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Factors affecting stock return volatility in the banking sector in the euro zone

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Abstract

Aim/purpose – The purpose of this paper is to examine the influence of internal and external historical determinants on the volatility of banks' stock returns in the euro zone. A dedicated database has been created to identify factors significantly affecting volatility.
Design/methodology/approach – The study is based on information about banks listed on the stock exchanges of the euro zone economies. Quarterly data from the period of 2004-2015 along with static panel models were used as the research method.
Findings – Results confirm that selected factors have a significant impact on the analysed variables: the ratio of long-term investments to assets, solvency ratio, price to book value, the unemployment rate, beta, as well as implied volatilities in S&P500 and EUROSTOXX50 indexes.
Research implications/limitations – Results can be used to estimate future stock return volatility more accurately. The survey focuses solely on the banking sector, which is the biggest limitations of this research and the findings cannot be used to other sectors.
Originality/value/contribution – Most volatility research serves the purpose of predicting future stock prices. Very few papers explain which factors in particular impact volatility.

Keywords: beta, unemployment, historical volatility, implied volatility.
JEL Classification: G11, G15, G21.

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1. Introduction

The historic volatility of numerous data (e.g. stock prices, interest rates, currency prices, commodity prices) has been widely analysed and described in economic papers. Those variables are used in day-to-day risk management in numerous institutions that may be affected by variations of variables for which they are calculated. Mathematic historic volatility is defined as a standard deviation of the variable in question in a unit of time, assuming that continuous capitalisation is taken into account in the calculation (Hull, 2011).

The estimation of stock return volatility based on the historic data may serve as a measure of uncertainty of the future level of stock return (Hull, 1998). Upon reviewing international literature on the subject, one may notice that numerous authors have endeavoured to identify factors that may have an impact on stock returns. It has been confirmed that stock returns may be affected by macroeconomic factors (Chen, Roll, & Ross, 1986; Geetha, Mohidin, Chandran, & Chong, 2001; Kaul, 1987; Mauro, 2000) and, in some cases, internal parameters of the public company (Banz, 1981; Bhandari, 1988; Basu, 1983; Beccalli, Casu, & Girardone, 2006; Campbell, 1991; Castrén, Fitzpatrick, & Sydow, 2006; Cooper, Jackson, & Gary, 2003; Fama & French, 1992). Those studies have shown that only certain factors are statistically significant. Despite that, the adjustment of those models has been rather limited (Chodnicka-Jaworska & Niewińska, 2016a). Therefore, it seems reasonable to reflect on the extent of external and internal factors affecting the historic volatility of stock returns.

In order to better understand the historic volatility of stock returns, this paper shall focus on the analysis of the banking sector in the euro zone. In particular, we shall analyse the impact of macro- and microeconomic factors on volatility.

Expanding our current knowledge on stock return volatility is particularly important for investment portfolios, and its determination is meaningful only for homogenous shares with a high level of liquidity. The stocks of banks seem useful for such an analysis due to their high levels of liquidity (related to high capitalisation) and transparency (e.g. owing to regulators), which leads to standardising this analysis. Only banks from the euro zone have been selected for the purpose of this study. Stocks of financial institutions are among the main components of investment portfolios, and therefore a proper identification of the volatility parameter is important for a correct evaluation of investments and a more exact estimation of future stock returns in the financial sector.

The paper is divided into five sections. The first section is a review of literature on stock return volatility; the knowledge gap left by the existing studies is indicated. The next section outlines the data and the research method used. In the third, study results are presented, along with an analysis of research assumptions. Conclusions are outlined in the final section.

2. Literature review

The analysis of international papers allows us to conclude that, although a significant number of studies have been devoted to the subject of predicting volatility, considerably fewer explore factors that influence it. Certain authors identify determining factors, but these publications are significantly less numerous than studies focused on predictions; GARCH and ARCH models are used in the majority of studies (Alberg, Shalit, & Yosef, 2008; Pagan & Schwert, 1990).

