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The Impact of Determinants on the Volatility of Banking Sector Stock Returns in Europe

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Katarzyna Niewińska*

The aim of the paper is to examine the impact of macroeconomic determinants on the volatility of banking sector stock returns in Europe. The research was conducted for 182 banks in 26 European countries in which banks are listed in the stock market. The research method used was static panel models. The results obtained indicate that the selected determinants that influence the analysed variables are: unemployment rate, long-term interest rate, beta as well implied volatilities of the S&P500 and EUROSTOXX50 indices.

Keywords: beta, historical volatility, implied volatility, unemployment rate.

Wpływ determinant na zmienność stóp zwrotów z cen akcji w sektorze bankowym w Europie

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Celem poniższego artykułu było zbadanie wpływu czynników makroekonomicznych na zmienności historyczne stóp zwrotu z cen akcji banków w Europie. Badanie zostało przeprowadzone dla 182 banków w 26 krajach europejskich, w których są ich akcje notowane na rynku giełdowym. Metoda badawcza wykorzystana w poniższym artykule to statyczne modele panelowe. Wyniki uzyskane świadczą, że z wybranych czynniki wyraźnie wpływa na badane zmienne: stopa bezrobocia, długoterminowa stopa procentowa, a także beta oraz zmienności implikowane indeksu S&P500 oraz EUROSTOXX50.

Słowa kluczowe: beta, stopa bezrobocia, zmienność historyczna, zmienność implikowana.

JEL: E44, G21, F37

* **Katarzyna Niewińska** – PhD, Faculty of Management, University of Warsaw.

Correspondence address: Faculty of Management, University of Warsaw, Szturmowa St. 1/3, 02-678 Warsaw; e-mail: kniewinska@wz.uw.edu.pl.

Ministry of Science and Higher Education
Republic of Poland

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1. Introduction

The problem of monitoring and analysing the volatility of numerous data (e.g. stock prices, interest rates, currency prices, raw material prices) is broadly described and examined by economists and addressed on a daily basis by risk managers in many institutions exposed to changes in prices of financial instruments. Volatility is mathematically described as a standard deviation of a particular statistic of the value generated by this variable over a given period of time, assuming that it is calculated with account being taken of continuous capitalisation (Hull, 2011), and is termed historical volatility in this classical meaning.

The estimation of stock return volatility on the basis of historical data may serve as a measure of uncertainty as to the future value of return on a given stock (Hull, 1998). Based on a world literature review, it can be noted that many studies attempt to indicate factors affecting stock returns. First and foremost, they have proved that returns are influenced by macroeconomic and market determinants (e.g. Chen, Roll and Ross, 1986, pp. 383–403; Kaul, 1987, pp. 253–276; Mauro, 2000; Geetha, Mohidin, Chandran and Chong, 2001) and, in some cases, also by internal parameters of a listed company (i.a. Banz, 1981, pp. 3–18; Basu, 1983, pp. 129–156; Bahandari, 1988, pp. 444–455; Campbell, 1991, pp. 157–179; Fama and French, 1992; Cooper, Jackson and Gary, 2003, pp. 817–885; Beccalli, Casu and Girardone, 2006, pp. 245–262; Castrén, Fitzpatrick and Sydow, 2006). The results of these studies show that only some factors have a significant statistical influence, yet the fit of these models is often very poor (Chodnicka-Jaworska and Niewińska, 2016, pp. 39–47). Hence, it seems reasonable to ask the question about the influence of external factors on historical volatilities of stock returns.

Therefore, in order to better understand the historical volatility of stock returns, this study focuses on the analysis of the banking sector in Europe. It will examine the impact of macroeconomic factors on selected volatilities.

The deepening of the current knowledge about the volatility of the stock market is important primarily in the context of portfolio investment. The determination of this volatility only makes sense for highly liquid and homogeneous goods. Bank stocks seem to be very valuable for this type of analysis due to high liquidity (banks are institutions with high capital) and a high level of transparency (given, for example, supervision requirements). Assets composed of stocks of financial institutions are among critical items of investment portfolios, hence the proper determination of the volatility parameter seems to be very useful for the correct assessment of investment.

