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The influence of macroeconomic factors on the stock markets in the Baltic countries and Western Europe - A comparison

by

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Abstract

The relationship between the stock market and the condition of a country's economy is a relevant topic in the recent economic and financial studies. Therefore, the purpose of our thesis is to investigate in finding long-term and short-term relationships between the stock market and macroeconomic variables in the three Baltic countries and compare the results with three more economically developed Western European countries such as Germany, Italy and UK. To achieve our goal, we apply three methods: Johansen cointegration test, vector error correction model (VECM) and Granger causality test. The results from cointegration test reveal that long-term relationship exists between the variables. VECM shows that the number of significant macroeconomic determinants of the stock market index is not noticeably higher in more developed European countries. Money supply is the dominant factor in explaining the changes in the stock market in the Baltic countries and interest rate – in Western European countries. The main findings from Granger causality test which is applied to the two subsamples – before and after the economic crisis are as follows: more significant relationships between stock index and macroeconomic variables occur after the crisis for the Baltic countries and the Western European countries – before the crisis.

Keywords: macroeconomic variables, stock indices, Johansen cointegration test, VECM, Granger causality test

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1 Introduction

The relationship between the stock market and the condition of a country's economy has been a relevant topic in recent economic and financial studies (e.g. Masuduzzaman, 2012; Gan et al. 2006; Ali, 2011). As more and more countries are becoming economically developed and open, their stock markets become more established and efficient, which attract more potential investors. All countries' stock markets are affected by different macroeconomic factors, each differently according to the country's openness, development level, geographical location, political regimes and so on. Most of the studies conducted in the previous decades focused on the developed markets like the US (Chen, Roll, & Ross, 1986), Germany and UK (Masuduzzaman, 2012). More recent studies focused more on developing countries like Korea (Kwon & Shin, 1998), India (Naik & Padhi, 2012), Czech Republic, Hungary, Poland and Slovenia (Barbic & Jurkic, 2011) and others. Those studies primarily concentrate on the single markets or a group of countries. Only a few researchers analyse the differences between different countries (e.g. Kenourgios & Samitas, 2007) and almost no research is made regarding the three Baltic countries – Estonia, Latvia and Lithuania.

After the collapse of the Soviet Union in 1990, three Baltic states – Lithuania, Latvia and Estonia have embraced the free market economy (Dudzinska, 2013). The stock markets were established early – for example, Lithuania's NASDAQ OMX Vilnius stock exchange was founded only three years after independence was gained – in 1993 (Nasdaq Baltic, 2016). The three countries all joined the European Union in 2004 and since then became one of the fastest growing economies in Europe (Dudzinska, 2013). Therefore, it is important to find out if the Baltic countries were as successful in adopting the values of the free and efficient markets as the economic growth. By exploring this issue, it will show to which macroeconomic variables investors should pay attention while investing into the Baltic markets and contribute to the previous literature by providing insight into the dependency of those markets on the macroeconomic environment.

Hence, the aim of this thesis is to identify the long-term and short-term relationships between macroeconomic environment and the stock market in the three Baltic states and compare the results with three more economically developed Western European countries – Germany,

Italy and United Kingdom (UK). To achieve this goal we aim to evaluate the relationship between the chosen macroeconomic variables and the stock indices in the sample countries by applying Johansen cointegration test, vector error correction model (VECM) and Granger causality. From our research, we expect to identify significant relationships between the macroeconomic variables and stock markets in the sample countries. Moreover, we assume that the relationships between the stock markets and macroeconomic environment might have changed during and after the financial crisis of 2007 – 2009. For this reason, we additionally analyse three subsample periods before, during and after the economic downturn.

From the VECM, we find that there is no substantial difference in the number of significant relationships between macroeconomic variables and stock prices in Baltic and Western European countries. Additionally, we discover that more significant relationships between stock index and macroeconomic variables occur after the crisis for the Baltic countries and the Western European countries – before the crisis.

The contribution this thesis aims to make is to the gap in the existing literature covering the relationships between stock markets and macroeconomic environment. Firstly, previous papers do not focus on finding the relation between Baltic stock market indices and macroeconomic factors by using cointegration analysis, VECM and Granger causality. Furthermore, our thesis includes the analysis of three subsample periods which have not been covered separately in the previous studies.

The thesis is organised in this way: the second chapter is comprised of the analysis of relevant studies on the macroeconomic factors which influence indices and the methods used to identify those relations. The third chapter describes the chosen macroeconomic variables and empirical model used to estimate their influence on stock market indices of the Baltic states and economically developed European countries. The fourth chapter analyses and discusses results followed by the final chapter which presents the conclusion from empirical tests.

2 Literature review

This chapter focuses on the existing literature which is related to the topic of our thesis. It mainly deals with the relevant research papers which tried to find the macroeconomic factors which influence stock market indices employing different econometric methodology. The more detailed description of variables which are employed in the studies is described in the section 3.2.2 Explanatory variables.

There are plenty of studies which employ cointegration test, VECM and Granger causality test in order to find the relation between the stock prices and macroeconomic variables in the countries with developing economies. VECM is used to avoid endogeneity problem noticeable in macroeconomic variables (Acikalin, Aktas, & Unal, 2008). The findings are inconclusive. Kwon and Shin's (1999) main results from the cointegration test and the vector error correction model conclude that some of the variables such as the production index, exchange rate, trade balance, and money supply are cointegrated with Korean stock market prices (KSE) and have long-run relation with it. However, Granger causality test results show that stock price indices do not cause changes in the macroeconomic variables. The different results are obtained in Ali's (2011) paper. He evaluates Dhaka Stock Exchange (DSE) and finds bidirectional causality between the import payment and stock index. The finding of significant causality from stock index to import payment is interesting because Bangladesh is included in the list of developing market countries, therefore this relationship is not expected (MSCI, 2010). Another paper analyses Istanbul Stock Exchange (ISE) and macroeconomic variables of the Turkish economy. They apply the same methods but use quarterly data and macroeconomic variables such as GDP, exchange rate, interest rate, and current account balance (Acikalin, Aktas, & Unal, 2008). The long-term relationships between ISE and macroeconomic variables are identified. The causality tests results show unidirectional relationships between macro indicators and ISE index, the same results are obtained in the Kwon and Shin (1999) study. The strength of their model specification is that it accounts for heteroscedasticity and autocorrelation in the residuals (Gujarati & Porter, 2009). The paper of Brahmasrene (2007) is focused on a stock market index of Thailand and analyses the period during the post-financial liberalisation (pre-financial crisis) and the post-financial crisis in

Thailand. The main finding is that cointegration relationship exists before and after the crisis. Overall, these papers lack comparison between similar countries, offer no explanation on more developed countries which have more mature markets as well as no comparison between developed and developing countries.

There are a couple of studies which focus on well-developed markets. The study which is performed by Masuduzzaman (2012) examines German and the United Kingdom stock returns long-term and short-term relation with macroeconomic variables such as consumer price index (CPI), interest rate, exchange rate, money supply, and industrial production employing Johansen cointegration and error correction model. The Johansen test results identify that cointegration is present between stock returns and five macroeconomic variables. The error correction model indicates that short-term and long-term relations exist between the same variables which are used in Johansen cointegration test. Similarly, Gan et al. (2006) investigate the relationships between the New Zealand Stock Index and seven macroeconomic variables. The Granger causality tests and Johansen multivariate cointegration tests are used. The cointegration is found between variables like in the previously described Masuduzzaman study. However, Granger causality tests reveal that New Zealand stock market does not affect changes in macroeconomic factors. The conclusion the authors make is that this is due to New Zealand market being small. This finding is interesting because New Zealand is included in the list of developed markets (MSCI, 2010) and controversially in the paper of Ali (2011) stock index influences macroeconomic variable. The performance of Germany, UK and New Zealand stock market indices differs from the smaller countries', therefore, our thesis attempts to extend the topic to Baltic countries.

The fact that there are few investigations done on Baltic countries makes this thesis relevant. The only research which contributes to Baltic countries is a paper by Rudzkis and Valkaviciene (2014) where they analyse the impact of macroeconomic processes on the stock markets in the Baltic countries. The simple ordinary least squares (OLS) regression is applied in order to find the relation between stock indices and macroeconomic variables. The significant relation is identified with dollar/euro exchange rate, gold and oil prices. One shortcoming of the research is that it overlooks a long-term effect on macroeconomic variables on stock market indexes and does not account for a possible endogeneity problem which is not mentioned in the paper.

A more similar study to our thesis which applies the same methods and uses the comparison between new and old European members is a paper written by Kenourgios and Samitas (2007). They compare if the future and current macroeconomic variables have short-term and long-term influence on stock returns in the countries which they call “new” (Poland, Czech Republic, Slovakia, and Hungary) and “old” (UK, France, Italy and Germany) by using Johansen cointegration test, causality test and vector error correction model. The findings are as follows:

1. The cointegrating relationship between the macro variables and stock returns exists.
2. The first part of causality test reveals that interest rates are a significant cause for share prices movements in “new” countries and industrial production (current and future) in “old” countries. The second part indicates that domestic macroeconomic factors have the greater impact on the shares of Germany and France, the opposite for Italy and UK. Finally, the ”new” countries’ stock market returns are affected by domestic and Germany’s economic variables.
3. VECM shows that current industry production has short-term causal relation with all countries’ except Czech Republic’s, Slovakia’s and Hungary’s stock market returns while interest rates with all except France’s and UK’s. The future industry production has short-term relation with Germany’s stock market returns and future interest rates with Germany’s and Hungary’s markets. By using current economic factors, error correction term, which shows long-run causality with all macro variables is significant for all countries except the UK, France and Germany. Instead with the future factors, the term is insignificant for the Czech Republic.

