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Stock Markets and Real Economic Activity

- Zooming out to show a broader picture using 12 EU Membership Countries

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Abstract

This thesis analyzes the long run relationship between stock markets and macroeconomic variables, such as the real industrial production index, consumer price index, money supply, and long-term government bonds. By the use of recent developments in cointegration methodologies a larger set of countries is analyzed due to mitigation of the issue where variables are integrated of different orders. Based on a present value model, this thesis applies an ARDL model and conducts the bounds testing procedure for analysis of cointegrating relationships among the variables. Complemented by the popular Johansen cointegration methodology, it is found that the variables are cointegrated for all of the twelve countries. Hence, the present value model provides a theoretical explanation of the long run connection between stock markets and macroeconomic variables. Finally, the long run relationship is estimated using both FMOLS and DOLS. Results show that real economic activity, proxied by the real industrial production index, enters a positive relationship with the stock market indices, and so does money supply. In contrast, the consumer price index and long-term government bonds enter a negative relationship with the stock market indices. Hence, this thesis adds to the literature by applying new methodologies to the topic, through which a larger set of countries can be analyzed, and by further analyzing the long run relationship between stock markets and real economic activity.

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List of Acronyms

Acronym	Definition
AIC	Akaike Information Criteria
APT	Arbitrage Pricing Theory
ADF	Augmented Dickey-Fuller Unit Root Test
ARDL	Autoregressive Distributed Lag
CPI	Consumer Price Index
DOLS	Dynamic Ordinary Least Squares
FMOLS	Fully Modified Ordinary Least Squares
GB	Government Bond
GDP	Gross Domestic Product
GNP	Gross National Product
IP	Industrial Production
M1	Money Supply
NYSE	New York Stock Exchange
OLS	Ordinary Least Squares
PVM	Present Value Model
RCK	Ramsey-Cass-Koopmans
SIC	Schwarz Information Criteria
SMI	Stock Market Index
TB	Treasury Bill
VAR	Vector Autoregression
VECM	Vector Error Correction Model

1. Introduction

Stock markets, its movements, changes, and returns. There has probably been an interest in unraveling the factors influencing stock market prices and assets returns since the very day they began to be traded. Nevertheless, since the introduction of modern technological advances allowing for continuous monitoring and analysis by a larger group of potential investors. Driven by the potential gains in wealth from having the best tools of how to analyze financial assets, there is yet no perfect answer to the question of how one predicts asset prices. Hence, it is not surprising that there exists a vast pool of literature concerned with theory and models aiming to explain and predict stocks prices and asset movements. While key performance measures of firms play a crucial role in the analysis of stock prices, economic activity within which the firm operates can be another determinant of expectation, and thereby also affect stock price. Therefore, this thesis analyzes the long run relationship between stock markets and macroeconomic variables.

Earlier publications by authors such as Ross (1976) and Fama (1990) focus on financial aspects such as expected return to explain stock market movements. On the other hand, macroeconomic theory often includes firms in growth models looking at economic activities of nations (Romer, 2012). However, over the past decades' authors have increasingly devoted their attention to combining the financial field with aggregate economics. Mukherjee and Naka (1995), Cheung and Ng (1998), Nasseh and Strauss (2000), and Humpe and Macmillan (2009) have all looked at the long run relationship between a number of macroeconomic variables and stock markets. The rather recent interest for analysis focusing on the long run relationship between stock market movements and aggregate economic variables can be explained by methodological developments by authors such as Engle and Granger (1987), Johansen (1991), and Pesaran, Shin, and Smith (2001).

Theoretically, Lucas (1978) discussed the connection between expectations and asset prices. The idea is that the price of an asset is determined by its expected future cash flows. This notion has led to the development of a Present Value Model (PVM) which explains the price of an asset as a function of its future cash flows and a discount rate of these cash flows. Therefore, Humpe and Macmillan (2009), as well as others before[1], argue that any factor influencing the expected future cash flows, or the discount rate, will in fact also affect the price of that asset.

[1] See *inter alia* Chen et al. (1986), Fama (1990), Cheung and Ng (1998), Nasseh and Strauss (2000), and Humpe and Macmillan (2009), all based on the PVM.

The relationship between stock markets and economic activity has been widely studied. However, the studies such as Mukherjee and Naka (1995), Cheung and Ng (1998), and Humpe and Macmillan (2009) that purely focused on analysis of the long run relationship, mainly chose to focus on rather large economies such as the U.S., Japan, and U.K., with the exception of Cheung and Ng (1998), and Nasseh and Strauss (2000). The former including a larger number of countries, yet still the major economies in the world, and the later focusing on European countries. One reason for limiting the analysis to these major economies could be due to limitations of long run estimation techniques. In these studies, the mostly applied methodology has been the Johansen (1991) cointegration methodology[2]. While popular, this methodology has the limitation of only performing well with variables integrated of order one[3]. Hence, previous literature using the Johansen (1991) methodology might have selected economies to analyze based on the variables of interest and their orders of integration. However, developments by Pesaran et al. (2001) relaxes the limitation of the Johansen (1991) methodology. Hence, allowing for analysis of countries and variables previously not possible.

Therefore, this thesis will contribute to the literature by applying the PVM using well established techniques as well as methods previously not used, to further analyze the relationship between macroeconomic variables and stock markets. By both using Pesaran et al. (2001) and Johansen (1991) cointegration methodologies, a larger number of countries will be possible to analyze. Hence, the aim and contribution of this thesis is twofold. First, the aim is to analyze a larger number of countries and countries previously not studied. Therefore, this study will include twelve EU membership countries. Second, this study uses Pesaran et al. (2001) bounds testing technique for analysis of cointegration, due to its robustness when the data set contains variables integrated of different orders, together with the popular Johansen (1991) cointegration methodology, in a panel data setting. Hence, this thesis aims to answer the question: Are stock markets related with macroeconomic variables in the long run, as predicted by the PVM?

The reminder of this thesis has the following structure: Section 2 presets previously conducted research on the topic, as well as the PVM. Section 3 outlines the methodological framework to be used in the analysis. Section 4 presents the data used in this thesis, while section 5 contains the results and analysis. Finally, Section 6 concludes this thesis.

[2] A detailed explanation of cointegration is found later in section 3.

[3] Order of integration refers to the number of times a series has to be first differenced to become stationary. For detailed explanation, see section 3.

2. Literature Review

The relationship between macroeconomic variables and the performance of various assets such as the stock market has been subject of discussion by scholars for many decades. While some have focused on the financial side of the matter (Fama, 1981), and Ross (1976) with the Arbitrage Pricing Theory (APT), others have chosen to include firms in macroeconomic theory explaining aggregate output and growth, such as the Ramsey-Cass-Koopmans (RCK) model (Romer, 2012). Lucas (1978) developed a model explaining asset prices based on their present value, more specifically the present value of dividends to be paid in the future. The Present Value Model (PVM) has been argued to link stock market returns with economic performance by authors such as Nasseh and Strauss (2000), Humpe and Macmillan (2009), and Alexius and Spång (2018), among others. Finally, a more general and rather recent framework was developed by Kung and Schmid (2015). The developed growth model endogenize asset prices, such as stocks, and productivity growth. Hence, variables such as consumption, income, dividend, and stock prices are linked together (Kung and Schmid, 2015). This general equilibrium stochastic growth model was used as the focal point by Alexius and Spång (2018), with the intuition that a broader range of macroeconomic variables together affect the stock market.

The APT has been a popular theory mainly applied to empirical analysis looking at the short-run relationship between returns of stock markets and macroeconomic variables, where short-run is stock variables in their first differences, or stationary variables[4]. The intuition is that changes in macroeconomic variables correspond to changes in systematic risk, thus affecting future stock market returns (Humpe & Macmillan, 2009). Fama (1981) used APT in this manner and analyzed the relationship between stock returns and inflation. He found support for the hypothesis that a negative stock market and inflation relationship can proxy a positive relationship between real macroeconomic variables and stock market returns. Following, Fama (1990) empirically showed that 30% of movements in the New York Stock Exchange (NYSE) could be explained by variables representing chocks in expected return and expected return itself. These findings were found to hold by Schwert (1990) who significantly increased the number of time periods and replicated the study by Fama (1990). Following the analysis of Fama (1981) on business life-cycle and its relationship with stock markets and economic performance, Beaudry and Portier (2006) show that opportunities in technology can be an

[4] Stationarity and nonstationarity is further discussed in section 3.

important determinant for changes in business life-cycles, using quarterly data for the U.S. over the last half of the 20th century.

Further studies based on the APT and focused on the short-term relationship include Fama and French (1989), Ferson and Harvey (1991), and Black, Fraser, and MacDonald (1997). Fama and French (1989) found that expected returns are higher in times of weak economic periods, and vice versa, when analyzing the NYSE. Additionally, Black, et al. (1997) found U.K. shares and bonds to be related with business conditions, and Ferson and Harvey (1991) found six economic variables to be related with the NYSE.

Another stream of literature instead tries to analyze the long-run relationship between stock markets and macroeconomic variables. The main issue arising when dealing with macroeconomic and financial variables is the issue of nonstationarity, and this can be mitigated using various cointegration techniques (Humpe & Macmillan, 2009). Engle and Granger (1987) define cointegration and argue that long-run relationships between nonstationary variables can be studied if the variables of interest are found to be cointegrated[5]. Johansen (1991) developed a methodology for hypothesis testing of cointegrating relationships. This methodology is based on Engle and Granger (1987) Vector Error Correction Model (VECM) and their discussion regarding the use of nonstationary variables (Johansen, 1991).

