Theoretical and Applied Economics
Volume XXVI (2019), No. 2(619), Summer, pp. 139-148

Exploring the nexus between macroeconomic variables and stock market returns in Germany: An ARDL Co-integration approach

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Abstract. *This study examines the interaction between macroeconomic variables and stock return in Germany for the period spam from 1990:Q1 to 2016:Q1. We employing bounds testing procedure proposed by Pesaran et al. (2001) and the Autoregressive distributed lag approach has been applied as yields consistent estimates of the long-run coefficients that are asymptotically normal irrespective of whether the underlying regressors are I(0) or I(1). Empirical results reveal that exchange return, the M3 aggregate and the oil return in Germany have positive and no significant impact on stock return. However, the interest rate has a negative and significant impact on stock return. The effect of CPI on stock return is positive and significant. The value of lagged ECM is negative and significant at 10% level of significance. The value of lag ECM is -0.1418 which show the speed of convergent towards equilibrium.*

Keywords: macroeconomics variable, stock price and ARDL Co-integration approach.

JEL Classification: C13, C22, C32.

1. Introduction

The interaction between the equity market and macroeconomic variables has always attracted the curiosity of academicians and practitioners as it has an innate appeal.

In the literature, it is suggested that macroeconomic fundamentals act on stock market prices. Asprem (1989) demonstrates that interest rate variations have considerable impact on the discount rate through their effects on the risk free nominal rate. Consequently, when the interest rate increases investors incur capital losses and leave the equity market. Interest rates exercise an impact on firms' operations. Indeed, any interest rate increase causes capital loss amplification. Consequently the firm has to exercise the labor force to generate higher yields in a high interest rate environment. Otherwise, interest expenditure related to inflation 2 destroys profits. If the interest rates increase so much that the firm cannot pay off its debt, the survival of the company will be endangered. In this case, investors will ask for an even higher risk premium."

In economic theory, there is no unified opinion on the relationship between stock returns and inflation. Fisher (1930) argues that inflation causes an increase in the nominal stock return. Bodie (1976) suggest that stock investment acts as an effective hedge against inflation. Moreover, some authors argument the presence of negative relationship between inflation and stock prices. An increase in inflation will result in high money supply. When the money in circulation decreases, demand remaining the same nominal interest rate will rise. An increase in discount rate will result in a decrease in stock prices. Inflation is measured in term of GDP deflator and consumer price index (CPI). Some authors using consumer price index to measure inflation rate. CPI measures changes in the prices of basket of consumer goods in a given time period.

A negative relationship between inflation and stock prices is discussed in the literature because an inflation rate increase is accompanied by a lower expected earnings growth and higher required real yields. A theoretical explanation was given by the literature concerning the negative relation between inflation and stock market prices. The objective of the central banks is the stability of prices, thus they control for the inflation level. Inflation indicator increase (decrease) (Consumer Price Index for example) causes a rise (decline) in the anticipated real inflation. Pearce and Roley (1985) show that this is a political restrictive sign by the central bank. So the inflation rate level increase involves a restrictive monetary policy, allowing increasing future cash-flows discount rate but do not act directly on the latter. The relationship between money supply and stock prices is documented by many studies. Increased nominal money supply results in a portfolio rebalancing. An increase in demand for equity shares will result in a rise in stock prices. Bernanke and Kuttner (2005) suggest that a rise in the discount rate decreases the present value of the future cash flows on the investment and results in a drop in the stock prices.

In this study, we use M3 as a proxy for money supply which is considered as narrow money which consists of currency plus demand deposits. Interaction between the foreign exchange market and the stock market is analyzed through two theoretical approaches: the "stock oriented" approach (e.g. Branson, 1983; Frankel, 1983) and the "flow oriented" approach (e.g. Dornbush and Fisher, 1980). In the first approach, the foreign exchange rate is

determined by the demand and supply of financial assets such as equities and bonds. In the second approach, the exchange rate is determined by a country's current account balance or trade balance. Flow oriented models provides a positive interaction between stock price and foreign exchange rate.