The main strength of this paper is that it includes US macroeconomic variables in order to see if they have more influence on stock returns of “old” or “new” countries. This comparison proofs that US economy has less impact on new European Union members. The main gap in this study is that the Baltic countries are not included in the list of “new” European countries and does not analyse the period before and after the financial crisis. These are the main findings from the previous studies which attempt to explain the influences of different factors on stock returns.

3 Methodology

This chapter focuses on the theoretical methods and approaches which are applied to the research question. The first subchapter discusses the research approach, the second subchapter describes the data used for the research and the third subchapter defines the methods used to test the research hypotheses.

3.1 Research approach

There are different approaches which can be applied to find the relationship between macroeconomic variables and the movements in the stock market – from simple multivariate regressions to more complex methods like error correction models, conditional volatility models or vector autoregressive models (e.g. Butt et al. 2010; Masuduzzaman, 2012; Ali, 2011; Rudzkis & Valkaviciene, 2014). The methods which are used in our thesis are cointegration analysis, VECM and Granger causality test. The main reason why the VECM is chosen is that it accounts for endogeneity problem as stock market indices can also cause or predict movements in macroeconomic variables. Moreover, it is applied to identify not only short-term but also the long-term relationship between the variables (Acikalin, Aktas, & Unal, 2008). We mainly focus on one of the VECM equations where the dependent variable is the stock market indices of the Baltic and more economically developed European states and the explanatory variables are the chosen macroeconomic factors of the corresponding country. We also include a dummy variable in the regression to analyse if the relationship between variables is different during the economic downturn and compare the periods before, after and during economic recession using Granger causality test. In short sample periods, this test is more appropriate than VECM as we do not expect the long-term relationship between the variables.

Firstly, we expect to find significant long-term and short-term relationships between some of the chosen macroeconomic variables and stock market indices in all countries. Furthermore,

we expect to identify different relationships between the variables in the three subsample periods – before, during and after the financial crisis.

3.2 Variables

3.2.1 Dependent variables

Previous studies which are conducted on the influence of macroeconomic variables on the stock market prices use broad-based stock market indices to represent the movements of the total stock market (e.g. Masuduzzaman, 2012; Gan et al. 2006; Ali, 2011). The dependent variables which are employed for our model's main equation are the monthly stock prices of the broad-based stock market indices of the three Baltic countries – Lithuanian OMX Vilnius, Latvian OMX Riga and Estonian OMX Tallinn. Additionally, for comparison, we include three broad-based stock market indices for the more economically developed European Union states – Germany's DAX30, United Kingdom's FTSE100 and Italy's FTSE MIB30. These three European Union countries are chosen based on the availability of data and for the reason that they all have relatively old and established markets.

3.2.2 Explanatory variables

The explanatory variables which are used for our model's main equation are major macroeconomic indicators which generally describe the state of the economy – economic activity, unemployment, interest rates, and money supply. These four chosen macroeconomic indicators are the most widely used to analyse the relationship between stock market and macroeconomic conditions in the previous studies, for example, Kwon and Shin (1999), Masuduzzaman (2012) and Boyd et al. (2005). These macroeconomic indicators are also included in the European Central Bank's Key Euro area indicators (European Central Bank, 2016).

To represent the growth in overall economic activity of the three Baltic countries and three more economically developed European states, we use local industrial production indices. The industrial production index is one of the most important statistic indicators in the short-term. It is applied to identify the turning points in the state economy and to access the possible future development of the country's GDP. It is also one of "Principal European Economic

Indicators" which are used to form EU monetary and fiscal policies (Eurostat, 2016). There is no definite consensus on the impact of economic activity and stock markets. Some researchers like Masuduzzaman (2012) and Kenourgios and Samitas (2007) find a positive relationship between the economic activity and stock market returns in German and the United Kingdom markets. One explanation for this relationship could be that the growing economy causes the growth of the companies listed in the stock market, thus increasing their future cash flows and the stock prices. Other researchers like Subeniotis et al. (2011) determine a negative relationship between production and stock markets. The reason for this relation could be, that the expected return of the stock contains risk and time premium which are negatively related to the economic conditions. When the economic conditions are unfavourable, the investors require a larger premium to compensate for additional risk and when the conditions are favourable, the investors agree to invest in a smaller premium (Marathe & Shawky, 1994). Another explanation offered by Fama and French (1989) states, that at the top of the business cycle, people have high income relative to their wealth. Based on the Modigliani and Brumberg (1955) Life cycle permanent income hypothesis, people smooth their consumption over business cycles, that is, saving more for the poor periods during the good economic periods. Reduced consumption results in lower future cash flows for companies and lower stock prices. Another argument is that in good economic conditions growing investment leads to high future capital stock and low marginal productivity of that future capital which decreases the returns of financial assets (Marathe & Shawky, 1994).

To represent unemployment variable in our model we take the monthly rate of unemployment in individual countries. Unemployment is one of the main variables to represent the state of the economy. High unemployment rate translates into lower income for individuals which in turn would translate into economic slowdown (Eurostat, 2016). Boyd et al. (2005) find that the relationship between the rise in the level of unemployment and stock returns is negative when the economy is contracting and positive when it is expanding. As most of the time, the economy is expanding the latter influence is more prominent.

To represent the interest rate variable in our model we use monthly three-month interbank borrowing rates of individual countries. Based on financial theory, interest rates affect the stock prices in two ways. First of all, it directly affects the discount rate used to discount the future cash flows and thus the value of the firm. Moreover, it affects the expectations of the future economic conditions and future cash flows by impacting the cost of financing

(Martinez, P. M., Lapena, R. F. & Sotos, F. E., 2014). This would imply a negative relationship between the stock returns and interest rates as higher discount rate would erode future cash flows and reduce the stock price (Chen, Roll, & Ross, 1986). This relationship is confirmed in a recent study by Huang, W., Mollick, A. V. and Nguyen, K. H. (2015) where they find a negative relationship between the stock returns and interest rates in the US stock market.

There are three categories of money supply: M1, M2 and M3. These money supplies differ with regards to including different forms of "money". M1 is the narrowest money supply and it includes currency, overnight deposits and other balances of immediate liquidity. M2 includes M1 and deposits with maturity for up to two years and deposits redeemable at the period of notice of up to three months. M3 includes M2 and marketable instruments issued by monetary financial institutions. It is the broadest of all three money supplies (European Central Bank, 2016). To represent the money supply in our model we choose M2 money supply, which was also used by Flannery, M. J., and Protopapadakis, A. A. (2002) in a similar research. In empirical studies, there is no consensus on the relationship between stock returns and the changes in the money supply. Summers (1981) and Flannery, M. J., and Protopapadakis, A. A. (2002) identify that the relationship between stock returns and changes in money supply is negative while Lastrapes (1998) find a positive impact of the changes in money supply on stock returns. However, most of the studies discover a statistically significant relationship between the changes in money supply and stock returns. Money supply can be interpreted as a proxy for inflation – according to the Quantity theory of money, in the normal economic situation, if the money base increases faster than the real output, the inflation rises. Financial theory, mainly the Fisher model suggest that inflation should have a positive correlation with the nominal stock return in the long-term (Fisher, 1930). However, numerous empirical evidence by Jaffe and Mandelker (1976), Nelson (1976), Fama and Schwert (1978) suggest, that in the short run inflation is negatively related to stock returns. Kaul (1987) argues, that the negative relationship between inflation and real economic activity which is affected by the counter – cyclical monetary responses can explain the negative relationship between stock returns and inflation.

3.2.3 Dummy variable

Our model also includes a dummy variable to represent the period of economic downturn during the financial crisis from June 2007 to March 2009 as we suppose that stock markets respond differently to some variables, like unemployment, during the economic downturn. The period is chosen by examining the negative trend in the Euro Stoxx 600 price index during our sample period (Appendix A) which also corresponds to the period of financial crisis. The significant dummy variable would indicate a different relationship between the macroeconomic conditions and the stock market during that period.

3.3 Data

All the data used in this research is on the monthly basis as daily data is not available for macroeconomic variables and quarterly data would provide too few observations for the selected sample period. All variables are in levels in order to apply the cointegration analysis and analyse long-term relationships. The research covers the period from January 2000 to January 2016, except for Latvia, which only covers from July 2003 as the data for the money supply M2 is missing before July 2003. All of the data is obtained from Datastream and Eurostat databases.

3.4 Descriptive statistics

It is important to analyse properties of the data by using key statistical measures in order to achieve better interpretations of coefficients in the regressions and to see if we could expect to find the relation between macroeconomic variables and stock market index. The key output of descriptive statistic includes mean, median, the minimum and maximum values of the variables, standard deviation, skewness, and kurtosis. The Table 1 below presents the key properties of the stock market indices of the three Baltic countries – Lithuanian OMX Vilnius, Latvian OMX Riga and Estonian OMX Tallinn and stock market indexes of German DAX30, UK FTSE 100 and Italian MIB30. The outputs of descriptive statistics of the macroeconomic variables are reported in Appendix B.

