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Krzysztof Jajuga
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Lucjan T. Orlowski *Editors*

Contemporary Trends and Challenges in Finance

Proceedings from the 3rd Wroclaw International Conference in Finance

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Preface

This volume presents papers from the 3rd Wrocław International Conference in Finance held at the Wrocław University of Economics on September 13–14, 2017. We have sought to assemble a set of studies addressing a broad spectrum of recent trends and issues in finance, particularly those concerning markets and institutions in Central and Eastern European (CEE) countries. In the final selection, we accepted 23 of the papers that were presented at the conference. Each of the submissions has been reviewed by at least two anonymous referees, and the authors have subsequently revised their original manuscripts and incorporated the comments and suggestions of the referees. The selection criteria focused on the contribution of the papers to the modern finance literature and the use of advanced analytical techniques.

The chapters have been organized along the major fields and themes in finance: econometrics of financial markets, stock market investments, international finance, banking, corporate finance, and personal finance.

The section on the econometrics of financial markets contains three chapters. The chapter by Krystian Jaworski suggests a new method of density forecasts of foreign exchange rates using Monte Carlo simulation with regime switching depending on global financial markets' sentiment. Przemysław Garsztka and Paweł Kliber investigate the dynamic relation between returns and trading volume of stocks traded on the Warsaw Stock Exchange and find an evidence supporting the compliance of measure of information asymmetry, especially for medium and small capitalization companies. The chapter by Radosław Pietrzyk and Paweł Rokita discusses the existing regulatory stipulations in EU law, proposing modifications suitable for binary options.

The section on stock market investments contains five chapters. Agata Gluzicka examines whether integration of national economies has a positive impact on the diversification of equity markets. Lesław Markowski in his chapter investigates the relationship between the beta coefficients in the classical and downside framework using time series of daily returns on sectoral indices quoted on the Warsaw Stock Exchange. The chapter by Paweł Miłobędzki and Sabina Nowak shows estimation of intraday trading patterns of stocks included in the main Warsaw Stock Exchange Index WIG 20 as a function of rates of returns, bid-ask spreads, and trading volumes. Joanna Olbryś analyzes correlations between alternative liquidity measures derived from intraday data on the Warsaw Stock Exchange (WSE). The chapter by Anna Rutkowska-Ziarko and Christopher Pyke analyzes whether there is a significant correlation between accounting betas with variance and semi-variance approaches for companies listed on the Warsaw Stock Exchange.

The section on international finance contains two chapters. Rafał Siedlecki, Daniel Papla, and Agnieszka Bem examine the accuracy of S-curve methodology for real GDP forecasting in transition economies. The chapter by Bogdan Włodarczyk and Marek Szturo investigates whether financialization of commodity markets contributes to price volatility.

The part on banking contains five chapters. The chapter by Martin Boďa and Zuzana Piklová assesses comparability or congruence of efficiency scores yielded by two competitive approaches in a framework of data envelopment analysis for Slovak commercial banks. Patrycja Chodnicka-Jaworska verifies the impact of competitiveness and concentration measures on credit ratings of banks. The chapter by Ewa Dziwok compares different approaches proposed under Basel II for modeling operational risk and discusses new Basel IV proposals of regulatory capital charge for the operational risk. Beata Łubińska argues that application of optimization techniques can provide useful information to understand the target structure for the banking book in terms of its composition of liabilities. The chapter by Katarzyna Kuziak and Krzysztof Piontek shows the application of two methods of CoVaR estimation: GARCH and quantile regression for Polish banking industry.

The part on corporate finance contains six chapters. Katarzyna Byrka-Kita, Mateusz Czerwiński, Agnieszka Preś-Perepeczo, and Tomasz Wiśniewski analyze operating performance associated with the CEO succession in companies listed on the Warsaw Stock Exchange by using an event study based on accounting data. The chapter by Patrizia Gazzola and Piero Mella analyzes a firm as system not only for the creation of economic and financial value for their shareholders but also for the social values. Józefa Monika Gryko examines the determinants of corporate cash holdings in CEE countries, particularly the effects of tax changes and tax uncertainty on cash holdings in industrial companies in Bulgaria, Latvia, Lithuania, Poland, Romania, the Slovak Republic, and Slovenia. The chapter by Julia Koralun-Bereźnicka examines the diversification of primary determinants of capital structure in European countries. Andrzej Rutkowski shows the effects of serial acquisitions on the financial management of purchasing companies for companies listed on the Warsaw Stock Exchange. The chapter by Piotr Staszkiewicz and Bartosz Witkowski discusses various applications of insolvency and bankruptcy measures for business failure modeling.

The part on personal finance contains two chapters. The chapter by Kutlu Ergün examines the relationship between financial knowledge and parental influence among university students in ten European countries. Katarzyna Kochaniak verifies the significance of households' financial well-being for the values of their sight deposits, under economic and financial destabilization.

We wish to thank the authors for making their studies available for our volume. Their scholarly efforts and research inquiries made this volume possible. We are also indebted to the anonymous referees for providing insightful reviews with many useful comments and suggestions.

In spite of our intention to address a wide range of problems pertaining to financial markets, institutions, and business organizations, we recognize that there are myriad issues that still need to be researched. We hope that the studies included in our volume will encourage further research and analyses in modern finance.

December 21, 2017

Krzysztof Jajuga
Hermann Locarek-Junge
Lucjan T. Orlowski

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About the Editors

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Part I
Econometrics of Financial Markets

Information Asymmetry, Liquidity and the Dynamic Volume-Return Relation in Panel Data Analysis

Przemysław Garsztka and Paweł Kliber

Abstract In the paper we investigate the dynamic relation between returns and volume of individual stocks traded on the Warsaw Stock Exchange. Theoretical models, such as the one proposed by Wang (J Polit Econ 102(1):127–167, 1994) suggest that this relation reveals the information asymmetry in the market and the role of private information. According to the models, the trade generated by risk-sharing and public information tends to decrease autocorrelation of returns, while the trade generated by private information has the opposite effect. To test this empirically we compared the coefficients obtained from the return-volume relation with other approximations of information asymmetry, based on liquidity. Unlike other works we have used dynamic regression to obtain the coefficients for 52 stocks, assuming that coefficients for individual stock can vary from month to month. Then we used panel regression with random effects to test the relationship between coefficient of information asymmetry and liquidity. We find an evidence supporting the compliance of measure of information asymmetry, especially for medium and small capitalization companies.

Introduction

In this paper we try to check how the information asymmetry affects liquidity risk of shares in the Polish stock market. We have calculated coefficients measuring the information asymmetry in the market and compare them with several coefficients measuring liquidity. According to the theory and to common sense believes segments of the financial market which are less liquid should also have greater asymmetry of information.

Research on asymmetry of information on the capital market plays a significant role in the modern finance. Asymmetry of information is important in the investment

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decision-making process. The paper (Llorente et al. 2002) presents a dynamic model whose parameter describes information asymmetry. In addition, the authors present a relationship between the proposed measure of asymmetry of information and an approximation of information asymmetry, such as bid-ask spread or capitalization. As the authors note, it is also possible to investigate whether there is a relationship between the proposed measure of asymmetry of information and other measures of asymmetry.

Asymmetric information is inextricably linked to liquidity risk. The work of Bagehot (1971), where liquidity in securities was modeled with a bid-ask spread, was significant. Since this work, a number of proposals have been made in the literature to measure liquidity risk, but no satisfactory consensus has been found. The most important liquidity measures are considered bid-ask spread (Copeland 1979; Amihud and Mendelson 1986; Stoll 1989; Hasbrouck and Seppi 2001) or volume size (Datar et al. 1998; Antoniewicz 1993; Stickel and Verrecchia 1994; Blume et al. 1994). One of the most popular measures is the lack of liquidity measure Amihud (2002). Lesmond et al. (1999) proposed a liquidity measure based on the difference between the cost of buying and selling shares. The LOT measure (from the authors' names) represents the influence of private information on the transaction. As a result of various approaches to measuring liquidity, it is difficult to answer the question of how coherent the measures proposed are and to what extent they reflect unobservable liquidity (Liu 2006).

According to the methodology included in Llorente et al. (2002), the article examined the relationship between the measure of asymmetry of information formulated in Llorente et al. (2002) and liquidity measures such as the bid-ask spread, LOT and Amihud's illiquidity measure. It was noted that, as in (Amihud 2002), the information asymmetry is related to the size of the company measured by its capitalization. For large capitalization companies there is no correlation between the asymmetry of information and measures of liquidity, as opposed to companies with medium and small capitalization. Based on the panel data, however, there are periods in which the surveyed relation was observed for all companies, regardless of company capitalization. This suggests changes in the dynamics of information asymmetry over time.

The article consists of four parts. The model was presented in the second part. The third one briefly discusses the liquidity measures used. The results of empirical research were presented in the fourth part and conclusions were drawn.

The Model

To evaluate the degree of information asymmetry for individual stocks we use theoretical framework used in (Llorente et al. 2002). It is a simplified version of an equilibrium representative-agent model of financial market developed in (Wang 1994). Here we present a brief description of their model and empirical conclusions.

Llorente et al. (2002) assume that there are two types of investors. The first group consists of informed investors and the second group consists of uninformed ones.

In the market there are two types of securities: a bond and a stock. Investments in bonds are risk-free and brings constant, nonnegative rate. The stock at each moment t pays a dividend, which consists of two components: a forecastable part and an unforecastable one.

All investors at each moment observe current dividends and the forecastable part of next-period dividends. Informed investors know also the unforecastable part of dividends in the next period. Investments in stock brings profits in form of dividends and in price changes.

The informed investors also have a possibility to invest in a risky production technology. The rights to a flow of income from this technology is a non-tradable asset. At each moment the investor decides how much of his wealth he is willing to allocate for this asset.

All investors have information about the current prices of assets, the current dividends and the forecastable part of the future dividends. Informed investors have also information about unforecastable part of future dividends. Therefore, for them investment in the stock and the riskless bond are equivalent. Their effective choice is to allocate wealth between the stock (or bond) and private investment in a production technology. The uninformed investors allocate their means between the bond and the risky stock. Since all investors within the same group share the same information and attitude toward risk, trading in stocks is possible only between informed and uninformed investors.

Investors from different groups have different motives for trading. The uninformed investors react to public information—the predictable part of future dividends. They try to adjust their portfolio to preserve optimal risk profile. The trade generated by this motive is called hedging trade. On the other hand, the informed investors react to the private information about dividends in the next period. They speculate on news concerning future dividends. Trade generated by informed investors is referred to as speculative trade.