Schwert (1989) published his analysis of stock return volatility, in which he demonstrated that it was dependent on business cycles. His study suggests that future volatility determined solely on the basis of historic data stock returns, without taking into account macroeconomic variables, may explain only weak (aggregated) changes of the stock market. Campbell & Hentschel (1993) have built upon the works of Schwert (1989) and described features characterising the volatility of returns from financial assets. They assume the existence of a negative correlation between the volatility of returns and the rate of return itself. Cambell & Hentschel (1993) studied monthly and daily rates of return on the basis of NYSE and ASE indexes from the period between 1926 and 1988. This study sparked an increased interest in consumption, on the basis of which the level of volatility of the market is explained (Cochrane, 1999; Mehra & Prescott, 2003; Tauchen, 2011). Heston (1993) introduced unobservable factors that explain the dynamics of returns. In his model, he assumed that the volatility of returns may by predicted through factors such as inflation and industrial production. Campbell (1996) proved that stock return volatility is determined by dividends.

Kearney & Daly (1998) attempted to identify factors impacting stock returns volatility on the Australian stock exchange. This study was based on the Australian All Industrials Stock Market Index from the period between July 1972 and January 1994. The volatility of this index was measured with a monthly frequency and the method used was GLS, i.e. Generalized Least Squares. Kearney & Daly (1998) used explanatory variables, i.e. the rate of return of Aus-

tralian All Industrials Stock Market Index, interest rate of 3-month bank--accepted bills, the rate of inflation of the wholesale price index, the current account deficit, the level of industrial production and the Australian to US dollar exchange rate. They study has confirmed the lack of statistically significant correlation between volatility and the foreign exchange market.

The subsequent study concerning factors impacting stock returns volatility was carried out by Mele (2007). He studied a long period that included 660 monthly observations (January 1948 – December 2002). The primary goal of this study was to separate the influence of determinants of the business cycle on stock return volatility. The following data were selected as variables: price to dividend, monthly changes of the price to dividend ratio, real returns, twelve--month returns, CPI, real risk-free rate (treasury monthly bills – YTM) and excess return volatility. Five years later, Mele (2007) along with Corradi, Distaso, & Mele (2013) expanded upon this analysis. In their paper, they explain stock returns volatility on the basis of macroeconomic data and unobservable variables using their 'no-arbitrage model'. Their variables include monthly data VIX, which is the implied volatility of the S&P500 index. A significantly shorter period of time was analysed (between January 1990 and December 2006 – 204 observations in time). Independent variables were changes in the CPI index and changes in the industrial production index (672 observations). Their results show that an increase of industrial production plays a significant role. A stable increase in industrial production results, over a longer period, in a 10-per-cent reduction in volatility. Additionally, they evidence in their analysis that 1/3 of volatility can be explained by macroeconomic factors.

Engle, Ghysels, & Sohn (2008) also analysed this impact of inflation and increase of industrial production on the volatility of daily returns. Like Schwert (1989), they explore in their study a long period. Each variable is analysed separately. They prove that macroeconomic variables (such as inflation and industrial production) have a significant statistical impact on stock return volatility.

Christiansen, Schmeling, & Schrimpf (2012) in their study on macroeconomic and financial determinants of volatility focus mainly on the analysis of stock returns volatility. Their model encompasses 38 macroeconomic and financial factors. The team emphasised the importance of understanding volatility, as it may be a consequence of entering into investment and of investors' decision to allocate assets on the market. A deeper understanding of the influence of macroeconomic fluctuations on the stock market is interesting in itself, as it helps to perceive correlations between changes of stock prices and risk factors, as well as

cyclical variables. They also show that this knowledge helps predict future revenue on the stock market.

The abovementioned review is focused on papers whose authors attempted to explain the influence of determinants on the volatility of stock returns. In many cases, studies are based on the stock market index (Grossman & Shiller, 1981; Kearney & Daly, 1998; Corradi, Distaso, & Mele, 2012). Another issue, frequently faced by researchers and practitioners, is taking into account an extended history of price changes in the calculation of the historic volatility. The most commonly used method of determining volatility on the basis of historic data involves selecting a time interval and the number of return rates which are to be included in the calculation. Next, the equation on standard deviation of those stock returns is applied. Therefore, the study presented in this paper shall be based on historic volatility including stock returns from a period of 30, 60, 90, 180 and 360 days.