Table 1 Descriptive statistics of the analysed indices

	Lithuania	Latvia	Estonia	Germany	Italy	UK
Mean	309.34	441.66	526.99	6,392.66	27,456.29	5,587.26
Median	342.38	420.45	597.51	6,235.56	24,918.85	5,774.43
Maximum	569.79	744.09	1,010.76	12,001.38	48,676.19	6,985.95
Minimum	68.27	210.96	122.03	2,450.19	12,739.98	3,625.83
Std. Dev.	150.60	125.07	260.25	2,080.11	9,292.47	872.53
Skewness	-0.28	0.53	-0.18	0.51	0.52	-0.46
Kurtosis	1.69	2.64	1.66	2.93	2.15	2.19
Jarque-Bera	16.43	7.81	15.40	8.41	14.40	11.98
Probability	0.00	0.02	0.00	0.01	0.00	0.00

The skewness coefficients are close to 0, positive and negative which implies that the data is asymmetrically distributed. Data of all stock market indices is not normally distributed as the skewness is not 0 and kurtosis 3. The Jarque-Bera test results draw the same conclusion about the distribution of the data. The null hypothesis is rejected for all variables at 5% significance level (Brooks, 2014).

The mean values let to determine the predictable values of the regression coefficients. Due to the fact that the mean values of German, Italian and UK prices are high could lead to higher values of the regression coefficients. The same with macroeconomic variables such as money supply and industrial production index. Comparing the relative measure of standard deviation (std.dev/mean) among analysed countries, reveals that the most volatile stock index is Lithuanian. The relative standard deviation of macro factors such as money supply and unemployment and stock market index prices are similar for all analysed countries. This could imply that the relation exists between some of the variables (Butt et al. 2010).

3.5 Econometric methodology

In order to accomplish the aim of the thesis, we apply different econometric models and approaches. The first step is to check for the stationarity of the time series data using Augmented Dickey-Fuller (ADF) test. The second step is to test if there is a cointegrating relationship between the variables using Johansen cointegration test. The third step is to identify the long-term and short-term relationship between variables using the VECM for the

full sample period. The final step is to analyse the relationships between variables for the split samples using the Granger causality approach.

3.5.1 Testing for stationarity

Testing for stationarity is important as non-stationary data usually produce spurious regressions. The spurious regressions are likely to have very high R^2 coefficients even if the relation between two independent and dependent variables is meaningless (Gujarati & Porter, 2009). Moreover, stationarity test should be performed in order to apply cointegration test in the next step of our analysis because this test requires that all variables will be integrated of the same order (Dritsaki, 2005).

The test which is the most widely used to check for stationarity is Augmented Dickey-Fuller Test (e.g. Butt et al. 2010; Ali, 2011; Acikalin, Aktas, & Unal, 2008). The ADF test is preferred to Dickey-Fuller (DF) as it solves the potential presence of serial correlation in the data (Tam, 2013). It is very important to determine a correct number of lags. The results of an inappropriate number of lags used for ADF test could lead to the unfavourable performance of this test especially in small samples (Fox, 1997). The number of lags should be selected by using Swartz information criterion (SBIC). The main reason is that SBIC is the most popular criterion used in the literature (Butt et al. 2010). The equation of ADF test with drift and trend could be written (Brooks, 2014):

$$\Delta y_t = \mu + \varphi y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta y_{t-i} + \lambda t + u_t \qquad (1)$$

where Y_t denotes country's stock market index or macroeconomic factor, u_t represent white noise, t is a time index and m is a number of lags.

These are Augmented Dickey-Fuller test hypothesis:

H_0: $\varphi = 0$ against alternative H_1: $\varphi < 0$

If H_0 is rejected data, then data has no unit root and is stationary. The null hypothesis is rejected if the critical values are larger (less negative) than test statistic under selected significance level (Patel, 2012). ADF stationarity test is applied for all variables which are used in our thesis.

3.5.2 Johansen cointegration test

One of the conditions for applying the VECM is that the variables in the model should be cointegrated (Dritsaki, 2005). Two or more variables are cointegrated, if they move together in a long-term, even if there are deviations in the short-term. If two or more non-stationary variables of the same order of integration are cointegrated and combined in a regression equation, that combination will be stationary. If the variables are cointegrated, we can examine a long-term relationship between them using error correction models (Brooks, 2014). In order to test, if the chosen variables are cointegrated the Johansen cointegration test could be employed. Johansen test is very popular with previous researchers for example Ali (2011) and Masuduzzaman (2012) which analyse the cointegration relationships. The test is more general than Engle-Granger two-step cointegration test as it allows including more than one cointegrated relationship (Brooks, 2014). Based on Hjalmarsson and Osterholm (2007) The Johansen test takes form of a VAR(p) equation:

$$y_t = A_1 y_{t-1} + \cdots + A_p y_{t-p} + \mu + \varepsilon_t \quad (2)$$

where y_t is the vector of endogenous variables which are integrated of order one, μ_t is the intercept and ε_t is the vector of innovations. The VAR(p) model above can be rewritten as:

$$\Delta y_t = \mu + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \varepsilon_t \quad (3)$$

where

$$\Pi = \sum_{i=1}^{p} A_i - I \text{ and } \Gamma_i = -\sum_{j=i+1}^{p} A_j \quad (4)$$

If the rank of Π matrix is equal to zero, then the second equation is reduced to a simple VAR(p) model. However, if matrix Π is not equal to zero and its rank is smaller than n then there exists r x n matrixes α and β each of them having a rank r such that $\Pi = \alpha\beta'$ and $\beta' y_t$ becomes stationary. Then we can say that the variables are cointegrated of the same order as the rank of matrix Π. Matrix α contains the adjustment parameters in VECM, β are the cointegrated vector and r is the number of possible cointegration relationships between variables. According to Masuduzzaman (2012), two statistics can be used to conduct the Johansen cointegration test my estimating Π of the unrestricted VAR and also perform a test, if the restrictions imposed by the r < n can be rejected – trace statistic and maximum eigenvalue statistic. The test equation for the trace statistic is:

$$LR_{trace} = -T \sum_{j=r+1}^{k} \ln(1 - \hat{\lambda}_j) \quad (5)$$

where T is the number of observations, $\hat{\lambda}_j$ is the j[th] largest canonical correlation, LR is the likelihood ratio statistic for testing whether the rank of Π is equal to zero and the variables are not cointegrated or smaller than n and the variables are cointegrated. The test equation for the maximum eigenvalue statistic is:

$$LR_{max} = -Tln(1 - \hat{\lambda}_{r+1}) \quad (6)$$

where T is the number of observations, LR is the likelihood ratio statistic for testing whether the rank of Π is equal to r_0 or equal to r_{0+1}. Where $r_0$is the starting rank for Π, which means, that it can test, for example, if the rank of Π is equal to one or two. The number of lags chosen for the Johansen test depends on the lag number optimal for VECM meaning the lag numbers for the test and VECM should be the same.

3.5.3 Vector error correction model

A vector error correction model is an extension of simple VAR model. This model could be used with two or more non-stationary series which are known to be cointegrated as it has the cointegration restrictions (Ali, 2011). This model checks causal relations between the cointegrated variables and their lagged values and thus, by estimating the equations for different variables simultaneously, accounts for endogeneity problem which is very likely between our variables (Asari et al. 2011). In our research, in the main equation, stock market indices are regressed on selected lagged different macroeconomic variables as well as the lagged values of itself (Equation 7).

$$\Delta Y_t = \omega_1 + \varphi_1 ECT_{t-1} + \sum_{i=1}^{m} \delta_i \Delta Y_{t-i} + \sum_{i=1}^{m} \gamma_i \Delta X_{t-i} + u_t \quad (7)$$

$$ECT_{t-1} = Y_{t-1} - \alpha - \beta X_{t-1} \quad (8)$$

Y_t denotes country's stock market index, ECT is error correction term, X_t is macroeconomic factors, u_t represents the white noise, t is a time index and m is a number of lags (Ali, 2011). The significance of combined lags of explanatory variables can be tested using Granger

causality/Block exogeneity Wald tests where the lags of the independent variables are restricted in one model and then compared with the unrestricted one (Brooks, 2014).

Additionally, this model estimates error correction term which lets us see the long-run equilibrium relation between variables. If this error term is significant, it shows that the past macroeconomic factors have a long-run impact on the current stock market index (Kwon & Shin, 1999). The value of this error correction term is expected to be between -1 and 0. A positive sign will imply, that the variables are diverging from the equilibrium instead of moving towards it. The closer the value is to -1, the faster the "errors" correct themselves and the quicker the variable converges to the mean (Bekhet, 2009). VECM lets to determine the values and the signs of coefficients between stock market index (dependent variable) and macroeconomic variables (independent variable) in our study.

There are two methods to determine the optimal lag length for the VECM – the cross-equation restrictions and information criteria. In this thesis, we chose to focus on the information criteria approach. There are three information criteria – Schwarz, Akaike (AIC) and Hannan – Quinn (HQIC). We have chosen to apply the HQIC criterion, as the SBIC usually underestimates and AIC overestimates the number of lags in the model. HQIC criterion is somewhere in between (Brooks, 2014).

The additional assumptions for the VECM are similar to OLS. The main things to consider when testing the model are autocorrelation in residuals, heteroscedasticity and normality of the residuals which all diminish the efficiency of the applied model although the regression coefficients remain unbiased. Autocorrelation is tested using the LM test, heteroscedasticity is tested using the White's test and normality of residuals – Jarque Bera test (Brooks, 2014)

3.5.4 Granger causality test

In our study, the Granger Causality test is mainly used to detect the short-term relation between stock returns and macroeconomic variables. This test allows us to see if macroeconomic variable causes changes in the stock market index or causality occurs in an opposite direction (e.g. Acikalin, Aktas, & Unal, 2008; Ali,2011; Kwon & Shin,1999). If the macroeconomic variables Granger cause stock market index returns, it means that macroeconomic factors could significantly affect stock returns. The equations which are used in this test are provided below.

$$Y_t = \alpha_0 + \sum_{i=1}^{m} a_i Y_{t-i} + \sum_{i=1}^{m} \beta_i X_{t-i} + u_t \quad (9)$$

$$X_t = \omega_0 + \sum_{i=1}^{m} \gamma_i X_{t-i} + \sum_{i=1}^{m} \delta_i Y_{t-i} + \varepsilon_t \quad (10)$$

Where Y_t denotes country's stock market index, X_t is macroeconomic factors, u_t and ε_t represent for the white noise, and m is a number of lags (Dritsaki, 2005).