Those two kinds of trade influence differently autocorrelation of stock's returns. If there is no information asymmetry and there are no good or bad news, then stock returns are not serially correlated. In case of hedging trade there is a negative autocorrelation of returns. Let's assume, for example, that good news was revealed about future dividends. Uniformed investors reallocate their portfolios buying more stock and in order to make a transaction they have to offer a higher price. The return in this period is thus higher. Since public signals concerning future dividends are not serially correlated, it is likely that in the next period return will be lower, which decreases autocorrelation of returns. On the other hand, let us consider the situation in which good news about future dividends are revealed only to informed investors. In this case the speculative trade, initiated by informed group, takes place. Again, to buy the stock they have to propose a higher price, so in this period the return is higher. In the next period the good news are revealed to all investors (the higher dividends are paid), which increases the return in this period. The autocorrelation of returns tends to increase.

The reasoning presented here and the results from more formal model, presented for example in (Wang 1994 or Llorente et al. 2002) lead to an empirical equation allowing to test the model and to measure the degree of information asymmetry for different assets (if the model is valid). This is commonly measured by the following linear regression model:

$$R_{it+1} = \alpha_{i0} + \alpha_{i1} R_{it} + \alpha_{i2} R_{it} V_{it} + \varepsilon_{it+1} \tag{1}$$

where R_{it} is the company's i stock return at the moment t, V_{it} is the logarithm of trade volume (empirically, usually trade turnover is used here as an empirical counterpart) of stocks at the moment t, and ε_{it+1} is a random error.

The parameter α_{i1} describes "normal" autocorrelation of returns, connected with the inflow of new public information. According to the earlier considerations, the price changes with no volume are connected with the changes of the valuation of company. The parameter α_{i2} measures the autocorrelation of returns conditioned on the volume. As it was indicated earlier, the sign of this parameter depends on the motive of trading. Hedge trade involves negative autocorrelation of returns, while speculation trade works in the opposite way.

The empirical model given by eq. (1) is usually used to measure information asymmetry for individual stocks. In Llorente et al. (2002), Sun et al. (2014) or Su and Huang (2004) the regression eq. (1) was estimated for each stock individually, giving the asymmetry measure α_{i2} for individual stock i. In Hasbrouck (1991) the empirical model was developed more intuitively, without developing theoretical model of trade. In this research we assume that information asymmetry can change dynamically. To measure it we used dynamic regression. The parameters α_{i0}, α_{i1} and α_{i2} are assumed to change dynamically and the changes can be described by the following state-space model:

$$\alpha_{ijt} = \alpha_{ijt-1} + \varepsilon_{ijt} \tag{2}$$

where i is the index of considered company, j is the index of parameters in eq. (1) ($j = 0, 1, 2$). The random variable ε_{ijt} describes random changes in the parameters α_{ij}.

The model given by eqs. (1) and (2) is a state-space model of dynamic regression and the parameters α_{ijt} can be estimated using Kalman filtering and smoothing.[1] For the purpose of this research we are interested only in the parameter α_{i2t}, which we take as a measure of information asymmetry for the stock i at the moment t.

Liquidity Measures

As mentioned earlier, the article examined the relationship between the asymmetric measure of information represented by the α_{i2t} parameter and the liquidity measures of the stock. We hypothesized, according to Proposition 3 in Llorente et al. (2002),

[1]See for example Petris et al. (2009) Chap. 2 or Cowpertwait and Metcalfe (2009), Chap. 12.

that between the measures of liquidity and α_{i2t} there should be a relation given by the formula:

$$\alpha_{i2t} = f(A_{it}), \tag{3}$$

where A_{it} is a measure of liquidity. We choose bid-ask spread, LOT and Amihud's measure of illiquidity.

The size of the daily bid-ask spread was calculated according to the Warsaw Stock Exchange methodology with the formula:

$$S(t)_i = \left| \frac{p_{ti} - m_{ti}}{m_i} \right| |, \tag{4}$$

$$m_{ti} = \frac{bid_{ti} + ask_{ti}}{2} \tag{5}$$

and

$$S_i = \frac{\sum_{t=1}^{n} (V_{ti} \cdot S_i(t))}{V}, \tag{6}$$

where p_i is the price of the stock i, m_{ti} is the midpoint of *bid* and *ask* price, $S_i(t)$ is the temporary spread at time t, V_{ti} is the volume turnover of transaction at time t, V is the total daily turnover for the instrument and S_i is the daily bid-ask spread. As the independent variable to study the relation with asymmetry of information we used the monthly average of the daily value of the spread.

The second measure of liquidity is the spread between the transaction costs incurred by the buyer and the transaction costs incurred by the seller:

$$LOT = a_{2,k} - a_{1,k}, \tag{7}$$

In the LOT model, an investor with additional information will make a transaction as long as the expected profit exceeds transaction costs. Investors who have additional information make a sale after the appearance of negative information, and purchase transactions upon the appearance of good information. Model LOT is therefore defined by a set of conditions:

$$R^*_{k,t} = \beta_k R_{Mt} + \varepsilon_{k,t}, \tag{8}$$

where R_{Mt} is market return at time t;

$$R_{k,t} = \begin{cases} R^*_{k,t} - a_{1,k} & \text{if} \quad R^*_{k,t} < a_{1,k}, \\ 0 & \text{if} \quad a_{1,k} \le R^*_{k,t} \le a_{2,k}, \\ R^*_{k,t} - a_{2,k} & \text{if} \quad R^*_{k,t} > a_{2,k}, \end{cases} \tag{9}$$

(with $\alpha_{1,\ k} < 0 < \alpha_{2,\ k}$) the parameters of which can be estimated based on the likelihood function.

Third measure of liquidity is lack of liquidity of shares based on the daily quotation, according to the formula:

$$ILLIQ_{iy} = \frac{1}{D_{iy}} \cdot \sum_{d=1}^{D_{iy}} \frac{|R_{iyd}|}{DVOL_{iyd}} \tag{10}$$

where D_{iy} is the number of days at the period y, for which we have quotation for stock i, R_{iyd} is the daily return of stock i, $DVOL_{iyd}$—is daily volume turnover of transaction of stock i, at day d of period y.

Empirical Results

Our sample consists of stock traded on WSE. We obtain data on daily returns, prices, volumes, turnover and intraday (tick-by-tick) data on prices and volumes of transaction. Our sample period is from 02-01-2006 to 29-12-2016. During the sample period we choose 52 stocks, for which we have all data. Based on our data we calculate all (asymmetry information and liquidity) measures for separated monthly periods. Finally, each of our panel data consist of 52 time series of 132 monthly observations. For each stock we performed dynamic regression (1) to obtain the measures of information asymmetry.

To decide between fixed or random effect we run a Hausman test where the null hypothesis is that the preferred model is random effects vs. the alternative the fixed effects. For all three cases we have no reason to reject the null hypothesis, so for the estimation we choose a model with random effects:

$$\begin{aligned} y_{it} &= B_0 + b_A A_{it} + u_{it} \qquad\qquad i = 1, \ldots, N, t = 1, \ldots, T, \\ u_{it} &= \varepsilon_{it} + \alpha_i + \lambda_t \end{aligned} \tag{11}$$

Table 1 summarizes the Breusch and Pagan test, based on which it can be stated that there are panel effects in the data (null hypothesis in test is, that variances across entities is zero). This is true for all three liquidity proxies. Table 2 contains the results of Hausman test for random effects. The results of the tests confirms that the proper model was chosen.

The Table 3 lists the models for all three liquidity proxies. Only in the case of ILLIQ given by eq. (10) we can confirm a significant relation with α_{i2t}. As expected, an increase in the lack of fluidity measured by the ILLIQ variable results in a decrease in asymmetry of information. Tables 4, 5 and 6 show the results of model

Table 1 Breusch and Pagan Lagrangian multiplier test for random effects

	Bid-ask spread as a proxy for liquidity	LOT as a proxy for liquidity	ILLIQ as a proxy for liquidity
chibar2(01) =	5507.58	5153.03	5061.96
Prob > chibar2	0.0000	0.0000	0.0000

Table 2 Hausman test for random effects vs. fixed effects

	Bid-ask spread as a proxy for liquidity	LOT as a proxy for liquidity	ILLIQ as a proxy for liquidity
$chi^2(01) = (b-B)' [(V_b-V_B)^{-1}](b-B)=$	1.76	0.72	0.24
Prob > chi^2	0.1845	0.3958	0.6234

Table 3 Panel data random effects model, all companies

		Bid-ask spread as a proxy for liquidity	LOT as a proxy for liquidity	ILLIQ as a proxy for liquidity
Coefficients (*p* value)	b_A	0.1274 (0.898)	−0.1453 (0.375)	−0.0014 (0.019)
	B_0	−0.0612758 (0.072)	−0.0634183 (0.046)	−0.0632445 (0.045)
R^2 within =		0.0000	0.0001	0.0007
R^2 between =		0.0340	0.0120	0.0130
R^2 overall =		0.0016	0.0000	0.0017
rho (fraction of variance due to u_i)		0.1186	0.1099	0.1098

B_0 is constant and b_A is the coefficient of the proxy for liquidity; u_i is between entity error

Table 4 Panel data random effects model, big companies (capitalization > 500 mln euro)

		Bid-ask spread as a proxy for liquidity	LOT as a proxy for liquidity	ILLIQ as a proxy for liquidity
Coefficients (*p* value)	b_A	−0.4960 (0.943)	−0.7928 (0.566)	0.0780 (0.363)
	B_0	0.0366 (0.670)	0.0158 (0.833)	−0.0072 (0.922)
R^2 within =		0.0000	0.0004	0.0005
R^2 between =		0.0522	0.1028	0.0112
R^2 overall =		0.0015	0.0012	0.0000
rho (fraction of variance due to ui)		0.0706	0.0656	0.0725

B_0 is constant and b_A is the coefficient of the proxy for liquidity; u_i is between entity error

Table 5 Panel data random effects model, medium companies (capitalization > 100 mln euro)

		Bid-ask spread as a proxy for liquidity	LOT as a proxy for liquidity	ILLIQ as a proxy for liquidity
Coefficients (*p* value)	b_A	5.9728 (0.000)	−0.2955 (0.015)	0.0020 (0.150)
	B_0	−0.1125 (0.027)	−0.0480 (0.295)	−0.05687 (0.248)
R^2 within =		0.0056	0.0023	0.0007
R^2 between =		0.0337	0.1454	0.0099
R^2 overall =		0.0109	0.0000	0.0012
rho (fraction of variance due to u_i)		0.2448	0.2217	0. 2485

B_0 is constant and b_A is the coefficient of the proxy for liquidity; u_i is between entity error

Table 6 Panel data random effects model, small companies (capitalization < 100 mln euro)

		Bid-ask spread as a proxy for liquidity	LOT as a proxy for liquidity	ILLIQ as a proxy for liquidity
Coefficients (*p* value)	b_A	−0.9959 (0.086)	0.3392 (0.025)	−0.0016 (0.000)
	B_0	−0.1361 (0.000)	−0.1649 (0.000)	−0.1423 (0.000)
R^2 within =		0.0018	0.0028	0.0007
R^2 between =		0.1127	0.0809	0.0130
R^2 overall =		0.0006	0.0000	0.0017
rho (fraction of variance due to u_i)		0.1629	0.1487	0.1098

B_0 is constant and b_A is the coefficient of the proxy for liquidity; u_i is between entity error

estimation for companies with different capitalization. In the case of large companies failed to confirm the relationship in any case examined. By contrast, for medium and small companies in two out of three cases, the relationship has been confirmed. For statistically significant parameters, asymmetry of information should increase with the increase in liquidity risk—what was confirmed in one case for medium companies and one case for small companies.