The analysis of papers on the subject suggests the existence of a research gap on factors affecting stock returns volatility. Furthermore, variables described and studied have a limited influence on the phenomenon in question. Researchers and practitioners strive to identify the main factors influencing stock return volatility and their effect for the real economy. For practitioners it is important to better understand the stock price. In both cases, a better understanding of stock return volatility is a significant challenge for researchers, businesses, as well as decision-makers responsible for economic policies (Corradi et al., 2013).

3. Research methodology

This study encompasses all listed banks from the euro zone which average market capitalisation in the period between January 2004 and December 2015 exceeded EUR 100 million. Quarterly data used for the analysis were acquired from the databases of Thomson Reuters Eikon and Bloomberg.

The study is based on five different historic volatilities: 30-day, 60-day, 90-day, 180-day and 360-day. Variables were acquired from the Thomson Reuters Eikon database. As per definition, these are risk measurements of asset price changes and, in this case, of stock prices of banks calculated on the basis of the equation of the daily logarithmic standard deviation of stock returns. They are presented as annual standard deviation, but each of these volatilities includes historic data on stock returns of 30, 60, 90, 180 and 360 days. Those measure-

ments are presented as percentage points. Explanatory variables are internal factors, related to the operations of a bank, as well as external factors describing the state of the economy and the financial market of a particular country.

Given the characteristics of the collected data, statistical panel data models were used to analyse the influence of internal and external factors on the volatilities of stocks returns of banks. These models combine cross-section data (from individual banks) with time-series data (quarterly variables). They allow for a cross-section analysis of banks listed on particular stock exchanges in the euro zone. In order to estimate single-equation panel models, which do not include a delayed dependant variable, panel models are based on the Methods of Least Squares (Dańska-Brosiak, 2011). In this analysis, the Panel Data Model with the Fixed Effect shall be used. Equations assume the invariance of parameters with explanatory variables referring to time and objects, and the heterogeneity of objects or the differentiation of the modelled phenomenon over time. These models allow us to understand the phenomena studied over a period of time and from the point of view of the banks surveyed. These models were selected owing to the availability of certain data in the database. In most cases, information about internal factors is only published quarterly, and in certain countries biannually. This is the greatest limitation of this study.

Two general equations of the panel model are presented below:

$$\boldsymbol{y1_{i,t}} = \sum_{\boldsymbol{k=0}}^{\boldsymbol{n}} \boldsymbol{\beta_k}\, \boldsymbol{x1_{i,t}^{T}} + \boldsymbol{\mu_{i,t}}, \boldsymbol{i} = \boldsymbol{1}, \ldots, \boldsymbol{N}, \boldsymbol{t} = \boldsymbol{1}, \ldots, \boldsymbol{T} \tag{1}$$

where:

$y1^{T}_{i,t}$ – banks stock returns volatility in the euro zone in time t

[$VOL30D_{i,t}$ – 30-day; $VOL60D_{i,t}$ – 60-day; $VOL90D_{i,t}$ – 90-day; $VOL180D_{i,t}$ – 180-day; $VOL360d_{i,t}$ – 360-day].

$x1^{T}_{i,t}$ – vector of explanatory variables of listed banks from the euro zone in time t [TDTA – total deposits to total assets, NETLOANSTD – net loans to total deposits, IITI – interest income to total income, NONIITI – non-interest income to total income, FCITA – fee and commissions income to total assets, NETLOANSTA – net loans to total assets, CASHDUEBANKSTA – cash and dues from banks to total assets, LONGTERMDEBTTA – long-term debt to total assets, LONGTERMINVTA – long-term investments to total assets, TOTALCAPITAL – capital ratio, OPERLVG – operating leverage, TDEBTCOMEQT – total debt to common equity, LVGRATIO – leverage ratio, PE – price to earnings, EPS – earnings per share, BVPS – book value per share, PTBV – price to book value, PTCF –

price to cash flow, PROFTASS – profit to total assets, PROFTEQT – profit to total capital, DIVYIELD – dividend yield, EVSALES – enterprise value to sales, EVPROF – enterprise value to profit, ROA – return of assets, ROE – return on equity].
β – vector of structural parameters.