Analyzing whether cointegrating relationship exists between stock markets and macroeconomic variables using the Johansen (1991) methodology has been successfully conducted for a range of rather large economies. Mukherjee and Naka (1995) found the Japanese Tokyo stock exchange to be significantly related with six variables including the macroeconomic variables Industrial Production (IP), Consumer Price Index (CPI), and money supply. Extending the analysis by Mukherjee and Naka (1995), Humpe and Macmillan (2009) compared U.S. and Japan in an attempt to see whether the same framework could be applied to both countries. By the use of the variables IP, CPI, money supply (M1), and Treasury Bill (TB) (for U.S.) and the Japanese official discount rate (Disco), cointegration was found and a majority of the variables were found to be significant. However, the variable money supply was insignificant in the case of U.S. and for Japan two cointegrating relationships were found (Humpe & Macmillan, 2009).

A broader picture on the topic was provided by Cheung and Ng (1998), and Nasseh and Strauss (2000) who chose to analyze a larger number of countries. The former included the countries Canada, Germany, Italy, Japan, and the U.S., while the latter focused on the European

[5] Detailed description of cointegration is found in section 3.

countries France, Italy, Netherlands, Switzerland, U.K., and Germany. Furthermore, using the Johansen (1991) cointegration methodology Cheung and Ng (1998) found general support for the cointegrating relationship between national stock market indices and variables in real terms, such as the price of crude oil, money supply, Gross National Product (GNP), and personal consumption. In contrast, Nasseh and Strauss (2000) chose to focus on the variables real IP and business surveys of manufacturing orders, to act as measures of the aggregate economic activity within the analyzed countries. Their dependent variable stock price was kept nominal and CPI was included as an explanatory variable with the rationale being that they also wanted to unravel the effects of inflation on stock markets. Moreover, short-term, and long-term interest rates were included in the analysis. Generally, cointegrating relationships between the variables were found for all countries, and IP and manufacturing orders are argued to be the driving force in explaining stock prices in the long-run (Nasseh & Strauss, 2000).

The general findings by Mukherjee and Naka (1995), Cheung and Ng (1998), Nasseh and Strauss (2000), and Humpe and Macmillan (2009) suggests a positive relationship between stock markets and economic activity, such as IP for the respective countries analyzed. In contrast, Cheung and Ng (1998) find inconclusive results regarding whether the relationship is positive or negative. However, they use the broader measure GNP compared to the other papers using IP as a measure of economic activity. Mukherjee and Naka (1995) found CPI to be negative, and this was later confirmed by Humpe and Macmillan (2009) by one of their cointegrating vectors. For the other cointegrating vector CPI was found insignificant (Humpe & Macmillan, 2009). On the other hand, Nasseh and Strauss (2000) found the coefficients of CPI to be positive for all of their six European countries. Regarding TB, or long-term TB for the case of Nasseh and Strauss (2000), the general finding is a negative relationship with stock markets (Mukherjee & Naka, 1995; Nasseh & Strauss, 2000; Humpe & Macmillan, 2009).

Theoretically IP as a measure of economic activity has been argued to be positively related with stock returns and stock market movements (Chen, Roll, & Ross, 1986) and as previously mentioned this has been documented numerous times. On the other hand, DeFina (1991) argues that unexpected inflation might influences real stock returns through changes in real profits of firms. Expectations on future price levels may change due to unexpected inflation and thereby also decrease the present value of cash flows (Humpe & Macmillan, 2009). Hence, authors have made use of CPI to account for these unexpected price changes (Mukherjee & Naka, 1995; Nasseh & Strauss, 2000; Humpe & Macmillan, 2009). Early discussions regarding the effects' money supply might have on stocks include Brunner (1961), Friedman and Schwartz (1963), and Rogalski and Vinso (1977). They found evidence arguing that money

supply is strongly related with asset prices and changes in stock markets. Humpe and Macmillan (2009) argue that money supply may affect the stock market in a number of different ways. It may negatively affect stock markets through unanticipated inflation, positively affect stock markets due to enhanced economic activity, and it may be positively related with the stock markets due to investment movements going from interest to equity (Humpe & Macmillan, 2009). Unexpected changes to the supply of money changes the equilibrium with financial assets through changes in price levels (Rogalski & Vinso, 1977). Friedman and Schwartz (1963) pinpoint the connection between money supply and business cycles, while Urich & Wachtel (1981) connect money supply with interest rates. The influence of money supply was later found significantly related with stock market movement in Australia (Chaudhuri & Smile, 2004).

A broader stream of literature differentiates through inclusions of specific variables of interest, or through analyzing specific countries. Nasseh and Strauss (2000) include business manufacturing surveys while the consumption-wealth ratio has been found to play a crucial role in explaining excess return and real stock return (Lettau & Ludvigsson, 2001). Using U.S. data on consumption, wealth, and the major stock markets index, Lettau and Ludvigsson (2001) argue that the variables are cointegrated. Furthermore, it was found that the consumption-wealth ratio is a better predictor of excess return and real stock return than the TB rate. In a forecasting setting it was found that the consumption-wealth ratio outperformed dividend yield and the dividend to payout ratio in predicting future returns at a short and intermediate time-horizon (Lettau & Ludvigsson, 2001). Bansal and Yaron (2004) develop a model where consumption, together with dividend growth, explain stock market movements. The connection with wealth and consumption is further analyzed by Benzoni, Collin-Dufresne, and Goldstein (2007), and Bansal, Ditmar, and Kiku (2009), using U.S. data. Furthermore, Benzoni, et al. (2007) find that wealth in terms of labor income is cointegrated with dividends. Hence, confirming the argument by Lettau and Ludvigsson (2001).

On the contrary Madsen, Dzhumashev, and Yao (2013) chose to analyze a larger set of countries. Their study included a panel of 20 countries and variables such as stock return, labor productivity growth, and technological chocks, over almost a century for some of the countries. Before the 1950's macroeconomic variables and economic growth were found to be positive and significantly related with stock markets in the analyzed data set. However, after 1950 the same relationship was not found (Madsen et al., 2013). Instead, Hossain and Hossain (2015) try to explain economic growth by stock market movements for U.S., U.K., and Japan. They include both a short-term and a long-term perspective and conclude that relationship between

the variables does not exist. This is true regardless of the time perspective (Hossain & Hossain, 2015). Alexius and Spång (2018) use a panel data method for the G7 countries and include the variables stock market indices, national Gross Domestic Product (GDP), and foreign GDP. It was found that the variables national and foreign GDP indeed were cointegrated with stock market indices among the G7 countries.

Hence, one can see that a major stream of the recent literature, focusing on analysis of the long run relationship between stock markets and economic variables, has been based on the Johansen (1991) cointegration methodology. Furthermore, one can see a trend in the choice of countries that have been analyzed. With the exception of broader studies such as the ones by Cheung and Ng (1998), and Nasseh and Strauss (2000), the majority of previous studies have chosen to focus on one or two countries. Regarding the directional relationship between stock markets and aggregate economic variables, none of the previously presented papers have been able to argue whether macroeconomic variables cause stock market movements, or vice versa. In fact, Hossain and Hossain (2015) use the stock market to explain movements in output. Finally, one can see that the PVM has been a popular theory applied to the topic of the long run relationship between stock markets and economic variables.

2.1. The Present Value Model

The discounted cash flow, or PVM model as it is also called, has been applied in a number of studies analyzing the long-term relationship between stock markets and a range of macroeconomic variables[6]. As theorized by Lucas (1978), these authors have all argued that the value of an asset is based upon future cash flows of that particular asset, and the discount rate of the cash flows themselves. Hence, aggregate economic variables such as GDP, IP, money supply, interest, etc. can affect expectations of future cash flows of firms, and thereby also affect the value of firms (Fama, 1990).

Humpe and Macmillan (2009) formulate the simplest form of a PVM where price of an asset can be expressed as follows:

$$P_t = \frac{E_t(d_{t+1})}{1 + E_t r} + \frac{E_t(P_{t+1})}{1 + E_t r} \tag{1}$$

[6] Studies based on the PVM include, but are not limited to, Chen et al. (1986), Fama (1990), Cheung and Ng (1998), Nasseh and Strauss (2000), and Humpe and Macmillan (2009).

where $E_t(\cdot)$ is an operator of expectations given all accessible information at time t, P_t is the price of an asset at time t, $E_t(d_{t+1})$ represents expected annual dividend received from the asset at the end of year one, $E_t(P_{t+1})$ denotes the expected price of an asset at the end of year one, and $E_t r$ represents the expected discount rate or represents a proxy for cost of capital (Humpe & Macmillan, 2009). Extending equation (1) to show the expected value of the price of an asset at time t can be written as:

$$E_t P_{t+i} = \frac{E_t(d_{t+i+1})}{1 + E_t r} + \frac{E_t(P_{t+i+1})}{1 + E_t r} \tag{2}$$

for $i = 1, \dots, N-1,$. Furthermore, substituting (1) into (2) and by substituting for expected future price of an asset Humpe and Macmillan (2009) get:

$$P_t = \sum_{i=1}^{N} \frac{E_t(d_{t+i})}{(1 + E_t r)^i} + \frac{E_t(P_N)}{(1 + E_t r)^N} \tag{3}$$

which after letting $T \to \infty$ results in:

$$P_t = \sum_{i=1}^{\infty} \frac{E_t(d_{t+i})}{(1 + E_t r)^i} \tag{4}$$

The final equation (4) shows that the price of an asset consists of the sum of expected future dividends and the discount rate, or formal cost of capital. The intuition being that "any macroeconomic variable that may be thought to influence expected future dividends and/or the discount rate could have a strong influence on aggregate stock prices" (Humpe & Macmillan, 2009, p.113).