These are Granger causality test hypothesis:

1. H_0: Macroeconomic factor does not Granger cause stock market index
   $\beta_1, \beta_2, \dots, \beta_m = 0$
   H_1: Macroeconomic factor does Granger cause stock market index
   $\beta_1, \beta_2, \dots, \beta_m \neq 0$
2. H_0: Stock market index does not Granger cause macroeconomic factor
   $\delta_1, \delta_2, \dots, \delta_m = 0$
   H_1: Stock market index does Granger cause macroeconomic factor
   $\delta_1, \delta_2, \dots, \delta_m \neq 0$

The null hypothesis is rejected if F-statistic is greater than the critical value under specified confidence level (Gujarati & Porter, 2009). The number of lags is selected according to AIC or SBIC (Xu, 2015). If both null hypotheses are not rejected, the Granger causality does not exist between two analysed variables. If the first hypothesis is rejected and the second is not then unidirectional causality is present. If both rejected – bidirectional causality occurs between two variables (Tangjitprom, 2012). In our thesis, Granger causality test is performed for the periods before the financial crisis, during the crisis and after as variables are not integrated of the same order.

4 Analysis and Discussion

This chapter focuses on the analysis and discussion of the results. The first subchapter discusses the results from Augmented Dickey-Fuller test, the second subchapter describes the Johansen cointegration test results, the third subchapter describes the results from VECM, and the fourth subchapter analyses the results from Granger causality test.

4.1 Augmented Dickey-Fuller test results

The first set of analyses examine the stationarity of each variable for the whole period and for the sample split into the period before, during and after the financial crisis. The stationarity test should be conducted as one of the objective of this study is to examine the variables having the same order of integration in order to apply Johansen cointegration test in the next step. The most popular Swartz information criterion is used to select the number of lags for the test. These tests of stationarity are conducted with the constant or linear trend and constant depending on their significance. The results from ADF stationarity tests by using full period reveal that all variables do not satisfy stationarity condition. These results are consistent with the previous literature that finds most macroeconomic variables and stock indices non-stationary (e.g. Acikalin, Aktas, & Unal, 2008; Ali, 2011; Kwon & Shin, 1999). The critical values are smaller (more negative) than test statistic under 5% significance level which leads to a failure to reject the null hypothesis of non-stationarity. Moreover, selected variables successfully satisfy the condition to be integrated of the same order under 5% significance level (Table 2, 3). The results are different if the sample is split into three periods. In each country, at least one variable is stationary during the different periods. One example is industrial production index of Lithuania during the pre-crisis period (January 2000 – May 2007) (Appendix C). What is more, in some cases variables need to be integrated of order two. Three macroeconomic variables of Germany – money supply, unemployment and interest rate during the crisis period (June 2007 – March 2009) become stationary after taking second differences.

Table 2 Augmented Dickey-Fuller test results for Baltic countries (full sample)

Variable	Lithuania			Latvia			Estonia		
	Test statistic		Integration	Test statistic		Integration	Test statistic		Integration
	Level	First difference		Level	First difference		Level	First difference	
Stock index	-1.79	-11.02***	I(1)	-1.74	-9.59***	I(1)	-1.66	-12.82***	I(1)
Production	3.39*	-17.89***	I(1)	-2.03	-14.13***	I(1)	3.27*	-16.64***	I(1)
Money supply	-1.81	-13.05***	I(1)	-1.55	-10.88***	I(1)	-1.30	-8.42***	I(1)
Unemployment	-1.76	-7.74***	I(1)	-1.94	-4.77***	I(1)	-1.62	-9.31***	I(1)
Interest rate	-2.72	-9.60***	I(1)	-2.72	-9.79***	I(1)	-1.47	-9.13***	I(1)

Notes: **,** and *** are the 10%, 5% and 1% confidence levels.*

Table 3 Augmented Dickey-Fuller test results for Western European countries (full sample)

Variable	Germany			Italy			UK		
	Test statistic		Integration	Test statistic		Integration	Test statistic		Integration
	Level	First difference		Level	First difference		Level	First difference	
Stock index	2.02	12.71***	I(1)	-1.34	13.66***	I(1)	-2.87	14.81***	I(1)
Production	3.16*	5.44***	I(1)	-2.52	5.58***	I(1)	-2.08	17.06***	I(1)
Money supply	1.56	-5.37***	I(1)	-3.04	-3.04**	I(1)	1.45	-5.95***	I(1)
Unemployment	-2.95	-2.72***	I(1)	-1.9	-15.85***	I(1)	-0.32	-4.75***	I(1)
Interest rate	-2.61	-5.74***	I(1)	-2.61	-5.74***	I(1)	-1.83	-8.18***	I(1)

Notes: **,** and *** are the 10%, 5% and 1% confidence levels.*

These findings indicate that VECM could not be applied to the split sample. Overall, these results suggest that in order to perform Johansen cointegration test, the larger sample should be used. Therefore, the following step, cointegration analysis by using Johansen cointegration test is performed for the full sample when the Baltic countries' index prices are available.

4.2 Johansen cointegration test results

The second step of analysis employs the Johansen cointegration test in order to see if the VECM could be applied to find the relation between the stock index and macroeconomic variables. The cointegration test among the stock market index, the industrial production index, money supply, interest rate, and unemployment is performed using the appropriate lag length. This optimal lag length is determined by generally accepted techniques like information criteria for lag selection – HQIC is used. The selected optimal number of lags is then adjusted to account for autocorrelation in the VECM residuals, as the number of lags in the VECM and Johansen test has to be the same. The maximum eigenvalue and trace statistics show the existence of one or two cointegrating relations at the five percent significance level

among the macroeconomic variables and stock market index for all countries. In order to apply the VECM, the variables need to have at least one cointegrating relationships. The results of the test are presented in Table 4.

Table 4 Johansen cointegration test results

	Baltic countries			Western European countries		
	Lithuania	Latvia	Estonia	Germany	Italy	UK
Lags	2	2	2	3	5	4
Trace statistics	1	2	2	1	1	1
Maximum eigenvalue	1	1	2	1	1	2

Notes: *The values in the table are the number of lags chosen and a maximum number of cointegrated relationships confirmed by one of the test statistics.*

These results provide a strong evidence of the existence of a long-run relationship between the variables. Moreover, the chosen variables could be used for implementation of VECM. The findings are in the line with the previous studies which apply cointegration analysis (e.g. Kwon & Shin, 1999; Brahmasrene, 2007; Kenourgios & Samitas, 2007).

4.3 VECM results

After establishing, that all selected countries' stock indices are cointegrated with the corresponding countries' macroeconomic variables we conduct VECM in order to verify if there is a long-term and short-term relationship between the stock market index and macroeconomic variables. In the first part of the subchapter, we focus on the three Baltic countries. In the second part, we shift our attention to the three economically developed European countries. Finally, we compare the results.

4.3.1 Baltic countries

The results for the main VECM equation of the three Baltic countries, where the dependent variable is the stock market index, are stated in Table 5 below. All three models indicate no serial correlation in the residuals. However, heteroscedasticity of the residuals is present in the model which diminishes the efficiency of the model estimates, but the coefficients remain unbiased. Jarque-Bera normality test indicates slightly excess skewness and kurtosis in most models which further diminishes the efficiency of the model.

Table 5 Results of VECM for the Baltic countries

Variables	Lithuania	Latvia	Estonia
Error correction term	-0.02	-0.07**	-0.01
Stock index (-1)	0.14*	0.15*	-0.03
Stock index (-2)	0.05	0.01	0.01
Production (-1)	0.30	-0.58	3.07***
Production (-2)	-0.09	-0.21	1.83*
Money supply (-1)	0.00	0.04**	-0.01
Money supply (-2)	0.01*	0.05**	0.05**
Unemployment (-1)	-0.77	-4.40	7.15
Unemployment (-2)	-1.99	-10.14	12.56**
Interest rate (-1)	-6.04	-3.00	19.60
Interest rate (-2)	4.07	-0.27	-28.99**
Intercept	2.37	-1.18	4.18
Dummy	-18.64***	-15.77**	-33.08***
R – squared	0.15	0.22	0.23
Adjusted R – squared	0.10	0.15	0.18
F – statistic	2.69	3.21	4.44

Notes: *The values in the table indicate the slope coefficients of the explanatory variables. *,** and *** are the 10%, 5% and 1% confidence levels.*

Estimation shows an existing long-term relationship between the stock market and macroeconomic conditions in Latvia. The slope coefficient of the error correction term is negative and significant at 5% confidence level. This means that the stock market responds significantly to the deviations in the macroeconomic variables and begins to restore the equilibrium relationship after the deviation occurs. This speed of adjustment for Latvia is 7% per month. Furthermore, Lithuania's and Latvia's stock markets show some autocorrelation – they respond positively to previous period's stock return. According to the weak form of efficient market hypothesis (EMH), past values of stock prices cannot influence future stock return (Fama, 1970). This means that autocorrelation in the stock prices would suggest a probable lack of efficiency in the market. The short run relationship between the stock market and combined lags of macroeconomic variables is examined using the Granger causality/Block exogeneity Wald test. The result of the test is shown in Table 6.