$$\boldsymbol{y2_{i,t}} = \sum_{k=0}^{n} \boldsymbol{\gamma_k}\, \boldsymbol{x2_{i,t}^{T}} + \boldsymbol{\mu_{i,t}}, \boldsymbol{i} = \boldsymbol{1}, \ldots, \boldsymbol{N}, \boldsymbol{t} = \boldsymbol{1}, \ldots, \boldsymbol{T} \quad (2)$$

where:
$y2^{T}_{i,t}$ – stock return volatility of listed European banks in time t
[$VOL30D_{i,t}$ – 30-day; $VOL60D_{i,t}$ – 60-day; $VOL90D_{i,t}$ – 90-day; $VOL180D_{i,t}$ – 180-day; $VOL360d_{i,t}$ – 360-day].
$x2^{T}_{i,t}$ – vector of explanatory variables of listed euro zone banks in time t
[GDPQQ – quarterly change in Gross Domestic Product; CPIQQ – quarterly change in Consumer Price Index; PPIQQ – quarterly change in Producer Price Index; RETAILSALESQQ – quarterly change in Retail Sales Index; UNEMPLOYMENT – Unemployment Rate; REALINTERESTRATE – Real Interest Rate; SHORTTERMINTERESTRATE – Short-Term Interest Rate; LONGTERMINTERESTRATE – Long-term Interest Rate; BONDS5Y – average 5 year yield of T-bonds; BETA – Beta in Sharpe's Model; EUROSTOXX50VOLIDX – Implied Volatility of EURO STOXX 50; SP500VOLIDX – Implied Volatility of S&P 500; TUNOVERSEQQ – quarterly change in the turnover of the stock exchange; MARKETCAPSEQQ – quarterly change in the market capitalisation of the stock exchange].
γ – vector of structural parameters.

For the abovementioned variables, Spearman correlation coefficients were calculated in order to verify the assumption of the regression analysis. If the model is correct, no mutual linearity of predicates should be observed (highly correlated, yet separate explanations). The above equations are consistent with the assumption.

4. Research results

The following tables show the results of estimations of internal factors (Table 1) and external factors (Table 2) on stock return volatility of banks from the euro zone. For each variable tested, the rate of its influence and the level of its significance was indicated with asterisks (***, **, * – significance level of 99%, 95% and 90%). The first estimation was based on approx. 550 observa-

tions in time; in the end, 31 banks were selected for analysis. In the case of the second estimation, 2,800 observations were used with information on 70 banks from the euro zone.

Table 1. Results of the estimation of internal factors on banks' stock return volatilities in the euro zone