The empirical evidence on the stock price – macroeconomic variable relationships has been document by numerous studies. For example, Spyrou (2004) examined the interaction between stock return and inflation for 10 selected emerging markets. For Mexico, he found that the relationship was insignificant during 1989M1–1995M12, 1989M1–2000M8, and 1995M12–2000M6. Husain (2006) examines the causal relationship stock market prices and Pakistani real sector by using annual data from 1960 to 2004. He found a causal relation between variables with several econometric techniques such as ECM, Engle and Granger cointegration, and the unit root tests. These researches indicate the presence of long-run relationship between the stock prices and real sector variables.

Rahman et al. (2009) used the VAR/VECM framework and explored the interaction between selected macroeconomic variables and stock prices for the case of Malaysia. They found that changes in the Malaysian stock market index do form a cointegrating relationship with changes in interest rates, exchange rate, money supply, reserves and industrial production index. Aloui and Jammazi (2009) combine a wavelet analysis and Markov regimes witching models (MS-VAR) and prove that the stock market reaction of three developed countries like France, Japan and UK to shocks affecting oil prices is asymmetric. In US, Odusami (2009) shows that oil price unexpected shocks have an asymmetric and non linear impact on stock returns.

More recently, Mohd Hussin et al. (2012) using the VECM methodology to examine the relationship between the development of Islamic stock market and macroeconomic variables in Malaysia. Their findings showed that Islamic stock price is negatively related with exchange rates and money supply and significantly and positively related with Consumer Price Index and Industrial production Index. In the other hand, Pierdzioch and Kizys (2012) compared the linkages between the stock markets in three NAFTA countries, namely, the U.S., Mexico and Canada based on the fundamentals and speculative bubbles. They showed that the fundamentals have stronger effects on stock prices than the speculative bubbles. P. Bhannu Sirresha (2013) uses a linear regression technique and investigates the effect of selected macroeconomic factors on the movements of the Indian stock market, Nifty including gold and silver prices. He found an interdependent relationship between the returns on stock, gold commodities and silver commodities.

Yu Hsing (2014) explored the interaction between the Estonian stock market and some macroeconomic factors and found that the index is positively affected by real gross domestic 3 product, the debt to GDP ratio and the stock market index in Germany. However, the index is negatively associated with interest rates for borrowing, the expected rate of inflation, domestic lending and the exchange rate. Cyrus and Kirwa (2015), using co-integration and vector autoregressive techniques, investigated the dynamic relationship between major macroeconomic variables in Kenya and stock prices. Positive relationships were found between the Nairobi share prices (NSE), Treasury bill rate (TBR) and exchange

rate. However, the authors found a negative relationship between the consumer price index (CPI) and NSE performance.

The main objective of this paper is to modelise the interaction between stock market and macroeconomic variables in Germany using the ARDL co-integration approach. The rest of the paper is organized as follows. Section 2 presents the econometric methodology. Section 3 displays and discusses the empirical findings and their interpretation, while section 4 provides our conclusions.

2. Econometric methodology

In this paper, we study the interaction links between the stock returns and macroeconomic variables. We consider the raw nominal exchange rates series, market prices and macroeconomic fundamentals with quarterly frequency spams from 1990:Q1 to 2016:Q1. All data are sourced from (http//www.ocde.com) and (http//www.eia.com) and (http//www.federalreserves.gov).

We used the autoregressive distributed lag (ARDL) approach developed by Pesaran and Shin (1999) and re-assessed by Pesaran et al. (2001) to analyze the short and long run linkages between selected variables. The ARDL model provides some advantages over traditional methods for evaluate short-run and long-run linkages and co-integration. The first advantage is that ARDL model can be applicable without investigating the order of integration (Pesaran and Pesaran, 1997). The second advantage of ARDL bound testing is that unrestricted model of ECM seems to take satisfactory lags that captures the data-generating process in a general-to-specific framework of specification (Laurenceson and Chai, 2003).

In order to analysis the causal relationship among macroeconomic variables and stock market returns in Germany, the ARDL approach is used, which is defined as follows in equation (1).

$$\Delta y_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{it}\, \Delta y_{i,t-i} + \sum_{i=0}^{p} b_{it}\, \Delta EURUSD_{i,t-i} + \sum_{i=1}^{n} c_{it}\, \Delta CPI_{i,t-i} + \sum_{i=1}^{n} d_{it}\, \Delta INTEREST\ RATE_{i,t-i} + \sum_{i=1}^{n} e_{it}\, \Delta M3_{i,t-i} + \sum_{i=1}^{n} f_{it}\, \Delta OIL_{i,t-i} + \beta_{1i} EURUSD_{t-i} + \beta_{2i} CPI_{t-i} + \beta_{3i} INTEREST\ RATE_{t-i} + \beta_{4i} M3_{t-i} + \beta_{5i} OIL_{t-i} + \varepsilon_{it} \quad (1)$$

Where Δ is the first difference of variables.