Only Estonia's stock index has a short-term response to the changes in all of the chosen macroeconomic variables. The production index and unemployment rate have a significant positive impact on the Estonia's stock market. These results are in line with Masuduzzaman's (2012) and Boyd's et al. (2005) studies. Estonia's interest rate has a negative short-term impact on the country's stock index. Changes in money supply have a short-term positive effect on the stock markets in Latvia and Estonia. This result is similar to Lastrapes (1998) findings of positive stock market's response to changes in money supply. Time period dummy

variables are negative and highly significant in all Baltic countries which means, that the relationship between the stock market and macroeconomic variables is different during the economic downturn and growth.

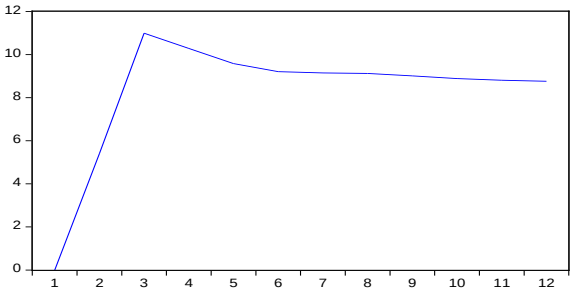
Table 6 Results of VEC Granger causality/Block exogeneity Wald test for the Baltic countries

Causality		Lithuania	Latvia	Estonia
From	To			
Production	Stock index	1.01	0.37	10.09***
Money supply	Stock index	3.72	10.64***	7.59*
Unemployment	Stock index	0.43	3.52	7.28**
Interest rate	Stock index	2.32	1.94	6.41**
Stock index	Production	3.38	0.34	0.82
Stock index	Money supply	1.69	0.11	0.70
Stock index	Unemployment	1.55	1.79	0.70
Stock index	Interest rate	1.07	1.11	0.29

Notes: *The values in the table indicate the χ squared test statistics. *,** and *** are the 10%, 5% and 1% confidence levels.*

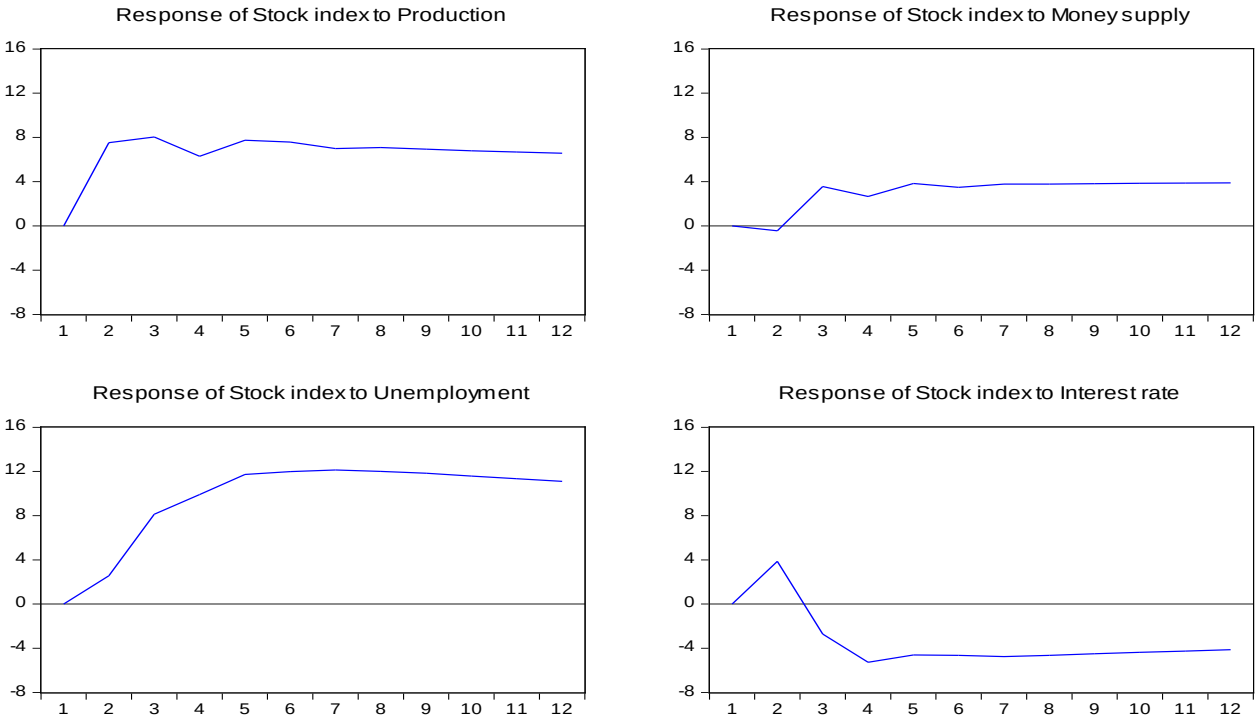
The impulse response functions which are obtained from the estimated VECM illustrate the magnitude of the impact of different macroeconomic variables on stock returns. Figure 1 shows the response of Latvia's stock market to the shock to Latvia's money supply. This is the only statistically significant relationship which is found in VECM. The stock market's reaction is positive throughout the period peaking after three months from the initial shock and then decreasing. The initial shock is very persistent and does not die out throughout the period of twelve months.

Figure 1 Impulse response function of Latvia's stock index to a shock of one Cholesky standard deviation in money supply



Granger causality test shows that all four macroeconomic variables have a significant short-term impact on the Estonia's stock market. The impulse response functions to the shocks in these variables are presented in Figure 2.

Figure 2 Impulse response function of Estonia's stock index to a shock of one Cholesky standard deviation in production, money supply, unemployment and interest rate



The stock market index responds positively to the shocks to production and unemployment throughout one year period. The response to a shock in money supply is negative (but close to zero) in the first three months and then stays positive throughout the period. Interest rate shocks have a positive impact in the first two months but the response becomes negative for a remainder of the year. Neither impulse response dies out quickly – all of them persist throughout the year.

From the VECM results, we can state, that the Estonia's stock market incorporates the most information from the macroeconomic environment into the stock index. However, only Latvia demonstrates a significant long-term relationship between stock market and economic activity. Lithuania's stock index does not show neither long-term nor short-term responses to the macroeconomic variables.

4.3.2 Western European countries

The results for the main VECM equation of the three economically developed European countries where the dependent variable is the stock market index are stated in Table 7. All three models indicate no significant serial correlation between the residuals. However,

heteroscedasticity and normality tests show the same problems as in the models for the three Baltic states. The estimation efficiency is lowered by the presence of heteroscedasticity and excess skewness and kurtosis in the residuals.

Table 7 Results of VECM for the three Western European states

Variables	Germany	Italy	UK
Error correction term	-0.01	0.02	-0.11***
Stock index (-1)	0.11	-0.06	-0.13*
Stock index (-2)	-0.10	-0.09	-0.07
Stock index (-3)	0.01	0.08	0.04
Stock index (-4)	-	0.06	0.03
Stock index (-5)	-	-0.02	-
Production (-1)	-15.93	-43.96	66.08***
Production (-2)	-18.32	-4.90	59.93***
Production (-3)	2.92	-19.95	36.31*
Production (-4)	-	20.82	20.64
Production (-5)	-	-29.01	-
Money supply (-1)	-0.17	0.00	0.01*
Money supply (-2)	-0.60	0.01	0.00
Money supply (-3)	1.17	-0.01	-0.01
Money supply (-4)	-	0.00	-0.01*
Money supply (-5)	-	0.00	-
Unemployment (-1)	144.79	-387.74	-101.58
Unemployment (-2)	-245.90**	-759.11	-279.03
Unemployment (-3)	178.32*	-300.95	-353.21**
Unemployment (-4)	-	346.35	-35.56
Unemployment (-5)	-	1009.55*	-
Interest rate (-1)	724.50**	2741.33**	34.14
Interest rate (-2)	-667.56**	-2203.68	-128.00
Interest rate (-3)	333.70	701.19	-42.91
Interest rate (-4)	-	178.49	-155.86
Interest rate (-5)	-	-2335.33**	-
Intercept	52.52	-33.80	111.79**
Dummy	-214.37**	-1045.31**	-337.54***
R – squared	0.12	0.21	0.24
Adjusted R – squared	0.04	0.08	0.14
F – statistic	1.40	1.63	2.41

Notes: *The values in the table indicate the slope coefficients of the explanatory variables. *,** and *** are the 10%, 5% and 1% confidence levels.*

The estimation results show, that there exists a highly significant long-term relationship between the macroeconomic variables and stock market index in the UK. The error correction term is -0.11 which means an 11% adjustment per month. The speed of adjustment for the UK is higher than in Latvia which indicated, that the stock index adjusts more quickly to the equilibrium relationship with the macroeconomic environment. Germany and Italy do not exhibit this long-term relationship. What is more, the VECM shows a significant

autocorrelation in the stock index for the UK and the time period dummy variable is highly significant in all three countries. This result is consistent with the one which is observed in the Baltic countries.

Following the same procedure as in the previous subchapter, the short run relationship between the stock market and combined lags of macroeconomic variables is additionally examined using the Granger causality test. The result of the test is shown in Table 8. The only macroeconomic factor which affects Germany's and Italy's stock markets is the interest rate. UK's stock market is being influenced by three out of four macroeconomic variables – production, money supply and unemployment. The UK is the only country in the sample which has a highly significant causality from stock index to the production, unemployment and interest rate which implies that the stock market movements could be used to predict the changes these macroeconomic variables.