	vol 360d		vol 180d		vol 90d		vol 60d		vol 30d	
EFFICIENCY										
TDTA	0.20	0.19	0.10	0.08	0.02	0.02	−0.06	−0.07	−0.10	−0.11
	*	*								
NETLOANSTD	0.00	0.00	0.00	0.00	−0.01	−0.01	−0.01	−0.01	−0.01	−0.01
							*	*		
IITI	−0.05	–	−0.03	–	0.03	–	−0.01	–	−0.03	–
NONIITI	–	−0.11	–	0.02	–	0.09	–	0.03	–	−0.03
FCITA	−3.03	0.20	−10.75	−8.54	−30.23	−27.51	−36.01	−30.82	−36.53	−30.57
					*	**	*	*	*	*
NETLOANSTA	0.06	0.05	0.37	0.37	0.20	0.25	0.23	0.23	0.06	1.89
			*	*						
CASHDUEBANKSTA	−0.10	−0.19	−0.04	−0.09	0.13	0.09	0.38	0.28	0.38	0.24
LONGTERMDEBTTA	−0.33	−0.40	−0.51	−0.58	−0.58	−0.66	−0.72	−0.79	−0.84	−0.91
		*	*	**	*	**	*	**	**	**
LONGTERMINVTA	−8.51	−8.38	−7.29	−7.28	−6.85	−7.11	−5.62	−5.83	−8.07	−0.82
	***	***	***	***	**	**	*	*	**	**
RISK										
TOTALCAPITAL	−0.99	−0.86	−2.08	−2.00	−2.48	−2.46	−2.59	−2.52	−2.03	−1.92
	***	***	***	***	***	***	***	***	***	***
OPERLVG	0.00	−0.01	0.00	0.00	0.01	0.00	0.01	−0.01	0.00	−0.01
TDEBTCOMEQT										
LVGRATIO	0.00	0.00	0.00	0.01	−0.01	0.00	−0.01	0.00	−0.01	−0.01
MICRO STOCK MARKET										
PE	0.00	0.00	0.00	−0.01	−0.01	−0.01	0.00	−0.01	0.00	0.00
EPS	−0.01	–	−0.01	–	0.00	–	0.00	–	0.00	–
	*									
BVPS	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00
								*		*
PTBV	−14.51	−15.04	−17.87	−17.91	−18.40	−18.59	−19.21	−19.21	−16.77	−16.89
	***	***	***	***	***	***	***	***	***	***
PTCF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 1 cont.

	vol 360d		vol 180d		vol 90d		vol 60d		vol 30d	
PROFITABILITY										
PROFTASS	0.90	–	−0.15	–	−2.32	–	−1.84	–	−1.97	–
PROFTEQT	–	0.23	–	0.17	–	0.10	–	0.14	–	0.18
		**		*						
DIVYIELD	−0.53	−0.45	−0.39	−0.30	0.31	0.46	0.01	0.17	−0.95	−0.84
EVSALES	−0.01	−0.03	−0.01	−0.02	0.02	0.02	0.06	0.05	0.10	0.09
									*	
EVEBITDA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		*								
ROA	–	−1.91	–	−1.04	–	2.03	–	1.83	–	−2.17
ROE	0.00	–	0.01	–	0.02	–	0.02	–	−0.01	–
_CONS	66.9	66.0	77.2	76.9	104.1	98.7	111.1	107.4	116.2	115.3
	***	***	***	***	***	***	***	***	***	***
NO OBS	ok. 550									
NO GRUP	31	31	31	31	31	31	31	31	31	31
WITHIN	0.21	0.21	0.24	0.25	0.25	0.24	0.20	0.20	0.14	0.15
BETWEEN	0.05	0.05	0.04	0.04	0.05	0.05	0.05	0.05	0.08	0.08
OVERALL	0.14	0.14	0.12	0.12	0.12	0.12	0.10	0.10	0.11	0.11
TEST	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE

***, **, * – level of significance of 99% (p-values 1%), 95% (p-values 5%) and 90%(p-values 10%).

Table 2. Results of the estimation of external factors on banks' stock return volatilities in the euro zone

	vol 360d		vol 180d		vol 90d		vol 60d		vol 30d	
MACROECONOMIC										
GDPQQ	−0.42	−0.88	−0.08	−0.17	−0.84	−1.17	−0.36	−0.29	−0.03	0.16
		*				*				
CPIQQ	2.45	−0.41	−0.74	3.00	0.50	3.71	0.36	4.54	0.42	2.99
	***			**		***		***		**
PPIQQ	1.13	−1.83	1.65	−2.05	1.90	−1.56	2.46	−1.48	1.58	−1.65
	***		***		***		***		***	
RETAILSALESQQ	−0.42	1.24	−0.26	1.99	−0.49	1.51	−0.47	1.58	−1.27	0.97
		**		***		**		**	***	
UNEMPLOYMENT	1.31	1.36	1.58	1.43	1.61	1.39	1.70	1.49	1.60	1.36
	***	***	***	***	***	***	***	***	***	***
COST OF MONEY										
REALINTERESTRATE	4.54	–	4.09	–	2.91	–	2.80	–	2.27	–
	***		***		***		***		***	
SHORTTERMINTERESTRATE	−2.36	–	−1.44	–	−0.98	–	−1.11	–	−0.61	–
	***		***		***		***		*	
LONGTERMINTERESTRATE	1.78	–	2.26	–	2.30	–	2.27	–	1.82	–
	***		***		***		***		***	
BONDS5Y	–	0.77	–	1.20	–	1.43	–	1.18	–	1.66
		***		***		***		***		***