The article consists of four parts. The first one is a review of the literature on stock return volatility and indicates a gap in the hitherto research. The next part describes the collected database and the research method. Part 3 presents the research results together with their interpretation in the light of the adopted assumptions. The last part contains the main conclusions of the analysis.

2. Literature Review

When reviewing the world literature, it can be noted that research is very strongly focused on the prediction of volatility, with a lesser concentration on its framing mechanisms. There are publications that seek to identify determinants, yet such works aremuch fewer than those on predictions that are based primarily on the GARCH and ARCH models (Pagan and Schwert, 1990, pp. 267–290; Alberg, Shalit and Yosef, 2008, pp. 1201–1208).

In 1989, G. Schwert published an article examining stock volatility and showing that it was dependent on the business cycle. He argued that future volatility determined solely on the basis of historical returns, without taking into account macroeconomic variables, might help explain only small changes in (aggregate) volatility in the stock market (Schwert, 1989, pp. 1115–1153). Campbell and Hentschel expand Schwert's work and describe the characteristics of volatility of returns on financial assets. They assume that a negative correlation exists in the economy between return rate volatility and return rates. Campbell and Hentschel studied monthly and daily return rates for the NYSE and ASE indices between 1926 and 1988. That study aroused greater interest in consumption that formed the basis for explaining the level of stock market volatility (see: Cochrane, 1999; Mehra and Prescott, 2003; Bansal and Yaron, 2004; Tauchen, 2005). In 1993, Heston presented latent factors that explained the dynamics of return volatility. His model assumed that stock return volatility could be predicted by means of variables such as inflation and industrial production. In his 1996 publication, Campbell argues that stock return volatility is determined by the volatility of dividend.

Daly, in his 1997 publication, seeks to identify the determinants of stock return volatility in the Australian stock market. He based his research on data from the Australian All Industrials Stock Market Index in the time interval between July 1972 and January 1994. The volatility of this index is investigated at monthly intervals, and the applied research method is Generalised Least Squares (GLS). Daly uses explanatory variables: returns on the aforementioned stock market index, interest rates (interest on 3-month Australian bank bills), volatility of the monthly wholesale price index, volatility of the monthly percentage change in the industrial production index, money supply volatility, current account deficit (volatility of the current account deficit of the balance of payments in Australia), and foreign currency volatility. The research results showed that what is only missing is the evidence of a statistically significant relationship between volatility in the foreign exchange market and volatility in the stock market in Australia.

Antonio Mele (2007) developed research into return volatility. He used a long time series for the analysis as it contained as many as 660 monthly observations (January 1948–December 2002). The primary objective was to identify the influence of business cycle determinants on stock return

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volatility. The following data were used as independent variables: stock price to dividend, monthly changes in stock price to dividend, constantly decreasing real rates of return, deflation of nominal CPI equivalents, risk-free interest rate (1-month yields on T-bills), incremental volatility of returns. Five years later, Mele, Corradi and Distaso expanded that research an explained stock return volatility on the basis of macroeconomic data and unobservable variables by means of the "no-arbitrage model". They adopted monthly VIX data, that is the S&P500 implied volatility, as the dependent variable. A much shorter time series was examined: from January 1990 to December 2006 (204 observations over time). The CPI change and the change in the industrial production index (672 observations) were adopted as independent variables. The research results indicate that industrial production growth plays a vital role, with constant industrial production leading to a 10% reduction in volatility in the longer run. In addition, they proved that approximately 1/3 of volatility could be explained by means of macroeconomic indicators.

Engle, Ghysels and Sohn (2008) also analyse the impact of inflation and industrial production growth on daily volatilities of stock yields. The study has a long time horizon, similarly to that by Schwert (1989). Each independent variable was examined separately. They also confirmed that macroeconomic variables (inflation and industrial production growth) had a statistically significant influence on stock return volatility.

2012 saw the publication of a study by Christiansen, Schmeling and Schrimpf, who examined macroeconomic and financial determinants of volatility. In their paper, they primarily focus on stock return volatility. The model includes 38 macroeconomic and financial factors. They emphasise that understanding volatility movements is essential since they may be a consequence of investments made and decisions on the allocation of assets taken by investors in the market. A deeper understanding of the impact of macroeconomic fluctuations on stock market volatility is interesting in itself as it helps discover links between stock price changes and risk factors as well as cyclical variables. Those authors also demonstrated that such knowledge was helpful in predicting future earnings in the stock market.