In conclusion, the relationship between the degree of asymmetry of information and the liquidity measures cannot be confirmed for all the companies examined. According to the results, large capitalization companies do not show the relationship between information asymmetry and liquidity measures. Therefore it can be stated that the model presented in (Llorente et al. 2002) is not appropriate for these companies. In the case of companies with lower capitalization, the correlation was confirmed. Thus, on the Warsaw Stock Exchange there is a correlation between liquidity measures and asymmetry of information defined in (Llorente et al. 2002). For models estimated for medium and small capitalization companies, not all cases have been able to achieve full compliance with the liquidity proxies used. The reason for this is the fact that Polish stock market is not fully developed and liquidity risk is difficult to estimate. The Warsaw Stock Exchange continues to be included in emerging markets despite the fact that a significant part of the requirements for developed markets have been met.

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Density Forecasts of Emerging Markets' Exchange Rates Using Monte Carlo Simulation with Regime Switching

Krystian Jaworski

Abstract We develop a novel method to produce density forecasts of foreign exchange rates using Monte Carlo simulation with regime-switching depending on global financial markets' sentiment. Using multiple density forecast evaluation tools the proposed approach have been examined in one month ahead forecasting exercise for 22 emerging markets currencies rates vs. dollar. According to the log predictive density score criterion, in case of the majority of emerging markets' foreign exchange rates, the forecasting performance of the proposed approach is superior to the random walk forecast and AR-GARCH benchmarks. Further analysis of the proposed approach using coverage rates and Knüppel test indicate correct calibration of the density model. The conducted evaluation of the proposed approach suggests that such tool can be suitable for economists, risk managers, econometricians, or policy makers focused on producing accurate density forecasts of foreign exchange rates. The proposed approach is a valuable contribution to the existing literature on foreign exchange density forecasting.

Introduction

Since the original work of Meese and Rogoff (1983), many studies have been dedicated to the production and evaluation of exchange rate point forecasts, and the well-established view is that usually a simple random walk is the best forecasting model. In addition, though point forecasts garner most of attention, density and interval forecasts of FX rates are also of importance for the market participants.

A portion of literature highlights the importance of investor risk appetite in the analysis of FX rates. Liu et al. (2012) established that FX rates behave asymmetrically in reaction to shifts in global risk aversion. Hopper (1997) saw that exchange

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rates seem to be influenced by market sentiment rather than by economic fundamentals. Cairns et al. (2007) show that most of the currencies exhibit significant sensitivity towards volatility indicators.

In this paper we follow on these two strands of literature (density forecasting and influence of global markets' sentiment on FX rates). The objective of this study is to provide a simple, although effective and universal framework for preparing density forecasts of emerging markets' exchange rates. For this purpose we use Monte Carlo simulation based on historical, daily exchange rate returns capturing changes in the financial markets' sentiment. Our forecasts are evaluated using the popular tests available in literature and are compared against some benchmarks.

The remainder of this paper is organized as follows. Section 2 summarizes the present state of the art and introduces the algorithm used in our forecasting procedure. In Sect. 3 we evaluate our density forecasts using popular tests from literature. Sect. 4 concludes.

State of the Art and the Proposed Forecasting Algorithm

Tay and Wallis (2000) provide a review of the density forecasting literature. The literature on the density forecasting of FX rates is quite limited. General studies (Boero and Marrocu 2004; Christoffersen and Mazzotta 2005; Clews et al. 2000; Diebold et al. 1999; Sarno and Valente 2005) mainly emphasise the FX rate density forecasts that are based on parametric densities. Usually the forecasting exercises utilize high-frequency data, also the multi-step-ahead density forecasts are rarely examined. Recent studies show that—contrary to the point forecasts—the simple random walk can be beaten by nonlinear models regarding the accuracy of out-of-sample density forecasts (Balke et al. 2013; Hong et al. 2007).

This paper contributes to the relevant literature in that we propose an approach taking into consideration the influence of global financial markets' sentiment on exchange rates. Our forecasting algorithm is outlined below.

We assume that the FX market on each day is in one of three states (regimes)—neutral/normal, "risk-on" or "risk-off". "Risk-on", "risk-off" correspond to investors' sentiment connected with the level of global market risk (risk aversion). When risk is perceived as low, market participants have a tendency to participate in higher-risk investments ("risk-on"). When risk is regarded as high, market participants usually tend to escape towards so-called save heavens, i.e. lower-risk investments ("risk-off"). Otherwise, we consider that markets are in "neutral" stance.

The method to determine the regime on the particular day is arbitrary. To do so we consider the value of VIX index (the "fear gauge"), a widespread indicator of the implied volatility of S&P500 index options. VIX quantifies the investors' expectations of equity market volatility over the next 30-day period. The high VIX readings indicate that market participants anticipate large changes of option prices in any direction. The VIX quotations will hover around low levels when market participants expect neither serious downside risk nor considerable upside potential for prices of options. Historically, the value of VIX was positively correlated with risk aversion (Whaley 2000).

We consider that if, on a given day, VIX stands above the 3rd quartile of its historical daily values it a "risk-off" day/stance. If VIX places below the 1st quartile, it is a "risk-on" day. Anything between these two values is considered a neutral state (regime). It is worth noting that Orlowski (2017) performed a Bai-Perron threshold test (allowing a maximum of one threshold) for the daily series of VIX market. The test has generated a VIX threshold of 23.89 (i.e. the threshold between tranquil and turbulent days), which is similar to the 3rd quartile of VIX (24.24), i.e. the threshold between "normal" and "risk-off" days). Such findings support our approach.

To calculate the VIX quartiles and resulting regimes we use the full sample (every available daily observation up to the point when the forecast is made). It means that the regimes' threshold values (VIX quartiles) are different depending on the FX forecasting period in question. This is a pseudo real-time approach.

Using historical data we can calculate a transition matrix between these three states. A 3x3 matrix used to describe the (empirical) probabilities of transitions between two given states (day after day). For clarity, let's denote "risk-on" = 1, "neutral" = 2 and "risk-off" = 3.

$$\boldsymbol{P} = \begin{bmatrix} p_{11} & \cdots & p_{13} \\ \vdots & \ddots & \vdots \\ p_{31} & \cdots & p_{33} \end{bmatrix}, p_{ij} = \Pr(s_t = j | s_{t-1} = i). \tag{1}$$

Also we can calculate a matrix of cumulative probabilities of transitions [$\boldsymbol{C}$]. It will be used later:

$$\boldsymbol{C} = \begin{bmatrix} p_{11} & p_{11} + p_{12} & p_{11} + p_{12} + p_{13} \\ p_{21} & p_{21} + p_{22} & p_{21} + p_{22} + p_{23} \\ p_{31} & p_{31} + p_{32} & p_{31} + p_{32} + p_{33} \end{bmatrix} = \begin{bmatrix} p_{11} & p_{11} + p_{12} & 1 \\ p_{21} & p_{21} + p_{22} & 1 \\ p_{31} & p_{31} + p_{32} & 1 \end{bmatrix}. \tag{2}$$

$$c_{ij} = \Pr(s_t \leq j | s_{t-1} = i) \tag{3}$$

For a given FX rate [FX_t] (e.g. USDPLN) we calculate its daily percentage returns for the same sample as in case of VIX—every available daily observation up to the point when the forecast is made; as. $r_t = \log(FX_t) - \log(FX_{t-1})$

We divide the daily returns into three separate groups (empirical distributions) according to the state, in which they occurred: "risk-on returns" f(r_1), "risk-off returns" f(r_3) and "normal returns" f(r_2). It must be noted that the main differences between the three distributions occur in the tails

Once the data is transformed, we can use it to prepare the (one month ahead) FX density forecast. Preparing a FX forecast for a different time period requires repeated calculation of regimes' threshold values, $\boldsymbol{P}$ and $\boldsymbol{C}$ matrices, as well as division of FX returns into three regimes.

At the end of month m we check how many trading days [h] there are in the month m + 1, i.e. the month, for the end of which we would like to prepare the FX rate forecast (e.g. h = 20 days). As a starting point of the forecast we take the close FX rate of the last trading day of the m month [FX_0]. We also note the regime that persisted on this day [s_0]. To prepare a forecast of FX rate on the first day of the m + 1 month [FX_1] we first simulate in what state the markets are on this (1st) day. To do so, we randomly choose a number [x] from a uniformly distributed range [0;1]. Then, by calculating the transition matrix **C** (as outlined above) we can compute the regime on the first day [s_1] of the month. Depending on the state s_0, we choose one row (risk-on = 1st row, neutral = 2nd and risk-off = 3rd) of the **C** matrix. Then we select the smallest element of this row that is larger than or equal to x. Depending on which element we chose (1, 2 or 3) we obtain the regime on the first day of the m + 1 month (s_1). Depending on what state ("risk-on", "risk-off" or "neutral") occurs on the first day of the current month (s_1) according to our simulation, we randomly choose a daily percentage return [r_*] from either f(r_1) or f(r_3) or f(r_2), respectively. Then we use it to obtain FX_1 as $FX_1 = FX_0 * (1 + r_*)$

In the same way (first randomly obtaining the regime using the transition matrix and then a return from this particular state) we can recursively calculate the FX rate values for all the remaining (h − 1) days of the current month, i.e. $FX_t = FX_{t-1} * (1 + r_*)$

Please note that r_* (dependent on the state occurring one day earlier and the transition matrix) is randomly chosen in each iteration, and is different in each iteration. Then using the Monte Carlo approach, we repeat the whole process of forecasting N times. The only restraint on N is the time required for calculation. We use N = 15000. By doing so we get a simulated distribution of one month ahead ($m + 1$) forecast of FX rate (N instances of FX_h).

Calculation and Evaluation of Density Forecasts

We have tested the out-of sample forecasting accuracy of this algorithm by preparing 72 one month ahead density forecasts for the end of each month in the period of 2010–2015, for each of 22 emerging markets' FX rates (eg. USDPLN, USDHUF, etc.; full list of FX rates is provided in Table 1). The first out-of sample forecast (for end of January 2010) was prepared with model using all available data, regarding VIX and a given FX rate, from the 1990–2009 period. Further forecasts are prepared on the rolling sample (window moving by one month). The use of rolling sample is vindicated due to the fact that the data-generating process in the financial markets is unstable and often changes as the time passes. At the same time the sample should be possibly long to properly capture the wide range of VIX values used in calculating the regimes. The above means that we follow a pseudo real-time forecasting approach.