Table 2 cont.

	vol 360d		vol 180d		vol 90d		vol 60d		vol 30d	
MACRO STOCK MARKET										
BETA	10.51	11.59	7.95	8.99	5.89	6.68	4.89	5.80	4.10	5.17
	***	***	***	***	***	***	***	***	***	***
SP500VOLIDX	–	0.91	–	1.04	–	0.99	–	1.01	–	1.00
		***		***		***		***		***
EUROSTOXX50VOLIDX	0.79	–	1.03	–	1.02	–	1.01	–	1.09	–
	***		***		***		***		***	
TUNOVERSEQQ	−0.01	−0.01	−0.01	−0.01	−0.01	−0.01	0.00	−0.01	0.00	0.00
	***	***	**	***	**	**				
MARKETCAPSEQQ	0.30	0.38	0.24	0.23	−0.08	−0.11	−0.23	−0.26	−0.15	−0.21
	***	***	***	***	*	**	***	***	***	***
_CONS	−13.8	−9.4	−24.0	−14.0	−22.1	−10.7	−22.2	−11.7	−20.9	−11.4
	***	***	***	***	***	***	***	***	***	***
NO OBS	ok. 2800									
NO GRUP	69	65	70	65	70	65	70	65	70	65
WITHIN	0.38	0.24	0.36	0.21	0.33	0.21	0.33	0.22	0.27	0.19
BETWEEN	0.54	0.52	0.50	0.46	0.43	0.36	0.42	0.34	0.41	0.36
OVERALL	0.44	0.34	0.41	0.28	0.37	0.24	0.36	0.24	0.31	0.22
TEST	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE

***, **, * – level of significance of 99% (p-values 1%), 95% (p-values 5%) and 90%(p-values 10%).

Measures of effectiveness of banks represent the first category among the variables; they are internal factors. Based on calculations presented in Table 1, one can deduce that the ratio of long-term investments to total assets is a statistically significant indicator that will influence all remaining variables. An increase in this variable by 1 percentage point results in an 8-percentage-point decrease of 360-day volatilities; 30-day volatilities decrease by 7 percentage points, while 180- and 90-day volatilities decrease by 6 percentage points. An increase in long-term investments in banks may be an indicator of stability of financial institutions. It is not a variable whose changes are significant, which may be accounted for by the specificity of this indicator. For investors, an increase in long-term investments as a component of assets may indicate an increase in the value of the bank which should result in an increase in stock prices. As the price increases, its historic volatility should decrease, as has been confirmed by this study. Another statistically significant indicator for the study of volatility in this category is the ratio of long-term debt to assets. An increase of this indicator by one percentage point results in a 0.4-percentage-point decrease of the 360-day volatility, a 0.6-percentage-point decrease of 180- and 90-day volatilities and

a 0.8-percentage-point decrease of 60- and 30-day volatilities. This variable shows that an increase of the ratio of debt to assets may have a positive impact on the effectiveness of banks. The ratio of fee and commission income to assets is another indicator in this category. This indicator has a significant statistical effect only for 90-, 60- and 30-days volatilities An increase of this variable by 1 percentage point results in a 30-percentage-point decrease of these volatilities. An increase in this indicator may indicate that a bank has increased its revenue from fees and commissions on bank products. This may result from an increase of these fees for the customers of a given bank. Investors may consider the increase of this indicator as positive and expect that it will decrease the stock return volatility of the bank.

The second category of internal factors is risk variables. In this category, the capital ratio is a statistically significant indication, with an impact on the results of the study. Its influence on results is always the same. A 1-percentage-point increase of this indicator will result in a 1-percentage-point decrease of the 360--day volatility and a decrease of approx. 2-2.5 percentage points of 180-, 90-, 60- and 30-day volatilities. This indicator describes the ratio of total regulatory capital to the sum of assets weighted with risk, and therefore the stability of bank increases in proportion to it. An increase in this indicator should result in a decrease of the historic volatility of the rate of return from stock. For current and future stockholders, an increase in this indicator should mean that the value of the bank increases, and so should its stock prices.