The above literature review focused on scholarly articles seeking to identify the impact of determinants on stock return volatility. The research was often based on stock exchange indices (i.a. Grossman and Shiller, 1981, pp. 222–227; Daly, 1997; Mele, Corradi and Distaso, 2012). Another common problem faced by researchers and market practitioners is what time span of asset price variations should be taken into account to calculate historical volatility. The most popular method for estimating volatility based on historical data is to select the time interval that we are interested in and the number of previous return rates that we wish to include in calculations, and then to apply the equation calculating the standard deviation of these rates.

Accordingly, the research presented below uses historical volatilities that take into account the return rates in the last: 30, 60, 90, 180 and 360 days.

The above literature review indicates a research gap as regards the factors behind stock return volatility. Moreover, the described and studied variables influence the analysed phenomenon in a limited way. Scholars and market practitioners seek the main factors affecting stock return volatility and their side effects on the real economy. For capital market practitioners, the need to better understand the stock price has become important. In both cases, better knowledge of how volatility levels of stock returns change is an enormous challenge for theorists, business and decision makers responsible for economic policy (Corradi, Distaso and Mele, 2013, pp. 203–220).

3. Research Method

The research was conducted for all European listed banks with average market capitalisation of above EUR 100 million in the period from January 2004 to December 2015. The data was downloaded from Thomson Reuters Eikon and Bloomberg. Quarterly data from 182 banks in 26 European countries were used for the analysis.

The study adopts five different measures of historical volatility as explanatory variables: 30-day, 60-day, 90-day, 180-day, and 360-day. Historical volatilities were downloaded from the Thomson Reuters Eikon database. According to the definition, these are measures of the risk of changes in asset prices – bank stock prices in this case – calculated by the formula for the standard deviation of daily logarithmic stock returns. They are presented on a scale of the annual standard deviation, taking into consideration historical data on return rates: from the last 30, 60, 90, 180 and 360 days. These measures are expressed as percentages. Explanatory variables are the factors that are not related to banking operations but to the condition of the economy and financial markets in a given country. They were divided into three sub-groups: macroeconomic, cost-of-money and stock-market-related factors.

Given the nature of the data collected in order to analyse the impact of external factors on the volatility of bank stock returns, panel data models were employed. These models will allow a cross-sectional analysis of banks in individual stock markets in Europe. In order to estimate single-equation panel models that do not take into account the delayed endogenous variable, panel models based on the Least Squares Method are used, including panel data models with random effect (RE) and panel data models with fixed effect (FE) (Dańska-Brosiak, 2011). A general equation of this model is presented below:

$$y_{i,t} = \sum_{k=0}^{n} \gamma_k x_{i,t}^{T} + \mu_{i,t}, \quad i = 1,\ldots,N, \quad t = 1,\ldots,T \qquad \text{Equation 1}$$

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where:

$y^T_{i,t}$ – stock return volatility for the i-th European bank listed in the stock market at 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*]

$x^T_{i,t}$ – vector of explanatory variables for the i-th European bank listed in the stock market at time t
[*gdpqq – Quarterly change of GDP growth; cpiqq – Quarterly change of Consumer Price Index; ppiqq – Quarterly change of Producer Price Index; retailsalesqq – Quarterly change of retail sales dynamics; unemployment – Unemployment rate; realinterestrate – Real Interest Rate; shortterminterestrate – Short-Term Interest Rate; longterminterestrate – Long-Term Interest Rate; centralbankinterestrate – Central Bank Interest Rate; lendinginterestrate – Lending Interest Rate; bonds5y – Average yield on 5-year bonds; Bonds10y – Average yield on 10-year bonds; Beta – Beta in Sharpe's single-ratio model; eurostoxx50volidx – Implied volatility of EURO STOXX 50; sp500volidx – Implied volatility of S&P 500; ftse100volidx – Implied volatility of FTSE 100; cacvolidx – Implied volatility of CAC; daxvolidx – Implied volatility of DAX; aexvolidx – Implied volatility of AEX; smivolidx – Implied volatility of SMI; tunoverseqq – Quarterly change of stock market turnover; marketcapseqq – Quarterly change of stock market capitalisation*]

γ – vector of structural parameters

For the above variables (Table 2), Spearman's correlation coefficients were calculated to verify the assumption of the regression analysis. In a well-designed model, no collinearity of predictors (highly correlated explanatory variables) should occur. Therefore, highly correlated variables were eliminated from the model, which allowed its final form to be designed.