The aim of this paper is the evaluation of density forecasts. Therefore extensive investigation of point forecast accuracy (using mean of the density forecast) is not performed in this paper. To evaluate the quality of the density forecast we follow the novel full-density/local analysis approach outlined in Gaglianone and Marins (2017).

Table 1 Rank of models based on LPDS and results of Amisano and Giacomini (2007) test

	Baseline	B1	B2	B3	B4	B5	Amisano-Giacomini test	
USDBRL	1	3	5	6	4	2	Baseline vs. B5 (0,623)	Baseline vs. B1 (0,477)
USDCLP	1	2	6	5	4	3	Baseline vs. B1 (0,501)	Baseline vs. B1 (0,501)
USDCNY	5	6	3	2	4	1	Baseline vs. B5 (0,103)	Baseline vs. B1 (0,765)
USDCOP	1	4	5	6	3	2	Baseline vs. B5 (0,781)	Baseline vs. B1 (0,023)
USDEGP	1	4	5	6	3	2	Baseline vs. B5 (0,325)	Baseline vs. B1 (0,056)
USDIDR	3	4	5	6	2	1	Baseline vs. B5 (0)	Baseline vs. B1 (0)
USDINR	3	5	6	4	2	1	Baseline vs. B5 (0,039)	Baseline vs. B1 (0,175)
USDKRW	1	4	6	5	3	2	Baseline vs. B5 (0,442)	Baseline vs. B1 (0)
USDMXN	1	3	5	6	4	2	Baseline vs. B5 (0,48)	Baseline vs. B1 (0,235)
USDMYR	1	2	6	4	3	5	Baseline vs. B1 (0,553)	Baseline vs. B1 (0,553)
USDPEN	3	4	5	6	2	1	Baseline vs. B5 (0,122)	Baseline vs. B1 (0,092)
USDPHP	1	4	6	5	2	3	Baseline vs. B4 (0,933)	Baseline vs. B1 (0,002)
USDRUB	1	4	5	6	3	2	Baseline vs. B5 (0,783)	Baseline vs. B1 (0,011)
USDTHB	3	4	6	5	2	1	Baseline vs. B5 (0,001)	Baseline vs. B1 (0)
USDTRY	4	2	6	5	3	1	Baseline vs. B5 (0,245)	Baseline vs. B1 (0,598)
USDTWD	1	3	5	6	4	2	Baseline vs. B5 (0,954)	Baseline vs. B1 (0,815)
USDVND	1	3	6	5	4	2	Baseline vs. B5 (0,259)	Baseline vs. B1 (0,007)
USDZAR	1	4	6	5	3	2	Baseline vs. B5 (0,598)	Baseline vs. B1 (0,175)
USDPLN	2	4	6	5	3	1	Baseline vs. B5 (0,427)	Baseline vs. B1 (0,21)
USDRON	1	4	6	5	3	2	Baseline vs. B5 (0,168)	Baseline vs. B1 (0,069)
USDHUF	1	4	6	5	3	2	Baseline vs. B5 (0,703)	Baseline vs. B1 (0,243)
USDCZK	1	2	6	5	4	3	Baseline vs. B1 (0,656)	Baseline vs. B1 (0,656)

Note: The best model according to the LPDS rank ordering (i.e. higher LPDS figures) is highlighted in grey for each exchange rate. In the second to last column the baseline model is compared with the best benchmark using Amisano-Giacomini test. In the last column, the baseline model is compared with random walk forecast. Grey cells indicate that the baseline model is statistically (at 5%) better than the corresponding benchmark; black cells indicate that the baseline model performs statistically worse than the corresponding benchmark. White cells signal no statistically significant difference between the density forecasts of the baseline model and the corresponding benchmark. Own calculations.

Coverage Rates

Clark (2011) points out that a good first step in the evaluation of density forecasts are coverage rates, namely the accuracy of interval forecasts. Other studies such as Giordani and Villani (2010) also observe that interval forecasts are a valid test of density forecast calibration.

In our case we chose a 70% coverage rate, which indicates the frequency with which actual FX rates belong to the 70% highest posterior density intervals calculated using the proposed approach. Correct interval should bear a frequency of ca. 70%. A frequency of less (more) than 70% indicates that, in case of the analysed sample, the estimated density is too narrow (wide). We tested the null of correct coverage (empirical = nominal rate of 70%), based on t-statistics using standard errors computed with the Newey-West estimator. The proposed forecasting approach yields correct interval forecasts (i.e. empirical coverage rates equal approximately to 70%) for 14 out of 22 exchange rates. For the remaining 8 FX rates the null hypothesis is rejected (at 5% confidence level). For USDEGP, USDIDR, USDKRW, USDTHB and USDTRY intervals turned out to be too wide, with actual observations residing within the intervals more often than the nominal 70% rate. On the other hand, in case of USDCNY, USDMYR and USDRUB the intervals are to narrow. These results are superior to those calculated using random walk forecast. For random walk density forecast, the null hypothesis is rejected 11 out of 22 times.

Knüppel (2015) Test

Berkowitz (2001) proposed a density test, which utilises a probability integral transformation (PIT). It assumed that the PITs are i.i.d. which implies that they are independent across time. In practice, PITs are usually subject to some form of autocorrelation (Dovern and Manner 2016). One test that allows accounting for autocorrelation in a straightforward way suggested by Knüppel (2015).

In our case, we employ the first four raw moments to build the test statistic. The Knüppel test reveals that the forecasts prepared using the proposed approach are not rejected for 18 out of 22 exchange rates (at 5% confidence level) which suggests correct calibration of the density model. In case of only four exchange rates—USDCNY, USDEGP, USDTRY and USDVND the null is rejected. In case of random walk forecasts, models for eight exchange rates were rejected.

Log Predictive Density Scores

The next indicator we employ to investigate whether the density forecast is properly calibrated is the log predictive density score (LPDS). This measure provides a way to classify analysed models (different benchmarks) regarding their accuracy (correct calibration). The LPDS of the model/benchmark m for the forecast of FX rate in the horizon h is given as:

$$LPDS_{m,h} = T^{-1} \sum_{t=1}^{T} \ln \left(\widehat{f}^{\,m}_{t+h,\,t}(Y_{t+h}) \right) \tag{8}$$

where $\widehat{f}^{\,m}_{t+h,t}$ is the density of the exchange rate calculated using model m and utilising information set available at period t. The mentioned density is assessed at the observed FX rate Y_{t+h} and log averaged using the out-of-sample observations. Adolfson et al. (2005) note that higher LPDS points to a superior model/benchmark, Amisano and Giacomini (2007) developed a likelihood ratio test for confronting out-of-sample performance of two rival density forecasts. They recommended calculating scoring rules, which are loss functions established based on the probability forecast and the actual outcome of the FX rate. The proposed test sets side by side the LPDS between two rival benchmarks. The null hypothesis assumes equal LPDS for both models (i.e. density forecasts are equally good). The alternative suggests that the performance of the model with higher LPDS is statistically superior to its counterpart (the model with lower LPDS).

We compare our model (Baseline) using LPDS criterion against five benchmarks. The first benchmark (B1) is a random walk model without drift. We have joined it up with a normal distribution to be able to generate the density forecast. The random walk point forecast indicates the expected value of the distribution, and the variance of the distribution is implied by the variance of past point forecast errors in the sample.

The second benchmark (B2) is an AR(1)-GARCH(1,1), normal distribution model estimated on the daily returns. The third benchmark (B3) is also AR(1)-GARCH(1,1) model, but with residuals that are Student's *t* distributed. Benchmarks four and five (B4, B5) are the same models as B2 and B3, respectively but estimated on monthly data instead on daily observations. The AR(1)-GARCH(1,1) was used due to its popularity in literature and universality across different FX rates. This simple specification is usually adequate to capture the FX rates volatility. In each case the benchmark models were estimated on the same (rolling) sample as the baseline model—a pseudo real-time forecasting design.

The LPDS ranking in Table 1 point, in general, to the proposed approach as the best model for forecasting majority (15 out of 22) of exchange rates. For the remaining 7 out of 22 exchange rates benchmark B5 shows superior performance. It is also noted that benchmarks (B1–B4) are usually overwhelmed in most of cases.

However, based on the Amisano and Giacomini (2007) test we cannot confirm the statistically superior performance of the proposed model. In the 15 cases there is no statistical difference between the LPDS of the baseline model and the best benchmark. Also in only three cases (USDIDR, USDINR, USDTHB; black cells) the baseline model is performs significantly worse than the best benchmark.

We have also compared the proposed approach directly against the random walk forecast (B1). In 7 cases (USDCOP, USDIDR, USDKRW, USDTHB, USDRUB, USDPHP, USDVND; grey cells in the last column) the proposed model is statistically better than the random walk forecast. In the remaining 15 cases the Amisano-Giacomini test signals no statistically significant difference between the density forecasts.

Results and Discussion

This paper examines the proposed novel approach to produce density forecasts of FX rates using Monte Carlo simulation with regime-switching depending on global financial markets' sentiment. Using multiple density forecast evaluation tools the approach have been examined in one month ahead forecasting exercise for 22 emerging markets currencies rates vs. dollar. We did not focus on point forecasts, but only investigate the ability to produce accurate density forecasts.

According to the LPDS scores, the forecasting performance of the proposed approach is superior to the random walk forecast for all 22 analysed exchange rates, and more accurate than AR(1)-GARCH(1,1) benchmarks in case of 15 out of 22 analysed exchange rates. However, using the Amisano and Giacomini (2007) test the advantage against the best benchmark is not statistically significant.

The difficulty to reject the null hypothesis (in other words: to single out the statistically superior model) is not disconcerting taking into the consideration the possibly low power of the utilised evaluation approach, on account of a somewhat short sample length (only 72 out-of-sample data points) to perform density forecast comparisons. On the other hand, in typical evaluations of density forecasts of financial markets' indicators hundreds or thousands of observations are being used—e.g. daily returns (Gaglianone and Marins 2017). Nevertheless, in 7 out 22 cases the proposed approach is statistically superior to random walk density forecast.

Although the results show that proposed method may not be universally used tool to produce density forecast for all exchange rates, sill the evaluation process indicates that it yields optimistic results for the majority of currency pairs.

Moreover, the proposed approach allows great flexibility. The possible modification of the procedure may include different definitions of financial markets' stances or introduction of more regimes. This is an avenue for further research, which is likely to enhance the forecasting performance of this approach.

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Determination of the Own Funds Requirements for the Risk of Binary Options

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Abstract Binary options are popular instruments, especially in non-regulated financial markets. Determination of adequate capital, if performed in compliance with binding legal regulations on own funds requirements, may be seriously misleading. This is particularly the case of short-term binary options. The aim of this article is to discuss critically the existing solutions in EU law and to propose some modifications that would be better suited to the nature of this type of financial instrument. The modifications allow to avoid overestimation of adequate capital and better reflect properties of the value of long-term and short-term cash-or-nothing binary options.