Another category are micro stock exchange indicators which are related to a particular bank (hence the name of the category: micro stock exchange). The ratio of price to book value is a statistically significant indicator for all studied variables. A 1-percentage-point increase of this indicator will result in a 15-percentage-point decrease of the 360-day volatility, while 180- and 90-day volatilities will decrease by18 percentage points, 60-day volatility by 19 percentage points and 30-day volatility by 17 percentage points. This indicator denotes how much a company is worth in relation to its book capital; as a consequence, an increase of this indicator will result in a drop in volatility.

In the last category of internal factors, i.e. profitability, no independent variable triggers a change of volatility. The study shows that investors are more concerned about the level of risk of a credit portfolio than about potentially improved results and, consequently, a greater profitability.

Table 2 presents the results of the influence of external factors on historic stock return volatility. The first category are macroeconomic factors. The unem-

ployment rate has a significant statistical impact on all variables related to banks. A 1-percentage-point increase of this indicator will result in an increase of approx. 1.5 percentage points of all volatilities. An increase in the unemployment rate is an indicator of an economic downturn which should result in a drop of stock prices as, in such situations, investors tend to abstain from investing on the stock market and turn towards more liquid assets. Therefore, an increase in the unemployment rate may result in an increase in the stock return volatility.

Quarterly change in Consumer Price Index, quarterly change in Producer Price Index and quarterly change in Retail Sales Index are variables which increase will result in an increase in volatility. It translates into an increase in producer and consumer prices, which results in the sale of stock of banks, as confirmed by the results of this study.

Another category is the cost of money in time. The long-term interest rate is statistically significant for volatilities examined in this study. A 1-percentage-point increase of this indicator will result in a 1.8-percentage-point increase of 360- and 30-day volatilities, while 180-, 90-, 60-day volatilities will increase by 2.3 percentage points. An increase of interest rates is expected to cool down the economy; loans become more expensive, which results in a decrease of the profitability of banks. In this situation, bank stock prices are very likely to decrease, while volatility tends to increase (as confirmed by this study). The same is true for the real interest rate: its increase by 1 percentage point will result in an increase in volatilities by approx. 2.3-4.5 percentage points. Short-term interest rate also impacts all variables studied; a 1-percentage-point increase will result in a 0.5-2-percentage-point decrease of stock return volatilities.

The last category of external indicators is macro stock exchange variables. A change in the quarterly capitalisation market of stock exchange is statistically important for all variables in question. A 1-percentage-point increase of this variable will result in a 0.3-percentage-point increase of 180- and 360- day volatilities and a 0.2-percentage-point decrease of all remaining volatilities. It is an example of a determinant which impact will be different on each historic volatility. It may be the due to the fact that volatilities react differently depending on the time period. The 360-day volatility describes the behaviour of stock over the course of the entire year, and the 30-day volatility refers only to the past 30 days. This study has demonstrated significant differences between explanatory variables in question. Another variable is beta. It is an explanatory variable which, in Sharpe's model, relates to the risk of an individual bank in relation to a main stock exchange of a country. An increase in beta translates into an increase in the

risk of a bank in relation to a market benchmark and, as a result, a 1-percentage--point increase in beta will result in a 7.2-percentage-point increase of stock returns volatilities. An increase in beta means an increase of risk of a particular bank in relation to the main index of the country in which the bank is listed. Increased risk will result in increased volatility, with suggests a drop in stock prices. For all subgroups analysed the influence of this variable was similar. The level of implied volatility of the main international indexes, i.e. S&P 500 and EUROSTOXX 50, is statistically significant for the study of variables explored in this paper. A 1-percentage-point increase of those variables will result in a 0.85-percentage-point increase of explanatory variables. The uncertainty of financial markets has an impact on the banking sector.