As shown by the PVM, and argued by Humpe and Macmillan (2009), the model provides an explanation to why authors such as Mukherjee and Naka (1995), Cheung and Ng (1998), Nasseh and Strauss (2000), and Humpe and Macmillan (2009) find a long run relationship between stock markets and macroeconomic variables. Since the PVM takes the expected annual dividends and the expected discount rate into account, factors influencing those variables will in turn affect the price of an asset. Hence, in times of high economic activity the model would predict high expected future dividends, in turn resulting in increased asset prices,

holding the expected future discount rate constant. Conversely, in times of low economic activity, expectations regarding future dividends might decrease and therefore affect asset prices negatively, holding the expected future discount rate constant. With respect to the discount rate, any factor lowering the expectations of the future discount rate will positively affect stock markets, while the opposite is true for expectations regarding increased discount rate.

Hence, a proxy for economic activity, such as the real industrial production index, is predicted by the PVM to enter a positive relationship with stock markets. On the other hand, CPI as a proxy for inflation might negatively affect the expected future dividends of firms. As discussed by previous literature, unexpected inflation may result in changes in real profits of firms, and therefore negatively affect expected future dividends. Thus, negatively affect stock markets in the long run. Money supply can affect stock markets in different ways. As discussed in the literature review, it can reflect enhanced economic activity and it would then result in increased expectations regarding future dividends. On the contrary, changes in money supply may be due to unexpected inflation. Hence, money supply might harm expectations regarding firms' real profits and thereby also harm expected future dividends and stock prices. Finally, government bonds, or any other proxy for the discount rate in equation 4, directly enters the PVM. Hence, changes in the discount rate will consequently also affect stock markets, as discussed in the literature review and explained above.

As seen in the previously conducted literature, authors have chosen to analyze large or niche economies, with few rather old exceptions conducting broader studies. Hence, the PVM will be the focal theory that this thesis, and the following analysis will be based upon. Therefore, the next section will outline the particular methodological framework by which the analysis of this paper is conducted.

3. Methodological Framework

This section of the thesis will guide the reader through the methods used in the analysis. Furthermore, it will contain an ongoing discussion regarding the rationale behind choices of used methods. As discussed and found by authors analyzing the long run relationship between stock markets and economic variables, the series used have been said to contain unit roots[7].

Gujarati and Porter (2009) explain the issue of unit root as a scenario where a series is non-stationary. This means that the series is not mean reverting, does not have constant variance, and has time dependent covariance. Additionally, it has been argued that most macroeconomic and financial variables, measured over time, contain non-stationary attributes such as unit roots (Phillips, 1995). Gujarati and Porter (2009) explain a unit root process assuming a time series Y_t. If it is the case that this series can be fully explained by itself one lag back in time, and an additional error term, then the series is said to have the unit root problem. Using series Y_t, we can write:

$$Y_t = \rho Y_{t-1} + u_t \qquad -1 \leq \rho \leq 1 \tag{5}$$

if $\rho = 1$ the issue of a unit root arises (Gujarati & Porter, 2009). A simple remedy is to take the first-difference of the series, if the series only contains one unit root. The number of times a series has to be first-differenced further defines the order of integration (Gujarati & Porter, 2009). However, taking the first-difference of a series results in a loss of long-run information of the variable (Philips, 2017). On the other hand, the issues related with unit roots can be mitigated using methods testing for cointegration among unit root variables (Engle & Granger, 1987).

As mentioned, Engle and Granger (1987) argue that integrated time series can be used for long-run analysis if the variables are cointegrated. However, the definition of cointegration was first established by Granger (1981). When two time series, integrated of order one (i.e. two I(1) series), are regressed on each other the results attained will be spurious and show falsely significant relationship. Furthermore, Engle and Granger (1987) argue that if there exist a linear relationship of two integrated series that is stationary (i.e. I(0), or integrated of order 0), then the variables are said to be cointegrated[8]. Hence, the integrated variables are cointegrated in the presence of a long-run common relationship (Gujarati & Porter, 2009).

[7] See *inter alia* Nasseh and Strauss (2000), Humpe and Macmillan (2009), and Alexius and Spång (2018).
[8] This can be extended to include more series, as for this thesis five series are included.

A statistical tool for testing whether a particular series contains a unit root process was developed by Dickey and Fuller (1979). The Dickey-Fuller test tests whether ρ in equation 5 is statistically different from 1. Therefore, the following hypothesis are tested:

$$H_0: \rho = 1 \ (i.e. Unit\ Root)$$
$$H_1: \rho < 1 \ (i.e. No\ Unit\ Root)$$

This test further evolved with the addition of adding lagged values of the first differenced variable of interest, due to issues of previously having assumed uncorrelated error terms. Finally, the test resulted in what is called the Augmented Dickey-Fuller (ADF) test (Gujarati & Porter, 2009). Furthermore, Gujarati and Porter (2009) explain that the appropriate lag selection for the ADF-test can be determined using various information criteria, such as Akaike Information Criteria (AIC) or Schwarz Information Criteria (SIC). With, respect to panel data, Im, Pesaran, and Shin (2003) developed a unit root test for heterogenous panels. This test calculates an average ADF-test statistic over the cross-sections included in a series. Hence, the tested hypothesis remains the same as in the standard ADF test, while providing a pooled and averaged test statistic for all cross-sections within the series (Im et al., 2003).

With respect to cointegration, a popular tool used in determining whether economic variables of interest are related with stock markets has been the use of cointegration methodologies such as the Johansen (1991) test for cointegration[9], and further elaborated by Johansen (1995). As mentioned in previous section, this methodology is based on the VECM and provides a likelihood ratio test for the cointegration rank (Johansen, 1991). The author initially assumes a general Vector Autoregressive (VAR) model such as the following:

$$\Delta X_t = \sum_{i=1}^{k-1} \Gamma_i \, \Delta X_{t-i} + \Pi X_{t-k} + \Phi D_t + \mu + \varepsilon_t \qquad (6)$$

where ε_t is a vector consisting of zero-mean consecutive p-dimensional white noise vectors, while D_t represents seasonal dummies, and X_t contains the variables of interest (Humpe and Macmillan, 2009). The outcomes of this model can be categorized into three cases. First, if

[9] Analysis by authors using Johansen (1991) include, but are not limited to, Nasseh and Strauss (2000), Humpe and Macmillan (2009), and Alexius and Spång (2018)

Rank $(\Pi) = p$, then X_t is stationary, if Rank $(\Pi) = 0$, then there is no stationary long run relationship between the variables included in X_t, and finally if Rank $(\Pi) < p$, then r denotes the number of relationships with cointegration (Humpe and Macmillan, 2009). Johansen (1991) provide two types of tests, one trace statistic and one maximum eigenvalue statistic. A fundamental limitation to the Johansen (1991) cointegration methodology, is that all variables must be integrated of the same order (i.e. integrated of order one, I(1)). Although Johansen (1991) does not argue that this is the case, Philips (2017) find an increase in Type I errors when including variables integrated of order zero. This might propose issues since stock markets and economic variables cannot strictly be assumed to be integrated of the same order and cannot strictly be assumed to be integrated of order one. Hence, other methods relaxing this assumption for analyzing cointegration might be necessary.

Another way of analyzing whether variables are cointegrated is the Autoregressive Distributed Lag (ARDL) modelling approach, with bounds testing. This method was developed by Pesaran et al. (2001) and does not have the constraint of only using explanatory variables that are I(1). In contrast to Johansen (1991), this method works with a mix of explanatory variables, where those can be either I(1) or I(0) (i.e. first-difference stationary, or stationary at level). However, the dependent variables must be integrated of order one, i.e. first-difference stationary (Pesaran et al., 2001). Philips (2017) state that the general ARDL (p, q) model (including one dependent variable and one explanatory variable, and where p and q represents the respective lags of the variables and the appropriate lag length is determined using AIC or SIC) can be written as:

$$y_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i y_{t-i} + \sum_{j=0}^{q} \beta_j x_{t-j} + \epsilon_t$$
$$\text{where, } \epsilon_t \sim N(0, \sigma^2) \qquad (7)$$

Hence, the dependent variable y_t is written as a function of the constant term α_0 and the sum of lags of itself, as well as the sum of the explanatory series x_t and lags of x_t[10], and finally an error term which has zero mean and constant variance (Philips, 2017). Furthermore, this model can be extended by additional explanatory variables and the model can then be written as an ARDL (p, q, …, q). The model can also be extended to a panel framework. However, the bounds testing approach is limited to time-series analysis of one cross-section (Pesaran et al., 2001).

[10] The particular dependent and explanatory variables used in this study are presented in section 4.