4. Results

The following table (Table 1) presents the estimation results for the impact of external determinants on the volatility of returns on European banks' stocks. Each examined explanatory variable is accompanied by the magnitude of the influence of external factors and the level of significance of this variable in the study (marked by asterisks). The estimation was based on approximately 5,200 observations over time, and 156 banks were ultimately selected for the analysis.

The first studied category includes macroeconomic factors. In this sub-group of explanatory variables, the unemployment rate statistically significantly affects all dependent variables. The results in the table show that a rise in unemployment of one percentage point in a given country will increase the volatility of stock returns for European banks by approximately 2 pp. An increase in the unemployment rate reflects a deteriorating economic condition, which should

	vol 360d		**vol 180d**		**vol 90d**		**vol 60d**		**vol 30d**	
	MACROECONOMIC									
GDPQQ	0.05	-	0.07	-	0.07	-	-0.01	-	-0.09	-
CPIQQ	-	-0.01	-	0.55	-	0.61	-	0.21	-	0.47
PPIQQ	-0.18	-	-0.01	-	0.44	-	0.54 *	-	0.45	-
RETAILSALESQQ	0.41 *	0.06	0.59 **	0.12	0.28	-0.2	0.41	-0.07	0.01	-0.33
UNEMPLOYMENT	2.21 ***	2.22 ***	2.47 ***	2.16 ***	2.44 ***	1.83 ***	2.45 ***	1.89 ***	2.17 ***	1.98 ***
	COST OF MONEY									
SHORTTERMINTERESTRATE	-0.39 *	-	0.43 **	-	0.58 ***	-	0.4 *	-	0.38 *	-
LONGTERMINTERESTRATE	-	1.2 ***	-	1.88 ***	-	1.96 ***	-	1.86 ***	-	1.38 ***
	RELATED TO STOCK MARKET									
BETA	8.95 ***	10.41 ***	6.64 ***	8.1 ***	4.74 ***	6.88 ***	3.30 ***	5.74 ***	2.56 ***	3.76 ***
SP500VOLIDX	-	0.75 ***	-	0.88 ***	-	0.84 ***	-	0.91 ***	-	0.89 ***
EUROSTOXX50 VOLIDX	0.71 ***	-	0.91 ***	-	0.91 ***	-	0.96 ***	-	0.93 ***	-
TUNOVERSEQQ	-0.01 ***	-0.01 ***	-0.01 ***	-0.01 ***	-0.01 ***	-0.01 ***	-0.01 *	-0.01	0	0
MARKETCAPSEQQ	0.26 ***	0.35 ***	0.17 ***	0.22 ***	-0.13 ***	-0.11 ***	-0.24 ***	-0.21 ***	-0.23 ***	-0.21 ***
_CONS	-10.4 ***	-15.6 ***	-17.3 ***	-18.7 ***	-16.1 ***	-14.7 ***	-15.7 ***	-15 ***	-12.2 ***	-11.8 ***
LICZBA OBS	ok. 5200									
LICZBA GRUP	155	155	156	156	156	156	156	156	156	156
WITHIN	0.26	0.28	0.23	0.25	0.22	0.23	0.22	0.23	0.18	0.18
BETWEEN	0.17	0.26	0.22	0.3	0.23	0.34	0.21	0.32	0.22	0.30
OVERALL	0.28	0.31	0.26	0.31	0.24	0.29	0.24	0.29	0.2	0.23
TEST	FE	FE	FE	FE	FE	RE	FE	RE	FE	FE

GDPQQ – *Quarterly change of GDP growth;* CPIQQ – *Quarterly change of Consumer Price Index;* PPIQQ – *Quarterly change of Producer Price Index;* RETAILSALESQQ – *Quarterly change of retail sales dynamics;* UNEMPLOYMENT – *Unemployment rate;* SHORTTERMINTERESTRATE – *Short-Term Interest Rate;* LONGTERMINTERESTRATE – *Long-Term Interest Rate;* BETA – *Beta in Sharpe's single-ratio model;* EUROSTOXX50VOLIDX – *Implied volatility of EURO STOXX 50;* SP500VOLIDX – *Implied volatility of S&P 500;* TUNOVERSEQQ – *Quarterly change of stock market turnover;* MARKETCAPSEQQ – *Quarterly change of stock market capitalisation.* ***, **, * – significance levels of 99%, 95% and 90% respectively.

