and the remaining three did not include lags. The explanatory factor for all six models was the frequency of IPOs and the explanatory factor was one of the factors selected for the study. Three hypotheses were generated for the study. We assumed that there would be a positive correlation between each macroeconomic factor and the frequency of IPOs. Of the hypotheses, only the hypothesis that assumed a positive correlation between index value and IPOs frequency was supported by the results of the study.

Generally, the study contributes to previous findings that there is a long-run relationship between macroeconomic factors and the frequency of IPOs. The results of the models partly confirmed and partly diverged from the results already obtained relating to correlation relationships. More specifically, the study supports those studies that have found a positive correlation between IPO activity and the stock market index, and a negative correlation between IPO activity and interest rates. No significant relationship was found between GDP and IPO activity, which contributes to the contradiction with the mainstream of older studies.

As in all studies, this study also faced certain limitations. The robustness of the models was reduced by the methods used and the small number of observations in the data. OLS-method or lagged distribution model were not the main modelling methods used in the old studies, but vector auto-regressive (VAR) and vector error correction models (VECM) were often used, depending on the nature of the variables. In this study, however, the use of these modelling methods had to be abandoned because the data set was so small that these models might not have performed as expected. The small data set also meant that the study of causality had to be abandoned. This study also did not consider the endogeneity of the variables, which in practice means that the variables are correlated with the model residuals and may lead to biased results. Endogeneity is also an issue that few old studies have considered and should be considered in future studies.

The study is one of the few studies on this topic to have been carried out in Europe. To get a better picture in Europe of how macroeconomic factors affect IPOs, it would be useful to extend the study to the other Nordic countries and to see if the results are consistent. As a modelling method, and in contrast to the mainstream of studies, panel data analysis could also be tried as an analytical method to compare the relationship between multiple countries and macroeconomic time series. In addition to external macroeconomic factors, the study could also include internal factors that influence listing decisions, thus strengthening the understanding of how strong the causality of macroeconomic factors on companies' listing decisions is.

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