The bounds test provides a t-statistic, as well as an F-statistic, with corresponding critical values for determining whether lagged levels of the variables of interest are significant or not in order to see whether cointegrating relationship exists. The bounds test has two critical points, one denoting the critical value of the I(0) hypothesis, and one for the critical value of the I(1) hypothesis (Pesaran et al., 2001). Hence, there can be three resulting outcomes of the test[11]. First, if the test statistic is smaller than the I(0) critical value then one cannot reject the null hypothesis and has to conclude that no cointegrating relationship exists among the variables. On the other hand, if the test statistic is larger than the I(1) critical value than one rejects the null hypothesis and concludes that cointegrating relationship exists among the variables. Finally, the third outcome deals with a situation in which the test statistic is between the critical values of I(0) and I(1). In this scenario, the outcome of the bounds testing procedure yields inconclusive results regarding whether a cointegrating relationship among the variables exists or not. (Pesaran et al., 2001; Philips, 2017).

A final stream of literature has been concerned with estimation of variables once cointegration has been established. Phillips and Hansen (1990) developed a method called Fully Modified Ordinary Least Squares (FMOLS) for estimating multivariate equations with presence of integrated variables. Compared with a standard Ordinary Least Squares (OLS) method, FMOLS makes use of semiparametric correction to deal with autocorrelation, heteroscedasticity, and endogeneity[12] (Phillips & Hansen, 1990) which is advantageous when dealing with integrated time series. However, Kao and Chiang (2001) criticize the FMOLS estimators by showing that they generally do not perform better than the standard OLS estimators when using panel data.

On the other hand, Stock and Watson (1993) developed a similar method for estimating long-run cointegrated equations. Namely the Dynamic Ordinary Least Squares (DOLS) method, which can be estimated after formal testing or theory suggesting cointegration among variables (Stock & Watson, 1993). Similarly, to the FMOLS estimation method, DOLS also has the advantage of dealing with endogeneity by adding lags and leads in the estimation process[13]. Finally, it has been found that DOLS is superior in estimating long run cointegrated

[11] Note that only the test procedure using the F-statistic is presented and used in this thesis. For details regarding the t-statistic, the interested reader is referred to Philips (2017) Figure 2.
[12] For detailed derivation and procedure of how FMOLS is estimated, the interested reader is referred to Phillips and Hansen (1990)
[13] The interested reader is referred to Stock and Watson (1993) for details regarding derivations and the process of how DOLS is estimated.

equations using panel data since these estimators outperform the estimators of OLS and FMOLS (Kao & Chiang, 2001). Hence, the main estimation technique of this thesis will be the DOLS method.

The following section of the thesis will present the data used in the analysis, as well as the variables and countries included in this study. The general equation summarizing the relationship of interest can be written as follows:

$$lnSMI_{it} = \beta_0 + \beta_1\, lnIP_{it} + \beta_2\, lnCPI_{it} + \beta_3\, lnM1_{it} + \beta_4\, lnGB_{it} + \varepsilon_t \qquad (8)$$

Hence, equation 8 shows that Stock Market Index (SMI) is a function of the real Industrial Production (IP) index, the Consumer Price Index (CPI), Money Supply (M1), and Government Bonds (GB). However, it is important to remember that this equation does not assume a causal relationship. The following section will therefore be limited to analysis of whether the variables are related in the long run, and not whether the chosen explanatory variables actually cause the dependent variables SMI.

4. Data

For the purpose of this thesis, and with respect to arguments by Chen et al. (1986) regarding the importance of judgment when choosing economic variables, previous research has been consulted for determining the appropriate variables of inclusion. Although some have made it their focal point to analyze specific variables of interest, and the variables' relationship with stock market movements[14], the aim of this paper is to provide a broader analysis by inclusion of countries previously not studied, and methods previously not used. The PVM will therefore be evaluated through two new ways. First, through inclusion of a larger set of countries, and second, through the application of new methodologies.[15] Hence, the choice of variables follows that of Humpe & Macmillan (2009).

The data set used in this study consists of twelve European countries, all members of the European Union. The data is measured at a monthly frequency ranging from January 2000 to November 2018. Data for all countries and all variables has been retrieved from Thomson Reuters Eikon data stream. Finally, the rationale for the choice of countries and length in time resides on data availability and the aim of a broader scope of analysis, compared to previous studies. For the dependent variable, as in Humpe and Macmillan (2009) one major stock market index per country was chosen to represent domestic stock market prices. The domestic stock market indices are measured in nominal terms and due to lack of cyclical behavior, no seasonal adjustment have been made.

Aggregate economic activity has mainly been measured in two ways. While Cheung and Ng (1998) Alexius and Spång (2018) use GNP and GDP respectively, others have made use of IP. Since the real seasonally adjusted IP index is available on a monthly frequency, this thesis follows previous studies such as Nasseh and Strauss (2000) and Humpe and Macmillan (2009) and use IP as a proxy for real economic activity. As discussed in section 2 with respect to inflation, previous studies have used CPI to account for unexpected inflation and its effect on stock markets. As Nasseh and Strauss (2000) point out, including CPI will account for stock innovations in the nominal stock price movements. Hence, CPI is included in the underlying dataset of this paper. With respect to cyclical behavior, correlograms of the monthly CPI used in this study do not show patterns of seasonal behavior. Hence, as for the stock market indices, no seasonal adjustments have been made with respect to monthly CPI.

[14] Some authors have for instance chosen to focus on wealth and consumption, see *inter alia* Lettau and Ludvigson (2001).

[15] To my knowledge, no previous study on this particular topic has contained more than seven countries, and no previous study has made use of Pesaran et al. (2001) ARDL modelling approach.

The inclusion of an interest or discount rate has been perused in a majority of the previously discussed studies. The rationale being that the interest rate directly enters the PVM (Humpe and Macmillan, 2009). While authors such as Chen et al. (1986) have chosen to include both a short-term and a long-term interest rate, Humpe and Macmillan (2009) argue that the short-term interest rate is highly driven by business cycles. Hence, following Humpe and Macmillan (2009), this thesis focuses on the long-run relationships and therefore the analysis is limited to only include a long-term interest rate. Namely, the end of month closing bid yield of domestic 10-year benchmark government bonds.

Although money supply and its relationship with stock markets has shown an inconclusive track record (Humpe & Macmillan, 2009), money supply is included in the analysis of this thesis. Given the larger number of countries chosen to be analyzed in this study, inclusion of money supply will enable for a broader understanding of its relationship with stock markets. As in Humpe and Macmillan (2009), seasonally adjusted monthly M1 will be used as the measure of money supply[16].

Mukherjee and Naka (1995) choose to include exchange rate in their analysis of stock market movements. However, Humpe and Macmillan (1995) argue that adjustments to currency developments is already accounted for in the domestic economy, due to foreign firms' income being channeled through exports. As mentioned in section 2, papers such as Fama and French (1989), Ferson and Harvey (1991), and Black et al. (1997), based on APT have chosen to include financial variables. However, these papers have had a focus on short-term analysis where such variables are stationary. Due to the long-term focus of this thesis, it will follow Humpe and Macmillan (2009) in their reasoning to only include variables that theoretically are expected to be non-stationary.

Presented below is table 1. In particular, table 1.A presents the countries and the specific stock market indices used as a proxy for each of the countries' stock markets. Furthermore, table 1.B presents descriptive statistics of the dataset, including the variables Stock Market Index (SMI), Industrial Production (IP), Consumer Price Index (CPI), Money Supply (M1) in billions, and Government Bond (GB). Values are calculated over all cross-sections (i.e. over all 12 countries).

[16] For details regarding how M1 is calculated see https://www.investopedia.com/terms/m/m1.asp

Table 1 - Stock Markets and Descriptive Statistics

Table 1.A - Countries and Stock Market Indices

Country	Stock Market Index (SMI)
Denmark	OMX 20 Copenhagen
Finland	OMX 25 Helsinki
France	CAC 40
Germany	DAGS
Greece	ATG
Ireland	ISEQ
Italy	FTSE MIB
Netherlands	AEX
Poland	WIG
Portugal	PSI 20
Sweden	OMX Stockholm 30
U.K.	FTSE 100

Table 1.B - Descriptive Statistics

	Variables				
	(SMI)	(IP)	(CPI)	(M1 Billion)	(GB)
Highest Value	66077,69	193,4469	331,14	2556,442035	36,591
Lowest Value	178,03	53,72955	71,936	14,99565904	-0,127
Median	4381,8	101,159	99,254	165,5603336	4,0205
Mean	8498,772674	103,0295	112,4719	487,0697519	3,989946
Variance	157629986,3	200,3262	3257,905	3,38199E+23	7,774352
Standard Deviation	12555,07811	14,15366	57,07806	5,81549E+11	2,788253
Number of Cross-Sections	12				
Number of Variables	5				
Number of Time Periods	227				
Total Number of Observations	13620				

Note: Comma is used as the separator in Table 1.B

As depicted in table 1.B, the dataset contains 12 countries and five variables ranging over 227 time periods. This amounts to a total of 13620 number of observations. An important note is that the variable GB contains five negative values. Namely, for Germany 2016 and the months August, September, October, and November, and for Netherlands 2019 during September. Since the analysis of this thesis will follow Humpe and Macmillan (2009) and use the variables in their natural logarithms, the five negative values for GB will henceforth be converted to 0,01 before logarithmic transformation. Hence, the following section of this thesis

will present the corresponding results attained from the dataset presented above, along with an analysis of the findings.