Tab. 1. Estimation results for the impact of external determinants on the volatility of returns on European banks' stocks. Source: Calculated by the author.

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cause a drop in stock prices in the stock market because investors, influenced by worse information in the market, may refrain from investing in the stock market for the sake of more liquid assets. Therefore, an increase in the unemployment rate triggers growth in all studied stock return volatilities.

The variables describing quarterly changes, namely GDP, consumer price index, producer price index and retail sales index, largely do not affect the examined explanatory variables.

Another category of external factors are indicators describing the cost of money. The determinant that describes the cost of money based on the long-term interest rate has a statistically significant influence on the level of the studied volatilities. An increase in this variable of one percentage point will drive 360- and 30-day volatilities up by about 1.3 pp and the remaining volatilities up by almost 1.9 pp. A rise in interest rates is supposed to cool down the economy, loans become more expensive, which directly decreases banking incomes, hence bank stock prices are highly likely to begin to decline then, thus increasing volatility (as confirmed by the above research).

The short-term interest rate affects all explained variables and its growth of one percentage point will increase the examined volatilities by about 0.4 pp. A rise in the short-term interest rate may cause short-term imbalances in the stock market, thus making stock prices decline within a short time. Hence, volatility should increase (Teachers Insurance and Annuity Association of America, 2017).

The last category of external factors includes stock-market-related indicators. The determinant of the quarterly change of stock market capitalisation is statistically significant for all the variables studied. Its increase of one percentage point will drive the 180- and 360-day volatilities up by around 0.2 pp. Interestingly, its growth of one percentage point triggers a drop of approximately 0.2 pp for the 90-, 60- and 30-day volatilities. This is an example of a factor that has different effects on historical volatilities. This may be because volatilities behave in a completely different manner depending on what period is included in them. The 360-day historical volatility assesses the changes in a stock price throughout the year to the day on which it is calculated, whereas the 30-day volatility only examines the last 30 days from the date of its calculation. In this study, a significant difference was clearly noted between the examined explanatory variables.

Another factor is beta. Beta is an explanatory variable that, based on Sharpe's single-ratio model, refers to the risk of each examined bank in relation to the main stock market index in a given country. Beta growth denotes an increase in a bank's risk against the market benchmark. Therefore, a one-unit increase in this variable will drive the studied volatilities up by 6.1 pp. An increase in beta indicates greater risk of an examined bank in relation to the main stock market index in the country in which the bank's stocks are listed. Greater risk causes an increase in volatility, indicating that stock prices will be falling.

The implied volatility level of main world indices, i.e. S&P 500 and EUROSTOXX 50, has a significant statistical impact on the dependent variables studied. Greater implied volatility of S&P 500 and EUROSTOXX 50 results in an increase in explained variables of approximately 0.85 pp.

The last studied factor in this category is changes in stock market turnover. A turnover rise of one per cent will decrease the following volatilities: 360-day by about 0.014 pp, 180-day by about 0.012 pp, 90-day by about 0.011 pp, 60-day by about 0.006 pp and 30-day by about 0.004 pp. The intensification of stock market turnover is a sign of increasing liquidity of financial instruments that are traded in the examined stock market. Hence, as turnover rises, bank stock return volatility decreases.

5. Conclusion

In conclusion, the above analysis of the volatility of banking sector stock returns in Europe identified five major external factors that have a significant statistical effect on all the dependent variables studied, i.e.: unemployment rate, long-term interest rate, beta, and implied volatilities of S&P500 and EUROSTOXX50.

Referring to the above review of the literature on the factors behind stock return volatility, it can be noted that the research results undermine previous studies on the impact of CPI on historical volatilities carried out by Heston (1993) and Engle, Ghysels and Sohn (2008). In the above investigation, this index does not have a statistically significant impact on the examined volatilities of bank stock returns in Europe.