Models with external explanatory variables have a significantly higher coefficient of impact on volatility than models with internal explanatory variables. It means that macroeconomic and market determinants describe more adequately historic stock return volatilities in the banking sector of the euro zone. It is confirmed by the level of the R-square coefficient in those models. In the first model, it is approx. 10 per cent, as compared to approx. 50 per cent in the second model, which means a 50-per-cent adjustment to reality of the second model.

5. Conclusions

The analysis of internal and external determinants of stock return volatility in the banking sector of the euro zone confirms that major factors affecting all variables can be identified, namely long-term investments to assets, fee and commission income to assets, capital ratio, price to book value, quarterly change in the Consumer Price Index, quarterly change in the Producer Price Index and quarterly change in the Retail Sales Index, the unemployment rate, long-term interest rate, short-term interest rate, beta and the implied volatility of S&P 500 and EUROSTOXX50 indexes.

It may be deduced that the results of this study on stock return volatility contradict the findings mentioned in the first section of this paper, namely studies on the influence of the CPI inflation indicator on the historic volatility by Heston (1993), as well as by Engle et al. (2008). This variable has a statistically significant impact on the volatility of stock of banks returns in the euro zone; in addition, other price indicators have a statistically significant impact on other dependent variables studied.

Additionally, the significant impact of the dividend yield on stock return volatility has been confirmed. Campbell & Hentschel (1993) expanded the study carried out by Schwert (1989) and described variables that characterise the volatility of returns on financial assets. They have proven that volatility increases in proportion to the volatility of information about future dividends. Campbell (1996) claims that stock return volatility determines the volatility of the dividend yield. The study presented in this paper proves that the dividend yield does not influence historic volatility.

Results confirm the outcome of analysis carried out by Kearney & Daly (1998), who studied the volatility of the Australian stock exchange. They claimed that historic stock returns are influenced by variables describing the cost of money in time.

The results of determination coefficient are promising in terms of the impact of macroeconomic and market factors. This leads to a conjecture similar to the conclusion reached by Corradi et al. (2013) who endeavoured to explain stock return volatility by macroeconomic data and unobservable factors. Their results have shown that approx. 1/3 of the volatility level can be explained by macroeconomic factors. According to their analysis, the second model was confirmed by reality in approx. 50 percent. In summary, the main results of this research identify key factors influencing stock return volatility and describe their effect. It is important, as it allows to understand and calculate future stock prices more correctly. A greater understanding of stock return volatility is important for researchers, businesses and decision-makers responsible for economic policies (Corradi et al., 2013). Stock return volatility must be taken into account in the process of making decisions on the allocation of assets by investors. In addition, the survey is very broad, and it focuses on the banking sector. On the basis of research results, it is possible to identify factors that significantly affect the volatility of stock returns.

Bearing in mind the results obtained in this study, it is worth emphasising that the better we understand the stock return volatility, so that we can understand the economy more profoundly. EBC (2002) found out that permanent increase in stock prices (that means the low volatility stocks return) induces higher current and future consumption. Additional in this paper highlight, that higher stock prices can also indirectly support future economic growth and influence improve consumers' moods, also for consumers who are not directly exposed to stock market fluctuations. Andersson & D'Agostino (2012) wrote the paper about stock price usefulness for predicting euro area GDP.

In conclusion based on the analysis, now we know what indicators and how they affect the variability examined (stock return volatility for euro zone banks). If volatility is at a high level, it means that the prices of the bank stock will go down, and if volatility is low, that the stock prices will grow. The results seem to be very useful because adjustment to reality is low for model examining the determinants of stock return (Chodnicka-Jaworska & Niewińska, 2016ab) compared to 50% R-square coefficient in stock return volatility models.

The main limitation of this study is that the results of the analysis only apply to the banking sector for the euro zone. Bank shares are usually characterized by high liquidity (these are institutions with high capital) and a high level of transparency (e.g. due to supervision requirements), which means that we cannot assume that we will achieve similar results for other sectors. In the future, research should be extended to other sectors and also be compared with other regions (e.g. USA, EU, CEE).

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