5. Results and Analysis

This section of the thesis will guide the reader through the empirical findings. Using the dataset and following the outlined methodological approach, the main results will be presented. As previously mentioned, twelve countries and five variables are included. Finally, it is important to stress that all variables have been used in the form of their natural logarithm, following Humpe and Macmillan (2009).

Following the outline presented in the methodology section, the first step was to ensure that all variables were following a unit root process (i.e. integrated of order one), or at least to make sure that the dependent variable SMI is I(1) for all of the countries. This was conducted using the ADF test and letting SIC choose the appropriate lag length of the variables in levels. Furthermore, the ADF test was consulted to make sure that none of the variables, for any of the countries, were integrated of an order higher than one. This was conducted by applying the ADF test to the first differenced variables and by allowing SIC to decide upon lag length. The resulting test statistics are presented in table 2 below. More specifically, Table 2.A depicts the panel data ADF test for the three conducted test specifications. Table 2.B presents the results from the individual ADF test including an intercept and table 2.C shows the results including an intercept and a linear trend. Finally, table 2.D presents the results from the individual ADF test using first differenced variables, and only including an intercept assuming loss of trend in the process of first differencing the variables.

Table 2 - ADF Tests

Table 2.A - Panel ADF Test (Im, Pesaran, and Shin W-Statistic)

Test Specification	ln(SMI)	ln(IP)	ln(CPI)	ln(M1)	ln(GB)
Level (Individual Intercept)	0.42970	-0.34055	-0.71487	-0.07256	0.47341
Level (Individual Intercept and Trend)	-0.07039	-1.27127	-0.42691	2.43403	-2.36221***
First-Difference (Individual Intercept)	-49.0685***	-53.3133***	-8.27102***	-51.7475***	-50.6773***

Table 2.B - ADF Test Level (Intercept)

Country	ln(SMI)	ln(IP)	ln(CPI)	ln(M1)	ln(GB)
Denmark	-0.535836	-1.192710	-2.409266	-1.550632	-2.229661
Finland	-1.437316	-2.377059	-1.604450	-0.512086	-1.197453
France	-1.979013	-1.470771	-1.864963	-1.324491	-1.410304
Germany	-0.780483	-1.849884	-0.703176	-0.619209	-1.475896
Greece	-1.202832	-1.046920	-2.733297*	-2.348291	-1.410965
Ireland	-1.458008	-1.472465	-3.064564**	-2.609242*	-0.730705
Italy	-1.728355	-1.727755	-2.947779**	-1.731847	-1.610528
Netherlands	-1.915501	-2.710931*	-3.728648***	-1.847885	-1.408312
Poland	-1.056379	-0.878736	-3.178860**	-1.386576	-1.600609
Portugal	-2.478333	-1.523059	-3.665606***	-1.131632	-0.745406
Sweden	-1.590844	-2.455807	-1.314274	-1.048556	-1.741563
U.K.	-1.487222	-1.610393	0.050993	-2.133014	-1.291467

Table 2.C - ADF Test Level (Intercept and Trend)

ln(SMI)	ln(IP)	ln(CPI)	ln(M1)	ln(GB)
-1.890838	-1.377890	-0.303575	-1.195959	-4.501942***
-3.288927*	-2.350991	-1.606330	-2.633263	-2.663126
-2.010349	-2.001567	-1.606330	-1.788315	-2.998053
-2.630044	-3.388208*	-2.032099	-2.220716	-3.505343**
-1.692285	-1.414994	-0.888481	-1.717925	-1.328708
-1.448023	-2.967023	-1.769803	-1.507409	-1.678645
-1.950269	-2.516654	-0.547785	-1.414285	-1.951569
-1.885332	-5.099572***	-3.230899*	-1.035580	-2.831667
-1.644766	-1.814237	-2.912828	-1.196509	-2.566247
-2.594591	-2.143500	-1.869867	-1.677202	-1.062167
-3.861750**	-2.393593	-2.234755	-1.901732	-4.075722***
-2.617156	-1.497518	-1.856360	-1.189432	-3.238624*

Table 2.D - ADF Test First-Difference (Intercept)

Country	ln(SMI)	ln(IP)	ln(CPI)	ln(M1)	ln(GB)
Denmark	-13.14494***	-16.18455***	-10.37464***	-15.89878***	-10.79393***
Finland	-12.08589***	-18.12197***	-13.45076***	-7.594379***	-10.82269***
France	-13.77586***	-21.52659***	-16.21834***	-15.94068***	-14.51525***
Germany	-13.91827***	-5.971415***	-21.16255***	-13.92887***	-9.860341***
Greece	-14.51491***	-28.17861***	-3.551631***	-14.73271***	-15.51070***
Ireland	-12.02700***	-5.104461***	-4.518541***	-13.70721***	-15.26683***
Italy	-14.73757***	-6.811200***	-7.375669***	-15.11935***	-14.66728***
Netherlands	-13.71946***	-14.59746***	-8.720691***	-15.18821***	-11.48322***
Poland	-13.67828***	-19.41589***	-10.32561***	-13.60056***	-15.76077***
Portugal	-13.22960***	-19.17192***	-3.883557***	-16.14107***	-14.87197***
Sweden	-7.011039***	-9.561762***	-4.848749***	-15.49916***	-12.21916***
U.K.	-15.20514***	-18.02771***	-4.590535***	-14.86264***	-14.58927***

Notes: * Denotes significance at the 10% level.

** Denotes significance at the 5% level.

*** Denotes significance at the 1% level.

As depicted by table 2.A all variables, except one, are insignificant when tested using Im et al. (2003) ADF test in the panel setting. Hence, these results suggest presence of unit root. When including an intercept, all variables in level are found to be insignificant. However, when including an intercept and trend, all variables except GB are found insignificant. Finally, the last row of the panel version of the test shows that all variables are first difference stationary.

A more detailed view is provided by table 2.B and table 2.C. Here one can see that the dependent variable SMI is found to be insignificant for all countries when including an intercept, and when including an intercept and trend, SMI is found insignificant for all countries but Sweden and Finland. Hence, the general results suggest presence of unit root in the variable SMI for all of the analyzed countries. Regarding the explanatory variables, mixed results are found. In the majority of cases, IP, M1, and GB is found insignificant. This is also true for CPI when including both an intercept and trend. However, CPI is found significant for half of the countries when only including an intercept, as depicted by table 2.B. Finally, looking at table 2.D one can see that all variables are found to be first difference stationary, which is true for all cross-sections.

These results are different from those found by authors such as Nasseh and Strauss (2000), and Humpe and Macmillan (2009) who find that the variables IP, CPI, M1, and long run interest are integrated of order one. As reported by 2.B, and 2.C this is not true for the dataset used in this study. For instance, IP is found significant for the Netherlands when including an intercept, and for Germany and Netherlands when including an intercept and trend. This is of particular interest since Nasseh and Strauss (2000) include both Netherlands and Germany and find IP nonstationary. As mentioned previously, authors analyzing the long run relationship between stock markets and economic activity do find the variables used in this study nonstationary. With respect to CPI, it is very surprising that the ADF tests yield significant results for some of the countries. In fact, CPI is found stationary at level for six out of the twelve countries used in this study, when including an intercept as presented in table 2.B. This is surprising since Johansen (1992) argue that inflation in some cases even can be found to be integrated of order two (i.e. second difference stationary). However, since this study uses a rather recent dataset, one reason to why others have chosen not to include some of the countries used here, could be due to the varying results from the ADF tests. As pointed out by Nasseh and Strauss (2000), the precondition to Johansen (1991) is that all variables have to be integrated of order one. Hence, the analysis of those papers would not be possible since there is a mixture between orders of integration, as seen in this dataset.

The next step in the procedure was to estimate the number of cointegrating vectors using Johansen (1991) methodology. However, it is important to stress that this methodology has been shown to result in an increased risk of committing Type I errors when including I(0) variables (Philips 2017), as discussed in the method section. Since it has been shown that the data used in this thesis contains variables with different orders of integration, the Johansen (1991) methodology will play a minor role in the cointegration analysis of this thesis. Therefore, the results from the Johansen (1991) test are presented in the appendix, yet included in this paper due to its popularity in previously conducted research. The appropriate lag was determined using SIC for both the country wise version and panel version of the test. As depicted in by table 5 in the appendix, the panel data results from the Johannsen (1991) test is insignificant for all of the three specifications. Namely, without intercept and without trend, with intercept and without trend, and with intercept and trend. Hence, the test in the form of panel version suggests no cointegrating relationship among the variables. Additionally, table 6 in the appendix, presents the results from the country wise Johansson (1991) test. In this setting, the general findings are that there actually exist at least one cointegrating relationship between the variables. This is true for a majority of the countries, and regardless of using the trace statistic or the maximum eigenvalue statistic, at the 10% and 5% level of significance.