Yet, the obtained results confirm the findings of the 1997 study by Daly, who explored the determinants of volatility in the Australian stock market. His analysis showed that historical volatility of stocks is affected by the variables that describe the cost of money.

The results for the coefficient of determination proved to be very good, which allows for drawing conclusions analogous to those reported by the research team of Mele, Corradi and Distaso, who also strove to explain stock return volatilities on the basis of macroeconomic data and unobservable variables. Their findings showed that about 1/3 of the volatility level could be explained by macroeconomic indicators.

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Appendix

	gdpqq	cpiqq	ppiqq	retail~q	unempl~t	realin~e	shortt~e	longte~e	centra~e	lendin~e	beta	EUROST~x	SP500V~x	FTSE10~x	CACVol~x	DAXVol~x	AEXVol~x	SMIVol~x	bonds5y	bonds10y	tunove~q	market~q
gdpqq	1.00																					
cpiqq	0.57	1.00																				
ppiqq	0.42	0.53	1.00																			
retailsale~q	0.43	0.26	0.24	1.00																		
unemployment	-0.41	-0.31	-0.17	0.01	1.00																	
realintere~e	0.06	-0.07	0.02	0.41	-0.15	1.00																
shorttermi~e	0.70	0.82	0.49	0.21	-0.30	0.00	1.00															
longtermin~e	0.68	0.76	0.46	0.19	-0.19	0.03	0.95	1.00														
centralban~e	0.68	0.81	0.46	0.21	-0.30	0.01	0.98	0.92	1.00													
lendingint~e	0.49	0.56	0.37	0.48	0.09	0.12	0.66	0.68	0.68	1.00												
beta	-0.37	-0.41	-0.16	-0.17	0.07	-0.25	-0.54	-0.54	-0.55	-0.35	1.00											
EUROSTOXX50	0.09	0.00	0.11	0.13	-0.01	0.05	0.06	0.01	0.03	-0.04	-0.10	1.00										
SP500VolIdx	0.08	-0.12	-0.01	0.15	-0.01	0.11	0.05	0.03	0.01	-0.05	-0.12	0.85	1.00									
FTSE100VolIdx	0.06	-0.08	0.04	0.18	0.01	0.08	0.05	0.01	0.01	-0.06	-0.13	0.92	0.95	1.00								
CACVolIdx	0.10	0.00	0.12	0.13	-0.01	0.02	0.07	0.01	0.04	-0.03	-0.11	0.98	0.81	0.90	1.00							
DAXVolIdx	0.08	0.01	0.10	0.16	0.01	0.01	0.07	0.02	0.04	-0.04	-0.12	0.98	0.85	0.93	0.99	1.00						
AEXVolIdx	0.09	0.02	0.11	0.18	0.01	0.02	0.11	0.03	0.06	-0.02	-0.11	0.95	0.83	0.93	0.95	0.96	1.00					
SMIVolIdx	0.08	0.02	0.12	0.15	0.01	0.02	0.09	0.02	0.05	-0.02	-0.10	0.96	0.82	0.92	0.97	0.97	0.98	1.00				
bonds5y	0.67	0.74	0.43	0.19	-0.22	0.06	0.96	0.99	0.92	0.67	-0.56	0.06	0.08	0.06	0.06	0.07	0.08	0.07	1.00			
bonds10y	0.67	0.73	0.42	0.18	-0.21	0.06	0.94	0.99	0.91	0.67	-0.54	0.04	0.06	0.03	0.04	0.04	0.05	0.05	1.00	1.00		
tunoverseqq	-0.09	-0.08	-0.05	-0.04	0.08	0.00	-0.03	-0.03	-0.02	0.05	0.05	0.06	0.03	0.05	0.08	0.07	0.04	0.09	-0.01	0.00	1.00	
marketcaps~q	-0.31	-0.18	-0.22	-0.28	0.18	-0.12	-0.23	-0.27	-0.15	-0.16	0.13	-0.19	-0.43	-0.34	-0.15	-0.19	-0.20	-0.17	-0.27	-0.27	-0.05	1.00

Tab. 2. Spearman's correlation coefficient for banks in Europe. Source: Calculated by the author.

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