In order to test for the reliability of a long run interaction between macroeconomic variables and stock returns, the OLS is used to estimate the equation (1) and then carry out an F-test for the joint significance of the coefficients of the lagged levels of some variables. The null hypothesis of no-co-integration between the variables in Eq (1) is:

$H_0: \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$

$H_1: \beta_1 \# \beta_2 \# \beta_3 \# \beta_4 \# \beta_5 \# 0$

We can estimate the short and long run interaction between macroeconomics variables and stock return in Germany. Equation (1) can be rewritten as the ECM version of ARDL model:

$$y_t = \alpha_0 + \sum_{i=1}^{P_1} \beta_1 y_{t-i} + \sum_{i=1}^{q_1} \beta_2 EURUSD_{t-i} + \sum_{i=1}^{q_2} \beta_3 CPI_{t-i} + \sum_{i=1}^{q_2} \beta_4 INTEREST\ RATE_{t-i} + \sum_{i=1}^{q_2} \beta_5 M3_{t-i} + \sum_{i=1}^{q_2} \beta_6 OIL_{t-i} + e_t \quad (2)$$

$$\Delta y_t = \delta_0 + \sum_{i=1}^{n} \delta_1 \Delta y_{t-i} + \sum_{i=1}^{n} \delta_2 \Delta EURUSD_{t-i} + \sum_{i=1}^{n} \delta_3 \Delta CPI_{t-i} + \sum_{i=1}^{n} \delta_3 \Delta INTEREST\ RATE_{t-i} + \sum_{i=1}^{n} \delta_3 \Delta M3_{t-i} + \sum_{i=1}^{n} \delta_3 \Delta OIL_{t-i} + + \delta_4 ECT_{t-i} + \mu_t \quad (3)$$

3. Empirical results

Table 1 report the empirical result of unit root test applied to determine the order of integration among time series data. ADF Test has been employed at level and first difference under assumption of constant and trend. Results indicate that macroeconomic variables and stock return series are stationary at the first difference. Therefore, it can be safely said that series are integrated of order one I (1) except ln (CPI) and ln (M3).

Table1. *Unit root test*

	ADF-TEST		Decisions
Variables	ADF-LEVEL	ADF-FIRST DIFF	
Ln(DAX30)	-2.319727	-10.32512*	I(1)
	(-3.453601)	(-3.454032)	
Ln(EURUSD)	-2.333486	-7.769707*	I(1)
	(-3.454032)	(-3.454032)	
Ln(CPI)	-3.785559*	------	I(0)
	(-3.454032)	------	
Ln(INTERESTRATE)	0.955968	-8.092090*	I(1)
	(-3.454471)	(-3.454471)	
Ln(M3)	-3.596796*	------	I(0)
	(-3.454032)	------	
Ln(OIL)	-2.922445	-10.88244*	I(1)
	(-3.453601)	(-3.454919)	

Note: * denote the significativity.

In the next step and after confirming the order of integration, we estimate the VAR lag length criteria to choose the optimal lag length. Table 2 reports the results of the optimal lag. We adopt the Akaike information criterion to determine the optimal lag. The AIC provide consistent and efficient results as compared to Hannan-Quinn information criterion (HQ) and SBC (Schwarz information criterion). According to results displayed in Table 2, there are one optimal lag for quarterly data series.

Table 2. Lag length criteria

VAR lag order selection criteria						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1.410236	NA	0.067913	0.148205	0.304515	0.211466
1	70.94570	134.5820*	0.016300*	-1.278914*	-1.096552*	-1.205109*
2	70.94859	0.005319	0.016631	-1.258972	-1.050558	-1.174623
3	71.30820	0.654495	0.016848	-1.246164	-1.011699	-1.151272
4	71.31254	0.007820	0.017189	-1.226251	-0.965734	-1.120815
5	72.19755	1.575309	0.017233	-1.223951	-0.937382	-1.107971

Notes: * indicates lag order selected by the criterion.