Introduction

This article discusses the problem of adequate capital for short positions in cash-or-nothing binary options. There are many financial institutions that offer options of this type to their clients. Their underlying instruments are typically currency pairs, but also gold and some other commodities. Very often, these are short-term options (expiring in less than one day) and they are usually written with the exercise price that is close or identical to the underlying price at the moment of writing. Because of the short time to expiration, the underlying price is unlikely to deviate much from the exercise price. The options are thus close to being at the money through all their lives. If such an option is slightly out of the money, then it may be switched to the in-the-money state even by a very small change of the underlying. Sometimes switching the option from paying nothing to paying the full amount of the payoff may be triggered by a one-tick change in the underlying price. The non-continuity of the payoff function and the fact that the payoff from the option is a fixed amount of money makes delta-coefficient-based approximation of the option value hardly applicable.

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The approach that is directly taken from existing regulations results in unnecessarily high own fund requirements if the option is close to being at the money, especially if the time to option expiration is short. The delta-risk equivalent, and thus also the total (joint) equivalent, exceeds significantly the maximum payoff from the option. This is due to high delta in a narrow neighborhood of the pricing function inflection point.

The proposals suggested for consideration in Sect. 5 of this article are attempts to overcome this problem at the cost of as small modification of the methodology that is currently required by law as possible.

When constructing the formulas of adequate capital charges, the following conditions were taken into account:

- The risk equivalent used to determine the adequate capital should not exceed the maximum negative cash flow that a position may ever generate.
- Its value should also depend in a way on the probability that the negative cash flow will be incurred.
- And finally, the own funds requirement should amount to only this part of the whole exposure value that results from risk weight imposed by relevant regulations.

From the considered approaches, the Approach 4 (Sect. 5) best fulfills the conditions. On the other hand, this one is most interfering with the existing legal regulations. Its application would be thus conditional to changes in EU legislation.

Bounding Legislation

Whenever the term "**CRR Regulation**" is used hereinafter, it shall be taken to mean the Regulation (EU) No 575/2013 of the European Parliament and of the Council of 26 June 2013 on prudential requirements for credit institutions and investment firms and amending Regulation (EU) No 648/2012.

Whenever the term "**Delegated Regulation**" is used, it shell be read as Commission Delegated Regulation (EU) No 528/2014 of 12 March 2014 supplementing Regulation (EU) No 575/2013 of the European Parliament and of the Council with regard to regulatory technical standards for non-delta risk of options in the standardised market risk approach.

Binary Cash-or-Nothing Option Under Assumptions of the Black-Scholes Model

If assumptions of the generalized Black-Scholes-Merton model hold (Black and Scholes 1973; Merton 1973; Black 1976; Garman and Kohlhagen 1983), prices of up (g_U) and, respectively, down (g_D) binary cash-or-nothing options are given by eq. 1 (Kosowski and Neftci 2015):

$$g_U = Qe^{-rT}\mathrm{N}(d_2); g_D = Qe^{-rT}\mathrm{N}(-d_2) \tag{1}$$

Their delta coefficients may be calculated as:

$$\delta_{bin_U} = Qe^{-rT}\frac{n(d_2)}{S\sigma\sqrt{T}}; \delta_{bin_D} = -Qe^{-rT}\frac{n(-d_2)}{S\sigma\sqrt{T}} \tag{2}$$

where: g_U denotes the price of an up option, g_D is the price of a down option, Q is the payoff, given that the option is exercised, S—price of the underlying instrument, σ—standard deviation of logarithmic returns on the underlying instrument, X—option exercise (strike) price, T—time to option expiration, r—risk free rate, $N(.)$—standard normal cumulative distribution function, $N(d_2)$—probability that the underlying price will exceed the exercise price at the moment of option expiration, d_2—the d_2 variable from one of the sub-models of the generalized Black-Scholes-Merton model, $n(.)$—density function of standard normal distribution, $\delta_{bin\ U}$—delta coefficient of the up binary option, $\delta_{bin\ D}$—delta coefficient of the down binary option.

Further in this text, the delta coefficient of an up binary option is denoted just with the symbol $\delta_{bin.}$, as only this kind of options will be discussed.

Using other option pricing models, like Heston and Nandi (2000), for example, will result in binary option deltas of similar general properties but different values. In some neighborhood of the point where the binary option is at the money, the slope of the option pricing function may be significantly different for different models. Thus, delta will also differ. For Heston-Nandi model, the slope is higher, for Black-Scholes—it is smaller. But, in both cases, delta is high relative to maximum payoff if the underlying price is close to the exercise price, especially for short times to expiration.

Calculation of the Delta and Non-delta Equivalents on the Basis of the Legal Regulations Currently in Force in the EU

The Delegated Regulation clarifies the content of the Article 329(2), Article 352(5) and Article 358(3) of the CRR Regulation. Taking the text of the Delegated Regulation literally, the value of the ***delta equivalent*** should be calculated in the following way: (point (b) of Article 3(1)):

$$D_{eq} = \delta_{bin} S_t w \tag{3}$$

where: w—risk weight, in line with the CRR Regulation, S_t—price of the underlying instrument at a given moment, δ_{bin}—delta coefficient of a cash-or-nothing binary option, D_{eq}—delta equivalent.

Let us denote the maximum payoff from a binary cash-or-nothing option with a symbol Q. For a short position in this option, it is the maximum and the only possible negative cash flow per one unit of the option.

The regulation addresses also the impact of the part of risk that is not explained with the delta equivalent. Pursuant to Article 4(3)(b) of the Delegated Regulation, for a short position in an option with a non-continuous pay-off function, the so called non-delta risk is taken into account by means of a ***non-delta equivalent***, which is calculated as:

$$N_{eq} = \max\left(0; Q - D_{eq}\right) \tag{4}$$

This is what binding regulations say. Why not to use the delta and non-delta equivalents just as they are? The problem is that they fail when applied to binary cash-or-nothing options, especially if the options are at the money, only slightly out of the money, or only slightly in the money, and close to the expiration moment.

In the next section, some approaches that better suit to the nature of binary cash-or-nothing options are proposed. Firstly, it seems necessary to add an upper limit to the delta equivalent. The second question is how to address the non-delta risk. The maximum level of the total equivalent should never exceeds the maximum payoff.

Considered Approaches

Four approaches to joint (total) equivalent determination are defined and compared. The first one comes directly from a literal interpretation of the CRR Regulation and Delegated Regulation. The second modifies the Delegated regulation method by limiting the equivalent to the highest possible payoff. The third one addresses the asymmetry between the situations when an option is out of the money and when it is in the money. The fourth one improves the way in which the risk impact multiplier is taken into account.

Approach 1
Delta and non-delta equivalent is calculated directly from CRR Regulation and Delegated Regulation taken literally:

$$D_{eq} = \delta_{bin} S_t w \tag{5}$$

$$N_{eq} = \max(0; Q - \delta_{bin} S_t w) \tag{6}$$

Approach 2
The approach is based on the text of the CRR Regulation and Delegated Regulation but it is corrected by imposing a limit on the value of the exposition. Both delta and non-delta equivalents contain the information about the maximum payoff.

$$D^{*}_{eq} = \min(Q, \delta_{bin} S_t) w \tag{7}$$

$$N^{*}_{eq} = \max(0, Q - \min(Q, \delta_{bin} S_t) w) \tag{8}$$

This limited equivalent, albeit not perfectly grounded on the basis of the existing legal regulations, is well justified. It may be backed by an analogy to positions in standard financial instruments that are no derivatives. There, the equivalent cannot exceed the value of joint exposure too.

Approach 3

The second approach has, however, an important drawback. The non-delta equivalent (eq. 8) approaches the maximum payoff when delta coefficient approaches zero. Delta is very close to zero whenever the option is deeply in the money or out of the money. And delta asymptotically approaches zero as the option becomes deeper and deeper in or out of the money. At the same time, it is hardly probable that an option that is deeply out of the money and has short time to maturity will be exercised. In turn, the probability is very high for an option that is deeply in the money. These two situations are thus very different. The joint delta-and-non-delta equivalent does not allow to reflect this asymmetry in any way. Under Approach 2, it really does not matter which option pricing model is chosen, nor whether delta is calculated correctly. The total equivalent is not affected by the choice of the delta-calculation model and is just equal to the maximum payoff. It seems therefore to be justified to take the non-delta risk into account only if the option is in the money or at the money. For an up option we obtain then:

$$N^{**}_{eq} = \begin{cases} 0 & \text{if} \quad S_t < X \\ \max(0; Q - \min(Q, \delta_{bin} S_t) w) & \text{if} \quad S_t \geq X \end{cases} \tag{9}$$

A reservation must be, however, made here. Under this approach, the total equivalent for a deeply-in-the-money option is equal to maximum payoff. This is also not perfectly in line with the idea of the risk equivalent.

Approach 4

In this approach, we propose to make the upper bound of the total equivalent conditional on the multiplier w. The non-delta equivalent is then modified in the following way:

$$N^{***}_{eq} = \begin{cases} 0 & \text{if} \quad S_t < X \\ \max(0; Qw - \min(Q, \delta_{bin} S_t) w) & \text{if} \quad S_t \geq X \end{cases} \tag{10}$$

Unlike the equivalent defined in eq. 9, the one given by the eq. 10 depends on risk weight, which makes it better suited to the idea that underlies the use of risk equivalents.

Performance of these approaches are illustrated by the numerical examples below.

Numerical Examples

This section presents results of the approaches discussed above, simulated for different deltas and different underlying spot prices. In the Example 1, delta equivalent, non-delta equivalent and total equivalent values are calculated for a short position in an up cash-or-nothing binary option, assuming some given price of the underlying instrument, for three cases with different sensitivities δ. In the Example 2, in turn, performance of the considered approaches is illustrated for different values of the underlying price.

Example 1
Short position in a binary up EURUSD option. Payoff: 10 EUR. Exercise exchange rate (strike): 1.1968 (USD per 1 EUR). Spot EURUSD exchange rate at the moment: 1.1968 (USD per 1 EUR). Risk weight: $w = 8\%$. Delta coefficient: $\delta = 1000; 1; 0.25$.

Table 1 presents the results of application of the four aforementioned approaches for different values of delta coefficient.

Each column of Table 1 refers to the same value of the exercise price and the same current spot price of the underlying instrument. The differences in delta may result from different times to option expiration or different option-pricing models backing the delta calculation. The option is now at the money. This is the state in which delta of a binary cash-or-nothing option may be really high. It must be pointed out that Approach 1 allows the amount of own funds requirement to exceed the maximum amount of payoff (see the case of δ = 1000). In the Approach 2 and Approach 3, the total equivalent is equal to the maximum payoff. In the fourth approach, the total equivalent reflects the risk weight set by regulations (it is equal to the maximum payoff times the weight).