Table 8 Results of VEC Granger causality/ Block exogeneity Wald test for the three Western European states

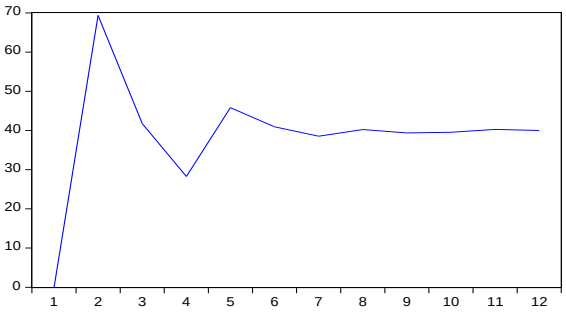
Causality		Germany	Italy	UK
From	To			
Production	Stock index	0.92	0.54	14.59***
Money supply	Stock index	0.20	2.87	11.07**
Unemployment	Stock index	5.32	4.63	8.33*
Interest rate	Stock index	7.66*	14.27**	5.48
Stock index	Production	5.00	6.62	9.61**
Stock index	Money supply	3.70	6.07	2.99
Stock index	Unemployment	0.78	6.34	7.84*
Stock index	Interest rate	4.21	3.73	12.64**

Notes: *The values in the table indicate the χ squared test statistics. *,** and *** are the 10%, 5% and 1% confidence levels.*

The lack of significant short-term relationships between Germany and Italy can be in part explained using the same argument as for the long-term relationship. The impulse response function in Figure 3 illustrates the reaction of the German stock market index to the shock in the interest rate. The reaction to the shock peaks during the second month after the initial impulse and then reduces but does not die out during the year. Throughout the period, the shock in interest rate has a positive impact on the stock market which is in contrast to the previous studies like Kenourgios and Samitas (2007) which found this relationship negative. One explanation could be, that the expected economic growth and the growth in future cash flows are expected to compensate for the higher interest rates which are interpreted as a

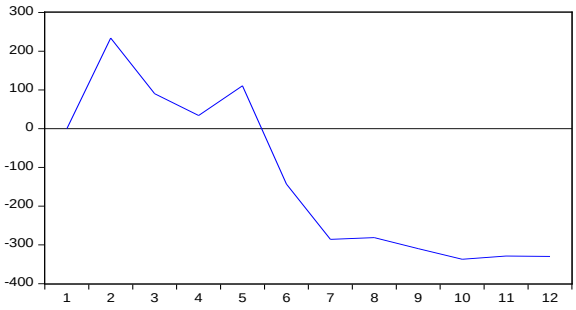
discount factor. In this case, the increase in interest rate is translated into the higher expectations of future growth.

Figure 3 Impulse response function of Germany's stock index to a shock of one Cholesky standard deviation in interest rate



The reaction of Italy's stock index to the shock in interest rate is different than Germany's (Figure 4). Although the response peaks at the second month after the initial shock, the reaction only stays positive until the fifth month. The remainder of the year the response is negative and does not die out. This means that the markets might have lower confidence in future economic growth.

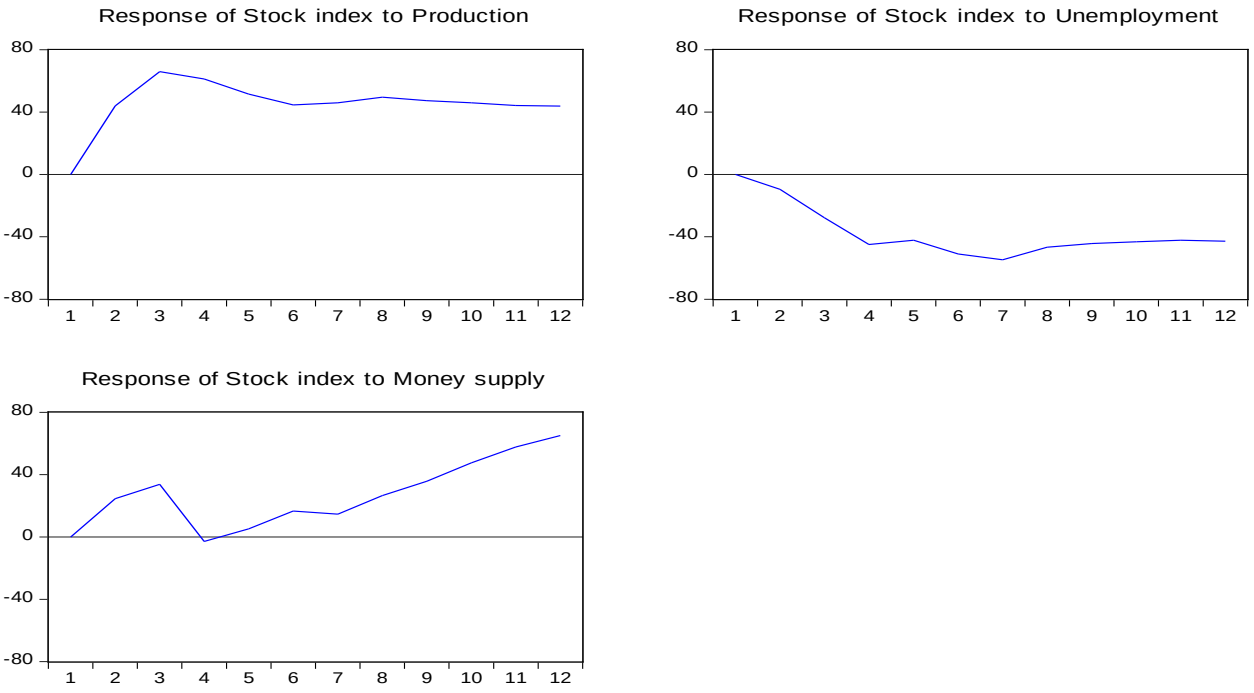
Figure 4 Impulse response function of Italy's stock index to a shock of one Cholesky standard deviation in interest rate



According to the Granger causality tests, UK's stock market depends on the three macroeconomic variables. The impulse responses to these variables are in Figure 5 below. Production has a positive impact on the stock market growth throughout the period of one year with a peak at the third month after the initial shock. This is in line with the study of Masuduzzaman (2012), Kenourgios and Samitas (2007) and is the same as in Estonia. Contrary to a study by Boyd et al. (2005), unemployment has a negative impact on the UK's stock market throughout one year period. This might suggest that UK's economy is in the economic downturn. However, the more likely explanation might be that the rising unemployment increases market's expectations of lower future demand for production which in turn diminishes expected future cash flows and overall stock prices. Money supply has an

overall positive influence on the stock price throughout the year – the result is consistent Lastrapes (1998) findings.

Figure 5 Impulse response function of UK's stock index to a shock of one Cholesky standard deviation in production, money supply and unemployment



The results of the estimations which are obtained from VECM show that the UK's stock market is the most integrated with macroeconomic variables of all three economically developed European countries. It is the only country of the three which exhibits both short-term and long-term relations between the prior mentioned variables. However, it is also the only country which shows autocorrelation in the stock market index which might indicate the lack of market efficiency.

4.3.3 Comparison between Baltic states and Western European countries

The results from the VECM do not show significant differences in the number of the macroeconomic stock market determinants between the Baltic states and more economically developed Western European countries. The ECT is significant in one out of three countries in both sample groups – Latvia and UK. The speed of adjustment to the long-term equilibrium is higher in the UK than in Latvia which means, that UK's stock market adjusts to the long-term equilibrium with the macroeconomic environment more quickly than Latvia's. Money supply is the dominant factor in explaining the changes in the stock market in the Baltic

countries and interest rate – in Western European countries. These variables are significant in two out of three countries in the corresponding groups. The additional presence of autocorrelation in the stock market index exists in two out of three Baltic and one out of three Western European countries, which suggest a higher lack of efficiency in the Baltic markets according to EMH.

More developed markets should play a bigger role in the countries' economy than lesser markets. Surprisingly, most of the Western European countries (except the UK) do not exhibit significant causal relationships from the stock market to the macroeconomic environment. This might suggest that the stock markets in these countries are not that significant to the overall economy during the analysed period.

4.4 Granger causality results

The results from VECM reveals that the dummy variables are significant for all sample countries therefore, it is important to analyse these periods separately. The Granger causality test is applied as not all variables are integrated of the same order during the split sample (three periods: before, during and after the financial crisis) (Appendix C). The optimal number of lags is selected according to Akaike information criterion. Due to a very small sample during the economic downturn, it is impossible to apply causality test for this period because the power of the test is too low. In the first part of the subchapter, we analyse results for each Baltic country. In the second part, we shift our attention to the three economically developed European countries. Finally, we compare the results.

4.4.1 Baltic countries

The results of the test for Baltic countries are reported in Table 9 with an optimal lag length selected. The output from the test for Lithuania which covers the period before the economic downturn provides evidence of unidirectional causality from stock index to the money supply. This finding is inconsistent with the empirical results from New Zealand case (Gan et al. 2006) where the stock index does not Granger cause other macroeconomic variables. The main argument for that result is that New Zealand market is small. The most surprising aspect is that according to MSCI (2010) Lithuania stock market is considered to be small and is not

well developed before the economic crisis, but Granger causality from the stock index to money supply occurs under 1% significance level. The significant variable which determines stock index after the financial crisis is interest rate under 1% significance level. There is no bi-directional causality between variables. The main reason why just a few causalities from the stock market to the macroeconomic variables are identified could be that Lithuanian market is not well developed.