Due to the limitations of the Johansen (1991) methodology, a different technique for analyzing cointegration had to be consulted. As discussed in the methodological section, the ARDL bounds testing approach relaxes the limitation of only including I(1) variables (Pesaran et al., 2001). Given the ADF results presented above one can see that the dependent variable SMI is I(1) for all countries. As discussed, this is a requirement for the ARDL modelling approach. Finally, since the explanatory variables are I(1) in some cases, and I(0) in other, the ARDL bounds testing approach becomes an essential tool in the analysis of this dataset. For this test, AIC was consulted for determination of appropriate lag length.[17] While the particular ARDL (p,q,q,q,q) model and corresponding estimated coefficients for each country are presented by table 7 in the appendix, table 3 below provides an overview of the results from the bounds testing procedure.

[17] For all of the tests conducted in this study, both SIC and AIC have been consulted. The rationale for relying on SIC has been due to its parsimonious results, compared with AIC. However, with respect to the ARDL modelling approach SIC tends to choose a model with no lags of the explanatory variables. In contrast, AIC tends to choose a model with more lags providing depth to the analysis. Hence, AIC was chosen as the information criteria for the ARDL bounds testing procedure.

Table 3 - ARDL Bounds Test Results

Country	F-Statistic	Conclusion (10% Level)	Conclusion (5% Level)	Conclusion (1% Level)
Denmark	4.444514	Cointegration	Cointegration	Cointegration
Finland	3.456411	Cointegration	Inconclusive	Inconclusive
France	3.379103	Cointegration	Inconclusive	Inconclusive
Germany	4.530997	Cointegration	Cointegration	Cointegration
Greece	2.200915	Inconclusive	No Cointegration	No Cointegration
Ireland	0.713892	No Cointegration	No Cointegration	No Cointegration
Italy	4.143300	Cointegration	Cointegration	Inconclusive
Netherlands	2.243827	Inconclusive	No Cointegration	No Cointegration
Poland	4.675013	Cointegration	Cointegration	Cointegration
Portugal	2.599503	Inconclusive	Inconclusive	No Cointegration
Sweden	4.468498	Cointegration	Cointegration	Cointegration
U.K.	2.682504	Inconclusive	Inconclusive	No Cointegration

Notes: Critical Values I(0): 1.9 at the 10% level of significance
2.26 at the 5% level of significance
3.07 at the 1% level of significance
Critical Values I(1): 3.01 at the 10% level of significance
3.48 at the 5% level of significance
4.44 at the 1% level of significance

As depicted by table 3 one can see that cointegration is found for seven countries at the 10% level of significance. In contrast, no cointegration is found for Ireland, while the remaining four countries yield inconclusive results at the 10% level of significance. With respect to Ireland, table 2.C shows that all of the variables are I(1) and one can therefore turn to the Johansen (1991) test for further analysis of whether cointegrating relationship among the variables actually exist. Looking at table 6 in the appendix, the general understanding regardless of model specification suggests at most two cointegrating relations among the variables for Ireland, at the 10% level of significance. As Philips (2018) point out, the Johansen (1991) test has higher power. Hence, this can be a reason to why cointegration is found using the Johannsen (1991) test. For Greece, Portugal, and U.K. the same logic can be followed. Results from the ADF test presented in table 2.C shows that all variables for these three countries are integrated of order one. Hence, one can turn to the Johansen (1991) test presented in the appendix by table 6. In the case of Greece, the general results suggest at most one cointegrating relationship, regardless of model specification and at the 10% level of significance. For Portugal, the Johansen (1991) test suggests at most one cointegrating relationship at the 10% level of significance, and with no additional inclusion of intercept and trend. Finally, for U.K. the

general result from the Johansen (1991) test suggests at most one cointegrating relationship among the variables, at the 10% level of significance and regardless of model specification.

Furthermore, the ARDL bounds testing procedure yields inconclusive results at the 10% level for Netherlands, as presented in table 3. Since, table 2.B and table 2.C suggests that the series IP and CPI are nonstationary at the 10% level of significance, the procedure previously conducted for Greece, Ireland, Portugal, and U.K. has to be taken with caution due to the limitations of the Johansen (1991) methodology. Yet one can note that the Johansen (1991) test presented in table 6, in the appendix, suggests that there exist at most three cointegrating relationships in the first model specification, at most one cointegrating relationships in the second model specification, and at most two cointegrating relationships in the third model specification[18].

The findings from the ARDL bounds testing procedure, complemented with the Johansen (1991) test, has shown that cointegrating relationships among the variables are found for all countries. However, the results regarding Netherlands have to be taken with caution due to the limitations of the Johansen (1991) test. Since cointegration has been found, the results show that there exists a long run relationship between stock markets and the macroeconomic variables for the twelve EU countries. This means that the PVM is successful in predicting a long run relationship between domestic stock markets and IP, CPI, M1, and GB. Therefore, the next step of the analysis is to estimate the relationship using FMOLS and DOLS.

This final section of the results consists of the long run estimations using FMOLS and DOLS. With respect to FMOLS, SIC was consulted for determination of appropriate lag length. Similarly, SIC was used in determining the amount of lags and leads for the DOLS estimations. It is important to note that FMOLS and DOLS was estimated using all of the twelve countries. Even though the cointegration results for Netherlands has to be taken with caution, Netherlands was included in the estimations. As a robustness check, FMOLS and DOLS was also estimated without the inclusion of Netherlands, without any statistically different results. Presented below in table 4 are the results from FMOLS and DOLS using all twelve countries. In particular, table 4 presents the conducted estimations using panel data. These are dived into two parts depending on panel method. Pooled represents the estimations conducted by pooling the entire dataset and grouped represents the averaged FMOLS and DOLS estimates after individual cross section estimation. Furthermore, table 8 in the appendix presents the detailed country wise

[18] Note that these results are at the 10% level of significance.

estimations using FMOLS and DOLS. In this estimation process SIC was used in the same manner as for the panel method estimations.

Table 4 - FMOLS and DOLS Estimations

Variable	Panel Method: Pooled		Panel Method: Grouped	
	FMOLS	DOLS	FMOLS	DOLS
ln(IP)	0.773018*	0.786790***	2.839265***	1.748477***
	(0.411046)	(0.145582)	(0.365282)	(0.210901)
ln(CPI)	-0.955661	-1.716699***	0.838353	-0.467144
	(0.821583)	(0.285297)	(0.767748)	(0.471856)
ln(M1)	-0.006256	0.218790***	0.097131	0.249342***
	(0.163822)	(0.056611)	(0.134491)	(0.076635)
ln(GB)	-0.416752***	-0.235430***	-0.149427***	-0.110580***
	(0.054459)	(0.018898)	(0.049222)	(0.027817)

Notes: * Denotes significance at the 10% level.
** Denotes significance at the 5% level.
*** Denotes significance at the 1% level.
Standard Errors are in brackets.
Trend Assumption: Linear Constant

As depicted by table 4, contrasting results are attained between FMOLS and DOLS using the pooled panel method. While all variables are significant at the 1% level when estimated using DOLS, only two variables are significant using FMOLS. Namely, IP at the 10% level of significance, and GB at the 1% level of significance. Furthermore, one can see that IP is positive and significant with a coefficient of approximately 0.8, regardless of estimation method. This means that a one percent increase in IP results in approximately 0.8 percent increase in SMI, *ceteris paribus*. Since the variables' CPI and M1 only are significant when estimated using DOLS, only the coefficients attained from the DOLS estimation are interpreted. However, one can note, with respect to CPI, that both estimation methods yield similar coefficient signs, while this is not true for M1. Furthermore, table 4 shows that CPI enters a negative and significant relationship with SMI. The coefficient is approximately -1.7, which means that a one percent increase in CPI results in approximately 1.7 percent decrease in SMI, *ceteris paribus*. The coefficient for M1 is approximately 0.2 and significant. Hence, a one percent increase in money supply would result in approximately 0.2 percent increase in SMI, *ceteris paribus.* Finally, the variable GB is found negative and significant. This is true regardless of estimation method for the pooled panel method, as depicted by table 4. Using

FMOLS, the GB coefficient is approximately equal to -0.4. This means that a one percent increase in GB results in approximately 0.4 percent decrease in SMI, *ceteris paribus*. In contrast, using DOLS the variable GB is approximately equal to -0.2 meaning that a one percent increase in GB would result in approximately 0.2 percent decrease in SMI, *ceteris paribus.*

Moving on to the grouped panel method, presented by table 4, similar results are attained. However, this time IP and GB are both significant at the 1% level when estimated using FMOLS. With respect to the DOLS estimation, CPI is no longer significant using the grouped panel method. However, the variables IP, M1, and GB are still significant at the 1% level. Hence, only IP and GB will be interpreted using FMOLS and the grouped panel method. Table 4 shows that the coefficient for IP is positive and approximately equal to 2.8. This means that a one percent increase in IP approximately results in a 2.8 percent increase in SMI, *ceteris paribus*. Finally, estimation using FMOLS and groped panel method show that the variable GB is approximately equal to -0.1. Hence, a one percent increase in GB would result in approximately 0.1 percent decrease in SMI, *ceteris paribus*. Moving on to the DOLS estimation, table 4 and the column for grouped panel method shows that the attained coefficient for IP is approximately equal to 1.7. Hence, a one percent increase in IP would result in approximately 1.7 percent increase in SMI, *ceteris paribus*. Similarly, the variable M1 is found to be positively related with SMI, and the coefficient is approximately equal to 0.2. Hence, a one percent increase in M1 would result in approximately 0.2 percent increase in SMI, *ceteris paribus*. Finally, the coefficient for GB is approximately -0.1, as depicted by table 4 under the grouped panel method and the DOLS estimation. Therefore, one can say that a one percent increase in GB would result in approximately 0.1 percent decrease in SMI, *ceteris paribus.*

5.1. Analysis of FMOLS and DOLS

This section of the thesis will focus on analysis of the results attained from the FMOLS and DOLS estimation. Furthermore, the results presented in the previous section will be related to previous research conducted on the topic, as well as the PVM. As previously mentioned, the Pesaran et al. (2001) ARDL modeling approach and its corresponding bounds testing procedure, together with the complementary Johansen (1991) test shows that cointegration exists among the variables. This means that support is found for the PVM's prediction of a long run relationship between stock markets and aggregate economic variables. In this particular thesis, results from the ARDL bounds testing procedure show that the variables SMI, IP, M1, and GB are cointegrated for seven of the twelve EU countries. Furthermore, complementary

analysis using the Johansen (1991) cointegration methodology shows that the variables for the remaining five countries also are cointegrated. However, with respect to the Netherlands results are limited due to varying orders of integration attained from the individual ADF tests. Hence, FMOLS and DOLS were the methods consulted for the long run estimation.