Table 1 The delta, non-delta and total risk equivalent for an at-the-money binary cash-or-nothing option under different values of delta (possible if time to expiration differs or delta is calculated on the basis of different option pricing models)

Approach	$\delta = 1000$		$\delta = 1$		$\delta = 0.25$	
1	Delta equiv.	95.74	Delta equiv.	0.10	Delta equiv.	0.02
	Non-delta	0.00	Non-delta	9.90	Non-delta	9.98
	Total	95.74	Total	10.00	Total	10.00
2	Delta equiv.	0.80	Delta equiv.	0.10	Delta equiv.	0.02
	Non-delta	9.20	Non-delta.	9.90	Non-delta	9.98
	Total	10.00	Total	10.00	Total	10.00
3	Delta equiv.	0.80	Delta equiv.	0.10	Delta equiv.	0.02
	Non-delta	9.20	Non-delta	9.90	Non-delta	9.98
	Total	10.00	Total	10.00	Total	10.00
4	Delta equiv.	0.80	Delta equiv.	0.10	Delta equiv.	0.02
	Non-delta	0.00	Non-delta	0.70	Non-delta	0.78
	Total	0.80	Total	0.80	Total	0.80

The Approach 3 and Approach 4 are, moreover, asymmetric. The merits of this have already been mentioned in the previous section. The Example 1 does not allow to illustrate this property because it is set for only one value of the underlying price.

Example 2
Let us assume that an institution writes a short-term up binary cash-or-nothing option on a foreign exchange rate. The underlying currency pair is EURUSD. The exercise price is set to be 1.1968, whereas the foreign exchange rate on the spot market is currently at the level of 1.1967. The option is written with the expiration horizon of 5 min (such a short term is typical for the market of binary cash-or-nothing FX options). The payoff has been set at 10 USD per one option. Risk weight for currency market instruments is 8%. Summing up, the parameters of the example are as follows:

$$S = 1.1967; X = 1.1968; T = 5\ \text{min}; w = 8\%; Q = 10\ \text{EUR}$$

In this example, assumptions of the generalized Black-Scholes-Merton model are used. Calculations of up binary option price and delta are based on the formulas presented in eq. 1. The model is calibrated on the basis of data from Aug. 29th, 2017. One-minute quotations are used. Because of a short time to option expiration (5 min), the risk free interest rates, both for EUR and USD markets, are assumed to be negligible and set to zero.

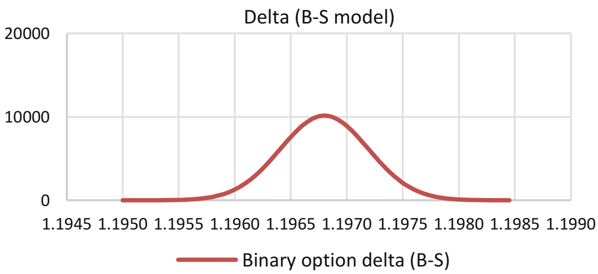
Fig. 1 illustrates the property that delta of a binary option is the higher the closer the underlying price is to the strike.

It should be noted that the peak of delta, when delta is treated as a function of the spot underlying price, may be really high relatively to the maximum payoff from the option. Here, for example, the value of delta is 10 141 when the underlying FX rate equals to the exercise price. Under literal interpretation of the CRR Regulation, this value of delta would imply that delta risk equivalent should amount to 970.94 EUR per one unit of option, whereas the maximum payoff from the option is 10 EUR.

To show how the delta and non-delta equivalent formulas work in more details, the equivalents are calculated using the approaches proposed in Sect. 5 for a set of underlying price values.

The total equivalent obtained from the Approach 1 may exceed the maximum payoff from the option (10 EUR). This is, of course, not complying with the idea of

Fig. 1 Delta of a binary cash-or-nothing option under Black-Scholes assumptions



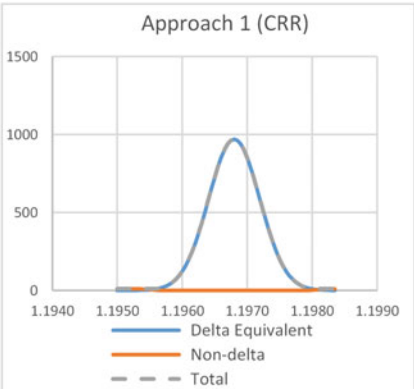
own fund requirement determination, even though it is in full accordance with the CRR Regulation and Delegated Regulation if read verbatim.

The relationship between the equivalents and the underlying price is illustrated by Panel I of Fig. 2.

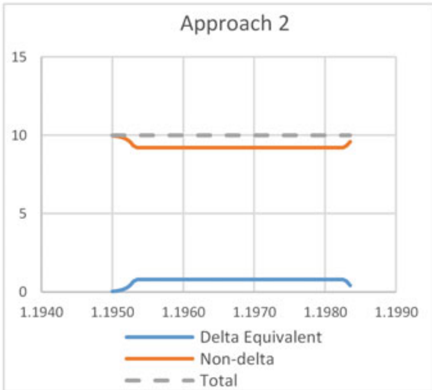
Panel II of Fig. 2 presents, in turn, results of application of the Approach 2. This approach gives a constant total equivalent.

The Approach 2 has the advantage that it limits the joint (total) equivalent to the amount of the maximum payoff. This way of own fund requirement calculation cannot be, however, directly inferred from regulations. Moreover, it is still not a good solution, because the total equivalent does not depend on the price of the underlying instrument, as, quite simply, the equivalent is constant.

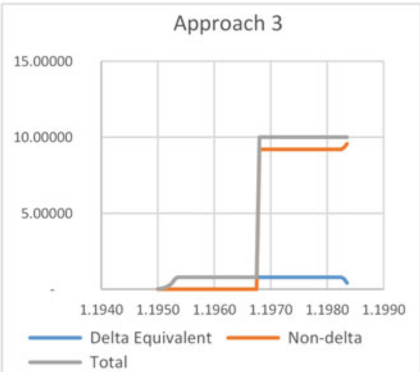
It seems necessary to find an approach that would better address both the nature of the financial instrument and the idea of adequate capital. For other types of financial



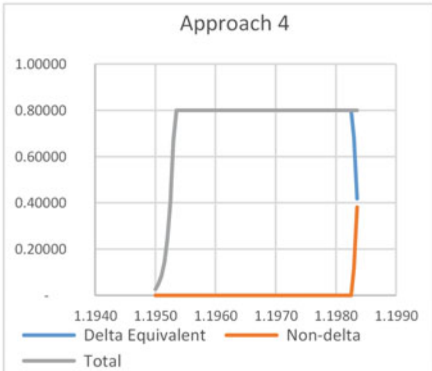
Panel I Delta, non-delta and total equivalent in the Approach 1



Panel II Delta, non-delta and total equivalent in the Approach 2



Panel III Delta, non-delta and total equivalent in the Approach 3



Panel IV Delta, non-delta and total equivalent in the Approach 4

Fig. 2 Delta, non-delta and total equivalents obtained in the considered approaches, presented as functions of the underlying price instruments, the adequate capital usually covers only part of the risk exposure. It should also depend on how likely the risk realization event is.

The Approach 3 is an attempt to meet these postulates. It is an asymmetric one. It significantly constraints the own fund requirement if the option is deeply out of the money. The non-delta equivalent is activated only one-sidedly then.

The way in which the equivalents obtained from the Approach 3 behave for different values of the underlying price is illustrated in Panel III of Fig. 2.

The Approach 3 is not without its flaws. The maximum value of the equivalent is still equal to the maximum payoff (that is—to the maximum cash outflow that may be incurred by the option writer) if the option is in the money. It is not what it should be like if the equivalent was to be in compliance with the very idea if adequate capital determination.

The last approach (Approach 4) is a modification of the Approach 3 so that the total equivalent may reach, at most, the amount of the possible payoff times the risk weight defined for this kind of exposure (for a currency position it is 8%).

Performance of the Approach 4 is shown in Panel IV of Fig. 2. The relationship between the underlying spot FX rate and the total equivalent is asymmetric, like in the Approach 3. This gives the advantage over the Approach 1 and Approach 2, because the total equivalent of the Approach 4 is the higher the more plausible it is that the written option will be exercised. At the same time, the own funds requirement resulting from this way of equivalent calculation is not equal to the full value of the exposure, but rather depends on the risk weight imposed by capital adequacy regulations. In all other discussed approach the use of the multiplier w did not make any difference.

Summary

As it has been shown in this article, the legal acts that are currently in force are not well suited to regulate own funds requirement for binary cash-or-nothing options. Options of this type, especially short-term ones, are very popular. The question how financial institutions should calculate the own fund requirements for this kind of exposure is a matter of vital importance.

The main flaw of the approach taken directly from literal interpretation of the CRR Regulation and Delegated Regulation is that it is based on delta coefficient. Delta is the first partial derivative of the option pricing function with respect to the price of the underlying instrument. In the case of options with a non-continuous payoff function and with a limit on maximum payoff, methods based on delta coefficient may be misleading. Even if the pricing function is continuous before the expiration moment, the closer to expiration and the closer to the point where the option becomes at the money, the less reliable the delta. For binary cash-or-nothing options, delta reaches high values relative to the maximum payoff (or even—dependent on the option pricing model used—approaches infinity) as the underlying price approaches the strike price.

The risk equivalent used to determine the adequate capital should not exceed the maximum negative cash flow that a position may ever generate. Its value should also depend in a way on the probability that the negative cash flow will be incurred. And finally, the own funds requirement should amount to only a part of the value of the whole exposure.

From the approaches proposed here, the Approach 4 is the one that fulfills all the aforementioned conditions. It is however hardly possible that a national supervisory authority would accept application of this approach by a financial institution, since this method is not in accordance with the CRR Regulation and Delegated Regulation. It is, in turn, highly recommended that the regulations are amended to incorporate this approach or a similar one.

Legal Acts

Regulation (EU) No 575/2013 of the European Parliament and of the Council of 26 June 2013 on prudential requirements for credit institutions and investment firms and amending Regulation (EU) No 648/2012

Commission Delegated Regulation (EU) No 528/2014 of 12 March 2014 supplementing Regulation (EU) No 575/2013 of the European Parliament and of the Council with regard to regulatory technical standards for non-delta risk of options in the standardised market risk approach

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Part II
Stock Market Investments

Relationships Between Returns in EU Equity Markets in 2005–2016: Implications for Portfolio Risk Diversification

Agata Gluzicka

Abstract Under certain conditions, there are different relationships between stock markets. These relationships are one of the most important issues in portfolio analysis and they affect on the asset allocation or diversified risk. Usually the relations between markets intensify during and after the global financial crisis. In the article the relationships between European Union stock markets are analyzed. The main goal of research is to determine if the countries strongly related have any influence to the level of diversification. The Principal Component Analysis are used to determine the relations between the EU markets. Selected stock markets are also analyzed according to the diversification. The level of diversification are measured by the Portfolio Diversification Index, Rao's Quadratic Entropy and the Diversification Ratio. In the research the data from the period 2005–2016 are used. Selected EU markets are analyzed in the sub-periods specified by the last global financial crisis which began in 2007.