Table 9 Granger causality test results for the three Baltic countries

Causality		Lithuania		Latvia		Estonia	
From	To	F-statistic	Optimal lag	F-statistic	Optimal lag	F-statistic	Optimal lag
2000.01 - 2007.05							
Production	Stock index	1.78	5	0.00	1	2.01*	5
Money supply	Stock index	1.22	2	3.31**	3	0.90	6
Unemployment	Stock index	0.02	1	2.61**	5	-	0
Interest rate	Stock index	0.08	1	-	0	0.33	3
Stock index	Production	1.10	5	1.19	1	1.69	5
Stock index	Money supply	15.96***	2	1.69	3	2.01*	6
Stock index	Unemployment	0.04	1	0.81	5	-	0
Stock index	Interest rate	0.08	1	-	0	2.29*	3
2009.04 - 2016.01							
Production	Stock index	0.24	1	-	0	3.73**	3
Money supply	Stock index	-	0	-	0	2.52	1
Unemployment	Stock index	0.62	2	0.04	2	2.46*	2
Interest rate	Stock index	3.14***	6	0.43	6	6.24***	5
Stock index	Production	0.93	1	-	0	0.03	3
Stock index	Money supply	-	0	-	0	0.11	1
Stock index	Unemployment	0.19	2	0.77	2	0.34	2
Stock index	Interest rate	1.61	6	2.41**	6	3.07**	5

Notes: **,** and *** are the 10%, 5% and 1% confidence levels. The variables' level of integration is according to the ADF test results. For Latvia the first period is from the July 2003.*

The Granger causality test results are different for Latvia. The unemployment and money supply are two variables which Granger cause stock index under 5% significance level before the crisis. This is consistent with the results from the Brahmasrene (2007) study which finds that money supply Granger causes stock index. The results after the economic downturn are different. Only stock index Granger causes interest rate under 5% confidence level. Some causal relationships cannot be checked as AIC information criterion shows zero lags. More significant causalities are identified for Latvia than for Lithuania, which is in line with VECM results for the full period. No bi-directional causalities exist.

The most unidirectional causalities between variables are found for Estonia compared to other Baltic countries. The finding shows that there is the causal relation between production, money supply, stock index, and interest rate under 1% significance level before the crisis. After the crisis industrial production index, unemployment and interest rate are influencing stock market index under different significance levels. However, bi-directional causality exists between interest rate and stock index after the economic downturn. Taken together, these results suggest that macroeconomic variables, as well as, the stock market play an important role in the economy of Estonia.

4.4.2 Western European countries

The results of Granger causality test for Western European countries are displayed in Table 10.

Table 10 Granger causality test results for the three Western European countries

Causality		Germany		Italy		UK	
From	To	F-statistic	Optimal lag	F-statistic	Optimal lag	F-statistic	Optimal lag
2000.01 - 2007.05							
Production	Stock index	0.87	5	0.91	2	0.62	1
Money supply	Stock index	2.15*	6	3.16**	3	6.01**	1
Unemployment	Stock index	0.76	6	-	0	-	0
Interest rate	Stock index	3.49***	5	3.16**	5	1.98	1
Stock index	Production	3.23**	5	5.27***	2	0.08	1
Stock index	Money supply	2.80**	6	1.60	3	5.47**	1
Stock index	Unemployment	0.96	6	-	0	-	0
Stock index	Interest rate	3.13**	5	1.88	5	5.12**	1
2009.04 - 2016.01							
Production	Stock index	0.89	2	0.00	1	-	0
Money supply	Stock index	-	0	0.50	2	3.18**	2
Unemployment	Stock index	0.98	6	-	0	1.20	1
Interest rate	Stock index	0.26	2	0.83	2	1.46	2
Stock index	Production	0.12	2	2.56	1	-	0
Stock index	Money supply	-	0	3.14**	2	0.38	2
Stock index	Unemployment	1.85	6	-	0	4.39**	1
Stock index	Interest rate	2.02	2	1.08	2	1.44	2

Notes: **,** and *** are the 10%, 5% and 1% confidence levels. The variables' level of integration is according to the ADF test results.*

The results for Germany show that two bi-directional causalities occur between money supply, interest rate and stock index before crisis under different significance levels. Moreover, a unidirectional causality exists running from stock index to production implying

that the stock market index can be used to predict industrial production index before the crisis. This can be explained by higher returns which attract more investors and consequentially leading to increase in industrial production index. One unanticipated finding is that after the crisis there are no significant Granger causality relationships.

The results of Granger causality test for Italy display that more causal relationships are found before the crisis which is consistent with the results from the Germany's case. Three Granger causality relationships exist between these variables: industrial production index (causality occurs from a stock index), money supply and interest rate. These findings suggest that macroeconomic variables are more important to predict stock index before the crisis. After the crisis, only stock index can be used to predict money supply.

The results of Granger causality test for the UK reveal that bi-directional causality exists between money supply and stock index and unidirectional between stock index and interest rate under 5% confidence level before the economic downturn. After the crisis, different causalities occur: the unidirectional relationship between the stock index and unemployment and no bi-directional causality between money supply and stock index.

4.4.3 Comparison between Baltic states and Western European countries

The macroeconomic factors have a stronger influence on the stock markets in Baltic countries (except Latvia) in the period after the economic crisis. Different results are obtained for the Western European countries. The macroeconomic variables in these three countries have a stronger influence on the stock market before the economic downturn. One possible explanation could be that after the financial crisis investors were more focused on other factors which determine stock return and not macroeconomic variables. Most Granger causalities are noticed with money supply or interest rate for all sample countries.

Contrary to the VECM results, causal relationships from the stock market to macroeconomic variables are found in the subsample periods. More of these relationships are found in the Western European countries than in Baltic states before the financial crisis. This could indicate that the Western European countries' stock market is more important for their overall economies than in the Baltic states during January 2000 – May 2007 period. However, the number of these relationships are reduced after the crisis in both sample groups which is a sign of the smaller influence of the stock markets' on the countries' economy after the crisis.

Most Granger causalities are noticed with money supply or interest rate for all analysed countries.

5 Conclusion

This thesis aims to investigate in finding short-term and long-term causal relationships between macroeconomic variables and three Baltic countries' stock markets. The results are compared with three Western European countries – Germany, Italy and UK. The main techniques which are in our thesis are cointegration analysis (Johansen cointegration test), VECM and Granger causality test. The four macroeconomic variables are chosen: the economic activity (industrial production index), unemployment, interest rates, and money supply as these variables are most widely used in the previous research papers.

In order to use Johansen cointegration test, Augmented Dickey-Fuller test is applied because this test requires that variables will be integrated of the same order. The findings are that all variables are integrated of the same order during the full sample. The different results are obtained when the sample is divided into three periods – before, during and after the financial crisis. Johansen cointegration test which is applied for full period reveals that a long-term relationship exists between variables in all sample countries.

The main findings from VECM are that the number of significant determinants of the stock market index is not higher in developed Western European countries. The results are as follow: for Latvia ECT which determines the long-term relationship and money supply and for Estonia all four macroeconomic variables are statistically significant. The autocorrelation present in the stock market index suggests that Lithuania's and Latvia's markets are not entirely efficient according to the weak form of EMH. The findings are different for Western European countries: for Germany and Italy, only interest rate has a significant relationship with the stock market while for the UK three variables – production, money supply and unemployment are significant. Additionally, VECM indicates autocorrelation present in the UK's stock market index prices which might be a sign of some inefficiency in the market. The lack of causal relationships from the stock market to the macroeconomic variables in most countries (except the UK) could also indicate that the stock markets are not a very significant determinant of the countries' economic environment.

One of the major findings from Granger causality test which is applied for two subsamples – before and after the economic downturn, is that more significant causal relationships from macroeconomic variables to stock index occur after the financial crisis in Lithuania and Estonia. What is more, different findings are obtained for the Western European countries as more significant relationships are found before the crisis. The number of significant causal relationships from the stock index to macroeconomic variables is greater in the period before the crisis in both sample groups. The overall number of these relationships is larger in the Western European states. The dominant Granger causality variables are money supply and interest rate.

The main contribution of our study begins with the literature. We contribute to a clear gap where the Baltic states are lacked in research. Hence, further research can benefit in this area. A further contribution is made through the results as macroeconomic variables such as money supply, unemployment, interest rate, and industrial production index significantly influence stock market indexes. Finally, the study contributes to the practical sense as to give investors some insight into which macroeconomic factors affect the Baltic countries' stock market indices and see how the impact differs for the Western Europe countries which have better-developed markets.

To sum up, this research extends our knowledge of macroeconomic factors influence on Baltic counties' stock markets. One possible recommendation for future research is to include a larger sample of data in order to avoid biased results. Another contribution would be to add more macroeconomic variables to analyse relationships between the Baltic stock markets and other factors, for example, fiscal policy or international trade.