The presence of long-run relationship between macroeconomic variables and the stock returns in Germany is tested by employing the ARDL bounds testing approach.

Table 3 explains the empirical results of ARDL bound testing approach. The results indicate that the calculated F-statistic is that we reject the null hypothesis of no co-integration between variables, since calculated values of F-statistics for LnDAX30 (4.2286) is greater than I(0) bound critical value of 3.96 at the significance level of 5%. We employ the Akaike information criterion (AIC) to determine the optimal lag length for the model. Results indicate that variables are co-integrated which implies that there is a long-run relationship between variables.

Table 3. *ARDL Bound testing for cointégration*

Model	optimal lag lenght	F-Statistics	Bound critical values	outcome
lnDAX30= f (lneurusd, lncpi, lninterestrate, lnm3, lnoil)	(2,0,0,1,0,1)	4,2286*	3,96	cointegration

Note: * denotes the rejection of the unit root at 5% level of significance.

Table 4 report the results of long run analysis. The results showed that exchange return, the M3 aggregate and the oil return in Germany have positive and no significant impact on stock return. However, the interest rate has a negative and significant impact on stock return. The effect of CPI on stock return is positive and significant. For more details, the increase of 1 percent for CPI leads to improvement in 0.7508 and the appreciation of nominal exchange rate of 1 percent lead to improvement in 0.0179. In addition the increase of 1 percent for oil leads to improvement in 0.0005.

The F-statistics is positive and significant at 1%. This result indicates that the model is significant. The values of Durbin Watson confirm the absence of autocorrelation. R squared show that 96% of dependent variable is explained by the independent variables. The sensitivity analysis based on normality of residual term, the LM test for serial correlation and white heteroscedasticity indicate the no evidence of autoregressive conditional heteroscedasticity and the serial correlation and the evidence of white heteroscedasticity. To detect the stability long run parameters, we employed the cumulative sum and cumulative sum of square test. Figures 1 and 2 plot the COSUM and the COSUM of square in critical bounds at 5%. Results indicate the acceptance of the hypothesis of correct specification of regression model.

Table 4. *Long run analysis*

		Dependant variable: DAX30		
Constant	Coefficient	Std-Error	T-Statistics	prob
Ln(DAX30)	0.924766*	0.047601	19.42758	0.0000
Ln(EURUSD)	0.017973	0.132922	0.135211	0.8927
Ln(CPI)	0.750865*	0.423514	1.585728	0.0861
Ln(INTERESTRATE)	-0.074704*	0.035870	-2.082597	0.0399
Ln(M3)	0.033319	0.074662	0.446272	0.6564
Ln(OIL)	0.000589	0.000620	0.949161	0.3449
R-Squared	0.962208			
Durbin - Watson	2.055947			
F-Statistic	411.6154*			
Prob	0.0000			
Diagnostic tests				
	Statistics	Prob		
Breusch-Godfrey LM test	0.133241	0.7159		
White heteroscedasticity test	2.189075*	0.0044		
ARCH-Test	0.328849	0.5676		
Ramsey RESET test	2.240656*	0.0274		
CUSUM	stable			
CUSUM of Square	stable			

Note: * denote the significance at 10%.

The results of short run analysis are reported in Table 5. The results showed that exchange return, the M3 aggregate and the oil return in Germany have positive and no significant impact on stock return. However, the interest rate has a negative and significant impact on stock return. The effect of CPI on stock return is positive and significant.

The value of lagged ECM is negative and no significant at 10% level of significance. The value of lag ECM is -0.0418 which show the speed of convergent towards equilibrium. In addition, the diagnostic tests indicate that there is no heteroscedasticity and no serial correlation in short run. We employ the COSUM and the COSUM of square to test the stability of coefficient. We confirm that parameters are stable in short run.