Introduction

Relations between stock markets are important issues in portfolio theory. Market relationships can be analyzed using different methods. The most commonly used approaches are mean-variance methodology, correlation coefficient analysis, cointegration and causality tests, univariate and multivariate general autoregressive conditional heteroscedasticity models. However the most useful tool to analyze the relations between variables (markets) is a factor analysis. Mainly, as a factor analysis two types of methods are applied: Principal Component Analysis (*PCA*) and the Maximum Likelihood (*ML*). The advantage of the *PCA* is that it is not necessary to assume the normality of the analyzed variables. And this is an important issue in the research of the financial markets. For this reasons the relations between markets are

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analyzed by the *PCA*. This method allows, among others, to determine what part of variance is explained by the principal components. By using the *PCA*, we can also identify which markets are strongly represented in the given principal component. Strong relationships exist between these countries which represent the first principal components.

Relationships between markets have a strong influence on the asset allocation and the international diversification. The term of international diversification was introduced by Markowitz (1952) and the research conducted by Grubel (1968), Levy and Sarnat (1970), Solnik (1974) showed that the international diversification reduces the systematic risk of a portfolio. One of the measure of the level of diversified risk is Portfolio Diversification Index defined by the principal component analysis.

In the article, the problem of international diversification for selected European Union countries and its relationships with relations between these markets are analyzed. Three measures of the level of diversification are considered: the Portfolio Diversification Index, Rao's Quadratic Entropy and the Diversification Ratio. The markets are analyzed in the period 2005–2016, divided into sub-periods, where long-term increases or decreases of quotations are observed. The application of such time division allows to state how the recent economic crisis has affected the relationships and the diversification on the EU markets.

Selected Diversification Measures

In the case of uncorrelated markets, the variance of the portfolio is equal to the weighted sum of variances for individual components of portfolio. Then the maximum diversified portfolio is this one whose weights are inversely proportional to the variance of portfolio components. However this situation does not exist in the real investment world. It is possible to use appropriate methods to transform the set of correlated data into the set of independent factors. One of such method is the principal component analysis. This approach can also be used in the diversification context.

Let's assume portfolio consists of N components (stocks). By Σ we denote covariance matrix between the rates of return of stocks. The covariance matrix can be transformed to the following form:

$$\Sigma = E\Delta E^T \tag{1}$$

where E is the square matrix of degree N composed of eigenvectors (e_i, $i = 1, 2, \ldots, N$) of covariance matrix Σ. Matrix Δ is the diagonal matrix of degree N whose elements are eigenvalues (λ_i, $i = 1, 2, \ldots, N$) of the matrix Σ. Eigenvectors define the set of N uncorrelated portfolios which are called the principal portfolios. Rates of return of these portfolios are responsible for randomness on the market and the eigenvalues λ_i correspond to the variances of uncorrelated portfolios.

Using the above procedure, Rudin and Morgan (2006) proposed the following Portfolio Diversification Index:

$$PDI = 2\sum_{i=1}^{N} iw_i - 1 \tag{2}$$

where $w_i = \lambda_i / \sum_{i=1}^{N} \lambda_i$ for $i = 1, 2, \ldots, N$.

The *PDI* index measures relative importance (validity) of principal components in portfolio. If original components of portfolio are strongly correlated then the few first principal portfolios are calculated for the majority of portfolio variance and the *PDI* index have low value. For a portfolio dominated by one component, the value of *PDI* index is equal to 1. If all components of portfolio are uncorrelated then *PDI* index is equal to the number of all components (N), only if the shares of all components are equal to the $1/N$. The value of *PDI* lower than N reflects the interaction in different assets (more variability of rates of return is explained by the few first principal components).

Most well-known diversification measures do not take into account the relationship between the correlation and the risk of portfolio. This relationship is essential in determining the level of diversification (Markowitz 1952). The Rao's Quadratic Entropy (Rao 1982a, b) is an example of measure that solves this problem. Generally, this is a measure of diversity. So far it was applied mainly in statistics (generalized analysis of variance) and in ecology (in the research of biodiversity). However it is possible to apply this measure in the portfolio analysis, including also the issue of diversification (Carmicheal et al. 2015).

For portfolio consisting of N components with the shares x_i, for $i = 1, 2, \ldots, N$, the level of diversification can be measured in the following way:

$$RQE = 2\sum_{i,j=1}^{N} d_{ij} x_i x_j \tag{3}$$

where $D = \left[d_{ij}\right]_{i,j=1}^{N}$ is a function of diversity that measures the differences between any two components of the portfolio. The diversity function can be defined in the different ways—for example by using the Kronecker delta or the covariance matrix of returns. It is also possible to define the function D using the correlation matrix. Then the *RQE* is defined as (Carmicheal et al. 2015):

$$RQE = \sum_{i,j=1}^{N} \left(1 - \rho_{ij}\right) x_i x_j \tag{4}$$

where $\rho = \left[\rho_{ij}\right]_{i,j=1}^{N}$ is the correlation matrix of rates of return. The higher value of *RQE*, the higher level of diversification of portfolio.

Measure *RQE* can also be used as a criterion for the construction the well-diversified portfolio. Maximizing the *RQE* measure we receive a portfolio with minimum concentration of information. This is portfolio that maximizes the effective number of independent risk factors. The *RQE* portfolios (*RQEP*) have two important properties. First, the dissimilarity between any asset that belong to the

RQEP and itself is equal to its portfolio *RQE*. The second properties is following: the dissimilarity between any asset that does not belong to the *RQEP* and itself is smaller than its portfolio *RQE* (Carmicheal et al. 2015).

The third considered measure of diversification is the Diversification Ratio (*DR*). This measure is constructed with the assumption that the diversification effect is connected with the difference between the risk of portfolio and the weighted sum of standards deviations of rates of return for stocks with the non-zero shares (Cheng and Roulac 2007; Choueifaty and Coignard 2008).

According to Cheng and Roulac (2007) the diversification ratio is a quotient of the weighted sum of risk of components and the risk of entire portfolio. Formally the diversification ratio can be formulated as:

$$DR = \frac{\sigma_a}{\sigma_p} \tag{5}$$

where σ_p denotes the standard deviation of the portfolio and σ_a is the weighted sum of standard deviations for components of non-zero shares. The weighted sum of standard deviations for components with non-zero shares is calculated as:

$$\sigma_a = \sum_{i=1}^{N} x_i \sigma_i \tag{6}$$

where: x_i—share of i-th component in portfolio, σ_i—standard deviation of i-th component, $i = 1, 2, \ldots, N$.

The values of the diversification ratio are higher than 1 so we can't state on the base of the *DR* how much risk can be diversified. We can only ordered portfolio according to the level of diversification—the higher value of *DR* the higher level of diversification. This ratio can also be used to construct the portfolio—called the Most Diversified Portfolio (*MDP*). Maximizing the value of *DR* we receive portfolio which maximizes the distance between two definition of portfolio volatility: the distance between the weighted sum of volatility of assets of portfolio and the total volatility of portfolio (Cheng and Roulac 2007).

In the case when all assets have the same volatility then the *MDP* is equal to the global minimum-variance portfolio. Any asset that does not belong to the *MDP* is more correlated to the *MDP* than any assets that belong to it. All assets from the *MDP* have the same correlation to it. The long-only *MDP* is the long-only portfolio such that the correlation between any other long-only portfolio and itself is greater than or equal to the ratio of their *DR*s (Choueifaty and Coignard 2008).

Relationships Between EU Markets and Their Impact on the Diversification: Empirical Analysis

The empirical research consists of two parts. In the first part the relations between the EU markets are analyzed. For this purpose the principal component analysis is applied. The second part of the research concerns the international diversification for the EU markets. To determine the level of diversification the presented measures are applied: the Portfolio Diversification Index (*PDI*), the Rao's Quadratic Entropy (*RQE*) and the Diversification Ratio (*DR*). The markets are analyzed in the whole periods 2005–2016 and in the following sub-periods:

- I period: January 2005–June 2007 (long-term increases of quotations),
- II period: July 2007–February 2009 (log-term decreases of quotations—period of crisis),
- III period: March 2009–March 2011 (renewed increases of quotations),
- IV period: April 2011–December 2016 (low fluctuations of quotations).

The sub-periods are stated on the base of the observations of the daily quotations of the Polish index WIG20. The research are carried out for the logarithmic daily rates of return for selected stock indices representing 20 countries of European Union: Belgium (BEL20), Bulgaria (SOFIX), Czech Republic (PX), Estonia (OMXT), Finland (HEX), France (CAC), Germany (DAX), Greece (ATH), Hungary (BUX), Italy (FMIB), Latvia (OMXR), Lithuania (OMXV), Netherlands (AEX), Poland (WIG20), Portugal (PSI20), Romania (BET), Slovakia (SAX), Spain (IBEX), Sweden (OMXS), United Kingdom (FTM). The selection of components and the analyzed period is related with the availability and completeness of the data.

In the Table 1 the results from the principal component analysis are presented. For the first sub-period, five principal component (*PC*) with eigenvalues higher than 1 are received. These principal components jointly explain 65.33% of variance. For each of the other sub-periods, three principal components have eigenvalues higher than 1. The percent of explained variance is equal: in the sub-period II—72.13%, in the sub-period

Table 1 Results of principal components analysis

Period	PC	Eigenvalues	% of variance	% of variance cum
I sub-period	1	8.0016	40.0080	40.0080
	2	1.6221	8.1107	48.1187
	3	1.3404	6.7019	54.8206
	4	1.0950	5.4752	60.2958
	5	1.0071	5.0357	65.3315
II sub-period	1	9.9476	49.7378	49.7378
	2	3.3712	16.8561	66.5939
	3	1.1096	5.5484	72.1424
III sub-period	1	9.8744	49.3721	49.3721
	2	2.1260	10.6299	60.0019
	3	1.0741	5.3708	65.3727
IV sub-period	1	9.5684	47.8421	47.8421
	2	1.8507	9.2534	57.0955
	3	1.0242	5.1212	62.2167
2005–2016	1	11.8132	59.0660	59.0660
	2	2.0849	10.4245	69.4905

III—65.37%, in the sub-period IV—62.22%. For the period 2005–2016 only two principal components are significant and they explain 69.49% of variance.

To determine the existence of relationships between markets, varimax rotation is applied for factors. Then those factors are selected for which the absolute value is higher than 0.7. The higher absolute values of the factor of principal component indicate countries more represented by the principal component. There are strong dependencies between such countries. Results are presented in the Table 2.