In general, the results attained in this thesis are line with previous research. IP is found positive and significant in this study, regardless of estimation technique, and regardless of panel method. These results further confirm the results by authors such as Mukherjee and Naka (1995), Nasseh and Strauss (2000), and Humpe and Macmillan (2009). When significant, the variable CPI is found to have a negative relationship with SMI. This is in line with previous research arguing that inflation is negatively related with the performance of asset prices. Hence, these results may suggest that inflation affects stock markets negatively through changes in price levels and expectations regarding future inflation. Surprisingly, CPI is found insignificant using FMOLS and the groped panel method, and insignificant using both FMOLS and DOLS when estimated through the groped panel method. These mixed results are not totally uncommon since Humpe and Macmillan (2009) also find CPI to be insignificant for one of the Japanese cointegrating vectors. However, since there is a difference between the results attained from the DOLS estimation, depending on panel method, these results may be driven by the particular panel methods. As one can see in table 8 in the appendix, the country wise FMOLS and DOLS estimation shows that CPI in general is not found significant. This is true regardless of using FMOLS or DOLS. Hence, the significance of CPI in the pooled panel method might be driven by the pooled method. Therefore, significance is lost when CPI is estimated using the groped panel method which takes into account the individual estimations.

Interestingly money supply is found insignificant when estimated using FMOLS, but significant when estimated using DOLS. In contrast to the results attained from CPI, these results do not vary depending on panel method. Humpe and Macmillan (2009) also find contradicting results for M1, while money supply is found insignificant for the U.S., it is found significant for Japan. However, as pointed out by Kao and Chiang (2001), DOLS outperforms FMOLS and the results from FMOLS with respect to M1 has to be taken with caution. As depicted by table 4, DOLS estimation of M1 enter a positive and significant relationship with SMI. Since M1 is found positive in this study, it may affect stock markets through reflection of enhanced economic activity, rather than through unanticipated inflation as pointed out by Humpe and Macmillan (2009).

Furthermore, in line with previous research this study finds long run interest rate, in terms of 10-year government bonds, to be negatively related with stock markets. This is in line with previous studies such as Mukherjee and Naka (1995), Nasseh and Strauss (2000), and Humpe and Macmillan (2009). Intuitively these findings make sense since the interest rate or discount rate directly enters the PVM. In the PVM, the discount or interest rate directly discounts the future cash flows. Hence, the model predicts that higher discount rate would decrease the present value of dividends, through which the asset price would be harmed. Hence, as predicted GB should enter a negative relationship with domestic stock markets, as shown in table 4.

The next and final section of this thesis will be concluding the paper. Hence, the major findings will be presented along with its corresponding analysis. Finally, suggestions regarding the future research agenda will be discussed.

6. Summary and conclusions

This thesis has analyzed the relationship between stock markets and macroeconomic variables. In particular, the paper has analyzed twelve EU membership countries with corresponding stock market indices. The aim was to see whether movements in these stock market indices were related to macroeconomic variables, such as IP, CPI, M1, and GB. Hence, the aim was to further analyze this relationship by zooming out through inclusion of a larger set of countries and by deploying more recent methodologies, compared to previous studies. Using the PVM to explain the long run relationship between the variables of interest, the general findings are in line with previous research. Cointegration was found among the variables for all twelve countries. Hence, the analysis showed that the PVM is successful in predicting a long run relationship between stock markets and macroeconomic variables for the twelve analyzed EU membership countries. Thus, answering the research question of this thesis. Finally, the results of this thesis highlight the positive long run relationship between stock markets and real economic activity, as measured by IP, and a negative long run relationship between stock markets and the discount rate, as measured by GB.

By using monthly data between January 2000 and November 2018, results from ADF tests showed that a majority of the variables per country contained unit roots. Hence, two different methodologies for testing of cointegration were consulted for the purpose of analyzing the long run relationship between stock markets and the economic variables. While the popular Johansen (1991) cointegration methodology was used, Pesaran et al., 2001 bounds testing procedure for ARDL models had to be consulted. Since, the ADF tests showed a mixture of variables being integrated of both order one and order zero at the country level, the bounds testing procedure became an essential tool since it relaxes the assumption of only using I(1) variables, compared to the Johansen (1991) methodology. Finally, the model was estimated using FMOLS and DOLS. For DOLS, SIC was used to determine the appropriate number of lags and leads. Similarly, SIC was used to determine the lags in the model when estimated using FMOLS.

Results from the ARDL bounds testing procedure showed that cointegration was found for seven out of the twelve included countries, at the 10% level of significance. On the other hand, four countries showed inconclusive results, and finally cointegration could not be concluded for Ireland. As a complement to the bounds testing procedure, the Johansen (1991) test was consulted with the general understanding that the variables indeed were cointegrated,

looking at the remaining countries. However, in the case of Netherlands the complementing Johansen (1991) test has to be taken with caution due to some variables being found stationary.

The major findings using FMOLS and DOLS are in line with previous research. Real economic activity, measured by the monthly industrial production index, entered a positive and significant relationship with the stock market variable. On the other hand, CPI was found insignificant when estimated using the grouped panel method. However, negative and significant when estimated by DOLS in the pooled panel method setting. Furthermore, money supply was found positive and significant when estimated using and DOLS, which was true for both panel methods, yet insignificant when estimated using FMOLS. Hence, suggesting that it reflects enhanced economic activity and thereby positively affects stock markets. Finally, the interest variable or discount rate, measured as long-term government bonds, was found negative and significant, regardless of estimation technique or panel method. Also, this result is in line with previous findings. Nevertheless, since the discount rate directly enters the PVM, by which an increase would decrease the value of future cash flows and thereby decrease stock prices.

One major limitation to the analysis of this thesis is that the long run relationships do not imply causality. As discussed earlier, some have chosen to explain real economic activity by stock markets. However, the majority of previous research, as this paper, has chosen to explain stock markets by the use of macroeconomic variables. Therefore, advice on future research agenda includes the proposition of causality studies. In order to actually determine the causal relationship between stock markets and real economic activity, a separate study with that as its major focus is of importance to the topic.

Finally, it is important to note that there today exits a wider range of statistical methods available for application to data with certain limitations. As seen in this thesis, a major limitation to using the popular Johansen (1991) cointegration methodology, is that variables can be integrated of different orders. Hence, other techniques for analyzing cointegration are necessary. The Pesaran et al. (2001) ARDL bounds testing procedure can be a tool, as used in this study, to allow for analysis of a wider range of countries as well as variables. Hence, it would be interesting to see future studies dwell into the topic of stock markets and real economic activity.

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Appendix

Table 5 - Panel Johansen Cointegration Test

No Intercept and No Trend

Null Hypothesis: No Cointegration

Alternative Hypothesis: Common AR Coefficients (Within-Dimension):

	Statistic	Probability	Weighted Statistic	Probability
Panel v-Statistic	1.006789	0.1570	1.169625	0.1211
Panel rho-Statistic	-0.537191	0.2956	-0.918566	0.1792
Panel PP-Statistic	-1.366033*	0.0860	-1.796323**	0.0362
Panel ADF-Statistic	-1.523773*	0.0638	-1.896304**	0.0290

Alternative Hypothesis: Individual AR Coefficients (Between-Dimension):

	Statistic	Probability
Group rho-Statistic	0.318464	0.6249
Group PP-Statistic	-1.127195	0.1298
Group ADF-Statistic	-1.051674	0.1465

Individual Intercept

Null Hypothesis: No Cointegration

Alternative Hypothesis: Common AR Coefficients (Within-Dimension):

	Statistic	Probability	Weighted Statistic	Probability
Panel v-Statistic	0.843747	0.1994	0.918209	0.1793
Panel rho-Statistic	0.173164	0.5687	0.030004	0.5120
Panel PP-Statistic	-0.557142	0.2887	-0.703213	0.2410
Panel ADF-Statistic	-0.303169	0.3809	-0.748192	0.2272

Alternative Hypothesis: Individual AR Coefficients (Between-Dimension):

	Statistic	Probability
Group rho-Statistic	1.270594	0.8981
Group PP-Statistic	0.112989	0.5450
Group ADF-Statistic	0.090004	0.5359