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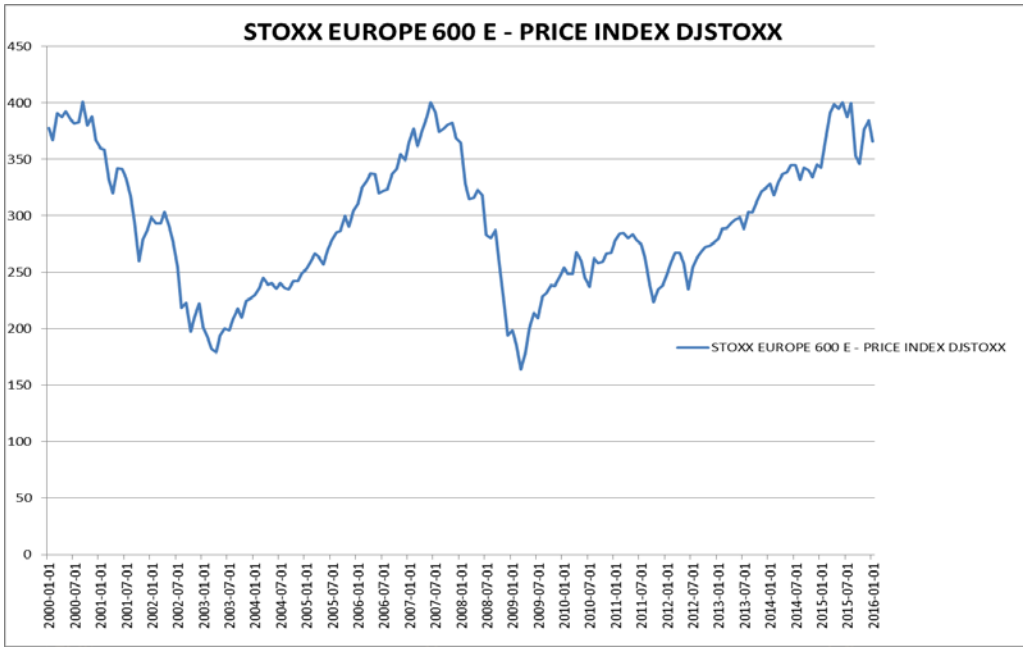
Appendix A

Figure 1 European stock index performance



Appendix B

Table 1 Descriptive statistics of macroeconomic variables

	Lithuania				Latvia				Estonia			
	Production	Money supply	Unemployment	Interest rate	Production	Money supply	Unemployment	Interest rate	Production	Money supply	Unemployment	Interest rate
Mean	96.66	10,512.66	9.05	3.29	106.54	7,928.61	9.47	3.34	99.37	6,659.44	9.85	2.94
Median	100.19	11,889.90	9.90	2.68	109.00	8,719.50	8.70	2.57	102.90	7,685.50	9.70	2.61
Maximum	128.29	21,992.70	15.30	14.23	124.80	11,506.60	17.30	17.03	135.00	12,703.00	19.20	7.84
Minimum	54.30	2,545.40	2.70	(0.15)	85.10	2,881.20	4.80	0.17	56.70	1,640.20	4.00	(0.15)
Std. Dev.	18.10	5,261.86	3.40	2.63	9.54	2,289.62	2.98	3.55	23.17	3,202.13	3.56	2.22
Skewness	(0.65)	0.10	(0.35)	0.92	(0.58)	(0.94)	0.65	1.28	(0.21)	(0.06)	0.34	0.30
Kurtosis	2.41	2.05	2.03	3.72	2.29	2.71	2.93	4.16	1.75	1.72	2.50	1.91
Jarque-Bera	16.45	7.54	11.59	31.64	11.57	22.95	10.56	49.97	14.10	13.37	5.75	12.45
Probability	0.00	0.02	0.00	-	0.00	0.00	0.01	-	0.00	0.00	0.06	0.00
	Germany				**Italy**				**UK**			
	Production	Money supply	Unemployment	Interest rate	Production	Money supply	Unemployment	Interest rate	Production	Money supply	Unemployment	Interest rate
Mean	99.55	1,762.16	8.66	2.18	106.11	969,754.80	8.98	2.18	107.49	1,045,839.00	6.09	3.08
Median	100.40	1,728.20	8.50	2.13	111.80	981,615.00	8.50	2.13	110.70	1,087,332.00	5.50	3.91
Maximum	110.80	2,633.60	12.70	5.11	121.90	1,374,261.00	13.10	5.11	116.80	1,587,464.00	8.50	6.58
Minimum	85.60	1,266.30	6.00	(0.15)	90.10	567,952.00	5.70	(0.15)	97.10	551,101.00	4.70	0.48
Std. Dev.	7.57	402.45	1.74	1.63	10.76	247,096.20	1.96	1.63	6.02	298,982.60	1.25	2.19
Skewness	(0.07)	0.44	0.30	0.24	(0.25)	(0.09)	0.54	0.24	(0.16)	(0.02)	0.64	(0.01)
Kurtosis	1.35	1.91	1.96	1.77	1.39	1.67	2.20	1.77	1.37	1.83	1.72	1.33
Jarque-Bera	22.06	15.73	11.52	14.01	22.91	14.40	14.71	14.01	22.20	10.93	26.33	22.50
Probability	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Appendix C

Table 1 Augmented Dickey-Fuller test results for Lithuania (split sample)

Variable	2000.01 - 2007.05			2007.06 - 2009.03			2009.04 - 2016.01		
	Test statistic		Integration	Test statistic		Integration	Test statistic		Integration
	Level	First difference		Level	First difference		Level	First difference	
Stock index	-1.84	-7.45***	I(1)	-2.38	-4.16**	I(1)	-2.77	-8.41***	I(1)
Production	-5.40***	-	I(0)	-0.88	-3.34***	I(1)	-5.74***	-	I(0)
Money supply	8.62	2.37	I(2)	-0.84	-4.34**	I(1)	-1.62	-8.34***	I(1)
Unemployment	-2.83	-6.33***	I(1)	-2.02	-2.54**	I(1)	-3.82**	-	I(0)
Interest rate	-0.18	-3.30**	I(1)	-2.07	-2.99***	I(1)	-2.92***	-	I(0)

Table 2 Augmented Dickey-Fuller test results for Latvia (split sample)

Variable	2003.07 - 2007.05			2007.06 - 2009.03			2009.04 - 2016.01		
	Test statistic		Integration	Test statistic		Integration	Test statistic		Integration
	Level	First difference		Level	First difference		Level	First difference	
Stock index	-0.95	-5.92***	I(1)	-2.51	-3.76**	I(1)	-2.44	-8.60***	I(1)
Production	-2.02	-2.61**	I(1)	-0.81	-5.40***	I(1)	-2.07	-10.49***	I(1)
Money supply	-1.46	-8.47***	I(1)	-0.32	-4.19**	I(1)	-1.68	-9.43***	I(1)
Unemployment	-1.93	-1.07	I(2)	2.6	-0.39	I(2)	-3.61**	-	I(0)
Interest rate	0.79	-5.28***	I(1)	-0.15	-3.21***	I(1)	-2.7***	-	I(0)

Table 3 Augmented Dickey-Fuller test results for Estonia (split sample)

Variable	2000.01 - 2007.05			2007.06 - 2009.03			2009.04 - 2016.01		
	Test statistic		Integration	Test statistic		Integration	Test statistic		Integration
	Level	First difference		Level	First difference		Level	First difference	
Stock index	-1.56	-10.10***	I(1)	-3.2	-4.90***	I(1)	-2.61	-8.88***	I(1)
Production	-4.68***	-	I(0)	-0.36	-6.77***	I(1)	-3.46**	-	I(0)
Money supply	9.3	0.5	I(2)	1.72	-6.14***	I(1)	-1.19	-13.97***	I(1)
Unemployment	-3.05	-11.28***	I(1)	0.65	-4.48**	I(1)	-3.27*	-	I(0)
Interest rate	0.88	-4.91***	I(1)	-2.77	-4.06**	I(1)	-3.67***	-	I(0)

Table 4 Augmented Dickey-Fuller test results for Germany (split sample)

Variable	2000.01 - 2007.05			2007.06-2009.03			2009.04 - 2016.01		
	Test statistic		Integration	Test statistic		Integration	Test statistic		Integration
	Level	First difference		Level	First difference		Level	First difference	
Stock index	-0.21	-9.11***	I(1)	-1.67	-3.53***	I(1)	-2.95	-8.58***	I(1)
Production	2.18	-5.13***	I(1)	-0.42	-3.72**	I(1)	-3.47**	-	I(0)
Money supply	-1.61	-7.76***	I(1)	-2.52	-2.23	I(2)	-2.77	-7.51***	I(1)
Unemployment	-0.07	-0.57	I(2)	-2.39	-2.76*	I(2)	-3.77***	-1.02	I(2)
Interest rate	-0.29	-3.85***	I(1)	-0.95	-1.73*	I(2)	-2.14	-4.24***	I(1)

Table 5 Augmented Dickey-Fuller test results for Italy (split sample)

Variable	2000.01 - 2007.05			2007.06-2009.03			2009.04 - 2016.01		
	Test statistic		Integration	Test statistic		Integration	Test statistic		Integration
	Level	First difference		Level	First difference		Level	First difference	
Stock index	-0.07	-10.57***	I(1)	-1.46	-5.91***	I(1)	-1.99	-8.71***	I(1)
Production	0.53	-9.79***	I(1)	-0.21	-3.09	I(2)	-3.06	-13.03***	I(1)
Money supply	-5.50***	-	I(0)	-2.55	-4.43**	I(1)	3.75	-4.00***	I(1)
Unemployment	-2.71	-11.16***	I(1)	-4.13**	-	I(0)	1.65	-9.04***	I(1)
Interest rate	-0.29	-3.85***	I(1)	-0.95	-1.73**	I(1)	-2.14	-4.24***	I(1)

Table 5 Augmented Dickey-Fuller test results for UK (split sample)

Variable	2000.01 - 2007.05			2007.06-2009.03			2009.04 - 2016.01		
	Test statistic		Integration	Test statistic		Integration	Test statistic		Integration
	Level	First difference		Level	First difference		Level	First difference	
Stock index	-1.28	-11.65***	I(1)	-1.57	-4.98***	I(1)	-3.30*	-10.33***	I(1)
Production	-2.43	-13.97***	I(1)	-1.01	-5.08***	I(1)	-2.24	-8.66***	I(1)
Money supply	-2.4	-13.61***	I(1)	3.06	-3.17***	I(1)	13.01	-1.29	I(2)
Unemployment	-2.01	-8.55***	I(1)	0.01	-6.12***	I(1)	-1.49	-8.18***	I(1)
Interest rate	-1.12	-5.58***	I(1)	-0.82	-3.34*	I(2)	-4.02**	-	I(0)