Table 5. *Short run analysis*

		Dependant variable: FDI		
Constant	Coefficient	Std-Error	T-Statistics	Prob
Ln(DAX30)	0.933108*	0.053949	17.29596	0.0000
Ln(EURUSD)	0.004626	0.138979	0.033283	0.9735
Ln(CPI)	0.511194*	0.492154	1.445065	0.0717
Ln(INTERESTRATE)	-0.074261*	0.036311	-2.045122	0.0436
Ln(M3)	0.022403	0.080942	0.276785	0.7825
Ln(OIL)	0.000573	0.000631	0.907142	0.3666
ECM(t-1)	-0.1418	0.116143	-0.360549	0.0792
R-Squared	0.960841			
Durbin - Watson	1.987311			
F-Statistic	333.0048			
Prob	0.0000			
Diagnostic tests				
	Statistics	Prob		
Breusch-Godfrey LM test	0.169117	0.6818		
White heteroscedasticity test	2.319270	0.0016		
ARCH-Test	0.196142	0.6588		
Ramsey RESET test	2.257625	0.0263		
CUSUM	stable			
CUSUM of Square	stable			

Note: * denote the significance at 10%.

Figure 1. *Plot of cumulative sum of recursive residuals*

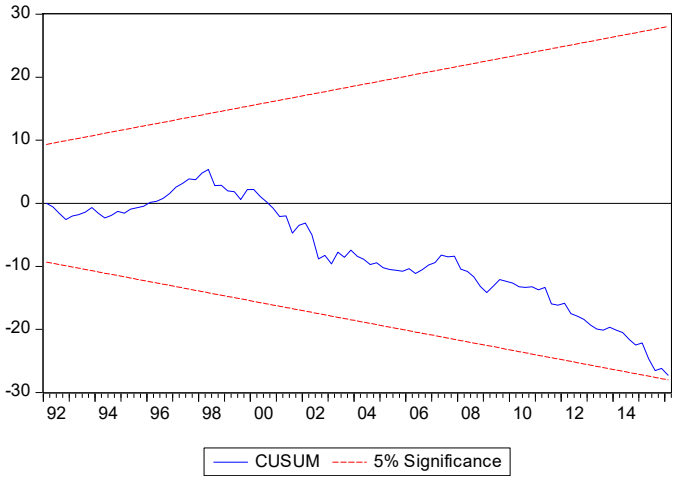
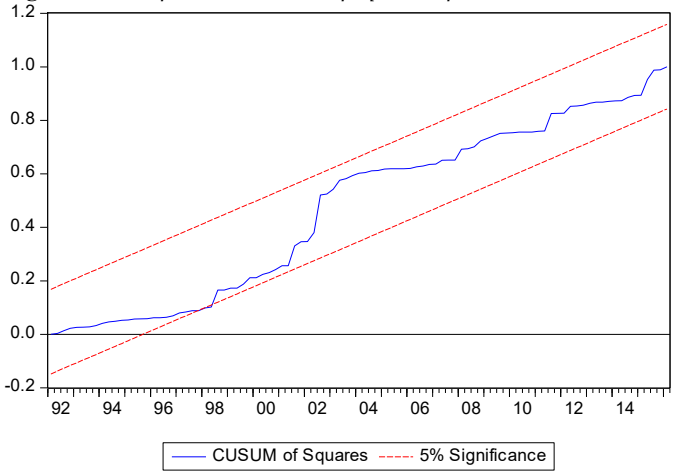


Figure 2. *Plot of cumulative sum of squares of recursive residuals*



4. Conclusions

The present study has attempt to examine the dynamic interaction between macroeconomic variables and stock market return in Germany using a quarterly time series data for the period spam from 1990Q1 to 2016Q1.

In the long run analysis, empirical results showed that exchange return, the M3 aggregate and the oil return in Germany have positive and no significant impact on stock return. However, the interest rate has a negative and significant impact on stock return. The effect of CPI on stock return is positive and significant. To detect the stability long run parameters, we employed the cumulative sum and cumulative sum of square test. Results indicate the acceptance of the hypothesis of correct specification of regression model. In

the short run analysis, results indicate that exchange return, the M3 aggregate and the oil return in Germany have positive and no significant impact on stock return. However, the interest rate has a negative and significant impact on stock return. The effect of CPI on stock return is positive and significant. The value of lagged ECM is negative and significant at 10% level of significance.

Economically, macroeconomic variables' effects on stock market volatility depend mainly on investors' anticipations explained by arbitrage. "In fact, when investors anticipate the interest rate increase, arbitrage to buy domestic securities is favorable." , "An interest rate rise induces an increase of the yields of securities denominated in the national currency." , "The national currency depreciation increases export flows, increases the exporting firms' profit and so raises their stock exchange values.

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