Individual Intercept and Individual Trend

Null Hypothesis: No Cointegration

Alternative Hypothesis: Common AR Coefficients (Within-Dimension):

	Statistic	Probability	Weighted Statistic	Probability
Panel v-Statistic	0.021731	0.4913	0.024540	0.4902
Panel rho-Statistic	0.497173	0.6905	0.360520	0.6408
Panel PP-Statistic	-0.630886	0.2641	-0.688792	0.2455
Panel ADF-Statistic	-0.416084	0.3387	-0.790963	0.2145

Alternative Hypothesis: Individual AR Coefficients (Between-Dimension):

	Statistic	Probability
Group rho-Statistic	1.082190	0.8604
Group PP-Statistic	-0.181146	0.4281
Group ADF-Statistic	-0.237572	0.4061

Table 6 - Country Wise Johansen Cointegration Test

Country	Test Type	Number of Cointegrating Relations by Model at 10% level			Number of Cointegrating Relations by Model at 5% level		
		No Intercept & No Trend	Intercept & No trend	Intercept & trend	No Intercept & No Trend	Intercept & No trend	Intercept & trend
Denmark	Trace	2	1	1	2	1	1
	Max-Eig	2	0	1	2	0	1
Finland	Trace	3	2	2	3	2	2
	Max-Eig	3	2	2	3	2	0
France	Trace	1	0	1	1	0	1
	Max-Eig	1	0	1	1	0	1
Germany	Trace	3	1	2	3	1	2
	Max-Eig	3	1	2	3	1	1
Greece	Trace	2	1	1	1	0	1
	Max-Eig	1	1	1	0	0	1
Ireland	Trace	2	2	2	2	2	2
	Max-Eig	2	3	2	2	2	2
Italy	Trace	1	1	0	1	1	0
	Max-Eig	1	1	1	1	1	1
Netherlands	Trace	3	1	2	3	1	2
	Max-Eig	3	1	2	3	1	2
Poland	Trace	1	3	3	1	1	2
	Max-Eig	1	1	2	1	0	2
Portugal	Trace	1	0	0	1	0	0
	Max-Eig	1	0	0	1	0	0
Sweden	Trace	3	1	2	2	1	2
	Max-Eig	0	1	2	0	1	1
U.K.	Trace	2	1	1	2	0	0
	Max-Eig	2	1	1	1	1	1

Table 7 - ARDL Output Summary

Country	ARDL(p,q,q,q,q)	Variables ln(IP)	ln(CPI)	ln(M1)	ln(GB)
Denmark	(2,0,10,0,0)	-0.059002	-1.626452	0.015991	-0.004287
		(0.035839)	(1.045320)	(0.021419)	(0.006057)
Finland	(4,0,5,9,0)	-0.036711	-1.447189	0.102961	-0.010291
		(0.068099)	(1.239327)	(0.116457)	(0.006919)
France	(1,3,7,1,0)	0.548093**	-0.946450	0.240355**	-0.009140
		(0.247037)	(1.107410)	(0.108396)	(0.006575)
Germany	(1,0,0,3,0)	-0.033961	-0.919326***	0.110216	-0.009147**
		(0.100450)	(0.302797)	(0.130408)	(0.004297)
Greece	(4,0,0,2,0)	-0.074881	-0.432798*	0.147955	0.012329
		(0.108087)	(0.231697)	(0.157358)	(0.017243)
Ireland	(6,0,5,1,0)	-0.033877	0.020246	0.094629	-0.002069
		(0.042479)	(0.873823)	(0.069684)	(0.011613)
Italy	(10,8,10,10,0)	0.027732	-1.849023	0.376258***	-0.007987
		(0.285829)	(1.999631)	(0.140040)	(0.015161)
Netherlands	(1,1,0,1,0)	0.144313	-0.130398	0.256794**	-0.000917
		(0.183800)	(0.148742)	(0.106521)	(0.006001)
Poland	(1,6,0,2,0)	0.248608	-0.070819	0.640583***	-0.015573
		(0.215352)	(0.079819)	(0.088801)	(0.018304)
Portugal	(2,0,0,2,0)	-0.007738	-0.213038	0.304530***	0.004489
		(0.059475)	(0.139600)	(0.109866)	(0.008578)
Sweden	(4,2,9,1,0)	0.148217	-2.264749**	0.231994**	-0.009410
		(0.099361)	(0.937297)	(0.098924)	(0.006445)
U.K.	(1,4,4,0,0)	0.608057**	0.419937	0.024546	-0.013601
		(0.272249)	(0.736468)	(0.017040)	(0.011633)

Notes: * Denotes significance at the 10% level.

** Denotes significance at the 5% level.

*** Denotes significance at the 1% level.

Standard Errors are in brackets.

Table 8 - Country Wise FMOLS and DOLS

Dependent Variable: ln(SMI)										
	FMOLS					DOLS				
Country	ln(IP)	ln(CPI)	ln(M1)	ln(GB)	C	ln(IP)	ln(CPI)	ln(M1)	ln(GB)	C
Denmark	2.989935***	2.380498**	0.091979	-0.136301**	-20.98699***	2.206413***	3.508115***	-0.047368	-0.099561*	-18.83124***
	(0.558292)	(1.211848)	(0.212394)	(0.061011)	(4.162028)	(0.461133)	(0.982722)	(0.167865)	(0.051976)	(3.449657)
Finland	1.719014***	0.300761	0.107277	-0.221721***	-4.104171	1.176904**	-1.577862	0.465682*	-0.192960***	-1.702256
	(0.660935)	(1.764161)	(0.328350)	(0.064097)	(4.002788)	(0.518875)	(1.363098)	(0.254107)	(0.050143)	(3.083915)
France	4.651957***	4.911291	-0.681564	-0.102592	-16.71188**	2.775692***	0.777478	-0.105298	-0.126868**	-5.068249
	(1.181505)	(3.005458)	(0.457516)	(0.076650)	(8.380515)	(0.785663)	(2.011584)	(0.304798)	(0.050375)	(5.543250)
Germany	3.238075***	5.561746	-0.958824*	-0.116049**	-4.911582	2.595517***	3.363185	-0.471297	-0.085231**	-5.457839**
	(0.918433)	(3.378987)	(0.490078)	(0.053727)	(3.707096)	(0.629473)	(2.473792)	(0.355130)	(0.037207)	(2.540965)
Greece	5.438188**	-0.692306	0.469873	-0.004100	-26.65567*	3.941934***	-1.930935	0.759023*	0.091787	-21.61642***
	(2.561482)	(4.143676)	(0.978988)	(0.309385)	(14.20274)	(1.191909)	(1.935672)	(0.452140)	(0.134768)	(6.218878)
Ireland	-1.328967*	1.425306	0.042155	-0.675930***	7.806861*	-4.437392***	2.729813***	0.313728***	-1.372546***	10.23174***
	(0.676427)	(2.403691)	(0.274045)	(0.168612)	(4.313135)	(0.380776)	(1.030045)	(0.110014)	(0.093543)	(2.110711)
Italy	3.715534***	0.794562	-0.128527	-0.117800	-7.011187	2.378536***	-1.006943	0.045848	-0.165824**	2.558616
	(0.686056)	(1.431381)	(0.260981)	(0.099645)	(5.564661)	(0.473376)	(0.974620)	(0.176593)	(0.068592)	(3.801616)
Netherlands	8.634278***	1.001058	-1.399269***	-0.297281***	-0.653411	2.445932**	-0.205117	-0.496189*	-0.165819***	9.040151***
	(1.986976)	(2.185917)	(0.451609)	(0.082877)	(5.844806)	(1.239223)	(1.272000)	(0.266052)	(0.049237)	(3.447643)
Poland	-0.214200	7.494164*	0.574710*	-0.512183	-37.05587**	0.164675	2.619151	0.500966***	-0.191203	-14.75746
	(0.964783)	(3.861230)	(0.318930)	(0.376472)	(17.95184)	(0.560855)	(2.234733)	(0.184205)	(0.220800)	(10.43599)
Portugal	2.100369	-4.661179*	1.384546**	0.338536*	-15.10483	0.959625	-3.644781***	0.872013***	0.176940**	-1.335671
	(1.764862)	(2.550415)	(0.660156)	(0.191903)	(12.06833)	(0.819407)	(1.113412)	(0.279316)	(0.079998)	(5.283821)
Sweden	-1.352384*	-13.15118***	2.012892***	-0.319508***	36.19080***	-0.327124	-7.653406***	1.268791***	-0.239365***	19.34931***
	(0.696332)	(3.127965)	(3.127965)	(0.083095)	(9.351923)	(0.486112)	(2.108809)	(0.298340)	(0.298340)	(6.310214)
U.K.	4.479382***	4.695512***	-0.349676**	0.371811***	-23.73385***	3.114692***	2.912645***	-0.184826*	0.110113	-13.75967***
	(0.832375)	(0.891855)	(0.152120)	(0.117367)	(5.712791)	(0.540085)	(0.590280)	(0.098180)	(0.077473)	(3.707792)

Notes: * Denotes significance at the 10% level, ** Denotes significance at the 5% level, and *** Denotes significance at the 1% level.

Standard Errors are in brackets, and C Denotes the long run deterministic linear constant.