It should be noted that for each sub-period in the first factor few countries are repeated: Netherlands, Belgium, France, Germany, Italy and Spain. It means that regardless of the nature of volatility of quotations, there are strong relationships between these six markets. Except the first sub-period, in other cases, we have other additional countries in the first principal component. In the second sub-period we have also: Hungary, Portugal, Czech Republic and Poland. For sub-period III the group of countries with the strongest relations is extended by Hungary, Finland, Sweden, Portugal, Czech Republic and Poland. In the IV period the strong relations exist between Netherlands, Belgium, France, Germany, Italy, Finland, Spain, Sweden and Portugal. Also for the whole period 2005–2016 we receive the similar group of related countries: Netherlands, Belgium, France, Germany, Italy, Finland, Spain, Sweden, Portugal, Poland. It should be emphasized the significant role of Polish market. In the II and III sub-periods and also for the period 2005–2016 Poland is a

Table 2 Countries representing individual principal components

Period	Factor	Country
I sub-period	1	Netherlands, Belgium, France, Germany, Italy, Spain
	2	United Kingdom, Finland, Sweden
	3	–
	4	–
	5	Bulgaria
II sub-period	1	Netherlands, Belgium, Hungary, France, Germany, Italy, Spain, Portugal, Czech Republic, Poland
	2	Latvia, Estonia, Lithuania
	3	United Kingdom, Finland, Sweden
III sub-period	1	Netherlands, Belgium, Hungary, France, Germany, Italy, Finland, Spain, Sweden, Portugal, Czech Republic, Poland
	2	Estonia, Lithuania
	3	Slovakia
IV sub-period	1	Netherlands, Belgium, France, Germany, Italy, Finland, Spain, Sweden, Portugal
	2	–
	3	Slovakia
2005–2016	1	Netherlands, Belgium, France, Germany, Italy, Finland, Spain, Sweden, Portugal, Poland
	2	Romania, Latvia, Estonia, Lithuania

part of the first principal components what means Poland is one of the countries strongly related.

In the second part of the research the problem of the international diversification is analyzed. First, all periods are compared in terms of risk diversification. Then the countries responsible for the diversification are determined and compared with the countries strongly related. For every periods two portfolios are computed: the *RQE* portfolio and the Most Diversified Portfolio.

The values of *PDI* index, Rao's Quadratic Entropy and Diversification Ratio for a given period are presented in the Table 3. According to the *PDI* index, the European market is the most diversified in the sub-period I and the lowest level of diversification is obtained for the period of crisis. Similarly, the *RQE* criterion indicates that the highest level of diversification is for the sub-period I and the lowest value we have in the sub-period III. For the *DR*, the best sub-periods according to the diversification is sub-period III and the worst IV. However, regardless of the measure used in research, the smallest opportunities for diversification are for the entire period 2005–2016.

Next the *RQE* and *MDP* portfolios are compared according to the components. In this part of the research two issues are considered: (1) the similarity between components of the *RQE* and *MDP* portfolios, (2) the differences between the group of countries selected to the *RQE* or *MDP* portfolios and the markets with the strong relations among themselves (indicated by the *PCA*). In the Table 4 the rankings according to the value of shares of components in *RQE* and *MDP* portfolios are presented. Value 1 means the country with the highest share in portfolio. The symbol "–" indicates countries with zero share.

The *RQE* and *MDP* portfolios are similar in compositions. In every period both portfolios have the same components but these components have different shares. On the base of presented results it is easy to state that the group of countries responsible for diversification in each period differs from countries responsible for the variability of variance. Three of twenty analyzed countries do not appear in any portfolios. There are: Finland, France and Germany—all these countries are strongly related according to *PCA*. Four countries appear in both portfolios only in one analyzed period: Belgium (II period), Czech Republic (I period), Netherlands (IV period) and United Kingdom (I period). In every period at least eight countries are in *RQE* or *MDP* portfolio: Slovakia, Latvia, Bulgaria, Romania, Estonia, Poland, Greece and Hungary. Poland is a component in both portfolios in every analyzed periods with the highest shares (the highest position in rankings) in the III period and the lowest share in the first period (11 position in both portfolios).

Table 3 Level of diversification according to the *PDI* index, Rao's Quadratic Entropy (*RQE*) and Diversification Ratio (*DR*)

Index	Period I	Period II	Period III	Period IV	2005–2016
PDI	8.56	5.755	6.836	7.214	5.499
RQE	83.08	75.70	75.19	77.96	57.03
DR	2.36	3.06	3.31	2.24	1.54

Table 4 Rankings of countries according to the shares in the *RQE* and *MDP* portfolios

Country	*RQE*					*MDP*				
	I	II	III	IV	2005–2016	I	II	III	IV	2005–2016
Belgium	–	3	–	–	–	–	4	–	–	–
Bulgaria	3	4	3	2	3	3	3	3	1	2
Czech Rep.	7	–	–	–	–	8	–	–	–	–
Estonia	5	6	5	9	10	5	5	4	5	10
Finland	–	–	–	–	–	–	–	–	–	–
France	–	–	–	–	–	–	–	–	–	–
Germany	–	–	–	–	–	–	–	–	–	–
Greece	12	9	6	4	2	12	8	6	9	4
Hungary	13	8	9	7	6	13	9	10	7	6
Italy	10	–	–	–	5	10	–	–	–	5
Latvia	2	2	2	3	4	2	2	2	3	3
Lithuania	6	–	11	5	11	6	–	9	4	11
Netherlands	–	–	–	12	–	–	–	–	12	–
Poland	11	5	4	6	7	11	6	5	6	7
Portugal	8	–	8	11	–	4	–	7	11	–
Romania	4	7	7	10	9	9	7	8	8	9
Slovakia	1	1	1	1	1	1	1	1	2	1
Spain	–	–	10	8	8	–	–	11	10	8
Sweden	–	–	12	13	–	–	–	12	13	–
United King.	9	–	–	–	–	7	–	–	–	–

Summary

The study demonstrates empirically that the nature of stock quotations in the analyzed period does not affect the group of strongly interrelated countries. Moreover, it shows that there is no connection between strongly related countries and the countries responsible for the diversification. On the base of the analysis of two diversified portfolios: the *RQE* and *MDP* portfolios we can state that both portfolios have the same components but they differ according to the values of shares. The comparison of three different measures of the level of diversification indicates that the assessment of diversification depends on the measure used in the analysis.

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The Relationships Between Beta Coefficients in the Classical and Downside Framework: Evidence from Warsaw Stock Exchange

Lesław Markowski

Abstract This paper presents the relationship between classical and downside beta coefficients in the context of data generating processes. The theoretical analysis were the basis for determining the relationship between the beta coefficients in the classical and downside framework. Empirical studies based on regression analysis and correlation of the time series of daily returns sectoral indices quoted on the Warsaw Stock Exchange. Our results suggest that the relationships between classical and downside systematic risk measures depend on the basic parameters of the distribution of returns of market portfolio approximation. There are statistically significant correlations between the standard deviation, asymmetry and kurtosis of market portfolio and measures expressing the relation of beta coefficients. The arguments may be an indication of choosing a systematic risk measures and evaluation of the real beta coefficients. This choice is determined by the data generating process, which may contribute to differences between results of CAPM tests.

Introduction

In accordance with the Capital Asset Pricing Model (CAPM), investment risk is measured as variance when positive and negative rates of return are treated the same. However, intuitively, investment risk is perceived as downward deviations from an anticipated rate of return (a risk-free rate of return or zero). In addition, the distribution of rates of return is asymmetrical and is dubbed "fat-tailed". Such a perspective on risk allows the development of the concept of downside risk, the main measures of which include semi-variance or downside beta, which is a derivative of lower partial moments. Downside beta is the basic risk measure in the so-called Downside Capital Asset Pricing Model (D-CAPM) which is an alternative to the standard CAPM. The relationship between those two models (and thus between

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those two risk measures) may depend on whether a two-dimensional distribution of return rates on securities and on a market portfolio is normal or whether it significantly deviates from it Nantell and Price (1979), Price et al. (1982). A comparison between the asset pricing models with the use of standard beta and downside beta was conducted in numerous developed and developing capital markets. Research carried out with the use of various individual rates of return in the European and Asian stock exchanges proved that the downside risk explains the level of rates of return on a majority of securities as compared to the standard risk measures Pedersen and Hwang (2007), Alles and Murray (2013), Markowski (2013).

When testing the CAPM, one may assume that rates of return are generated in the mean-variance process or, alternatively, in the mean-semivariance process, therefore in terms of the downside risk. This paper using daily returns presents a theoretical and empirical analysis of the correlations between standard beta and downside beta, considering two different processes. Unlike the previous studies in this paper there are no assumption on the distribution security returns. This gives explanation of the relationship under general conditions. The similar derivation of relationships between two kinds of beta were conducted by Galagedera (2007) using monthly returns on the sample of emerging markets.

Study possible differences in the estimates of beta values may help to explain the discrepancies in CAPM test results.

Downside Risk Measures

The conception of systematic risk measures in the context of the downside risk in this part of the work will be based on the second lower partial moment Rutkowska-Ziarko (2010). The downside systematic risk will be consider. The relationships between systematic risk measures will be consider with the use of downside measure proposed in the literature. This is the downside beta coefficient defined by Hogan and Warren (1974) and Bawa and Lindenberg (1977) and it expressed as follows

$$\beta_i^{HW} = \beta_i^{BL} = \frac{E\left[\left(R_{it} - R_f\right)\min\left(R_{Mt} - R_f; 0\right)\right]}{E\left[\min\left(R_{Mt} - R_f; 0\right)\right]^2}, \tag{1}$$

where R_{it}, R_{Mt}, R_f are respectively the return in time t for security i, the market portfolio return in time t and the risk-free rate.

In the downside framework the key factor of interpretation and in assessing downside risk is a threshold rate. In the theory, there are many varieties of downside beta distinguished with different formulas Estrada (2002) and threshold rates. Market participants may treat risk as downside deviations below the threshold that is the average market portfolio returns as opposed to the risk-free rate Harlow and Rao (1989).

Relationships Between Beta Coefficients

Relationships Between Beta Coefficients in the Mean-Variance Framework

In the context of mean-variance framework a data generating process consistent with the CAPM (where the only factor in common asset price movements is a market portfolio) is the market model expressed in terms of excess return and include an intercept term. It can be written as

$$R_{it} - R_f = \alpha_i + \beta_i\left(R_{Mt} - R_f\right) + \xi_{it} \tag{2}$$

where ξ_{it} is a white noise process. The slope parameter of relation (2) is equal to the CAPM beta.

The relationships between classical and downside risk measures in the mean-variance framework, making simple transformations may be expressed as Galagedera (2007)

$$\beta_i^{BL} = \alpha_i \frac{E\left[min\left(R_{Mt} - R_f, 0\right)\right]}{E\left[min\left(R_{Mt} - R_f, 0\right)\right]^2} + \beta_i = \alpha_i K_1(R_M) + \beta_i^{CAPM} \tag{3}$$

where $K_1(R_M) = E[min(R_{Mt} - R_f, 0)]/E[min(R_{Mt} - R_f, 0)]^2$. The term $K_1(R_M)$ is always negative and is a function of the market rate of return. It is easy to see when the intercept term (α_i) (return independent from market) is zero (a condition consistent with the CAPM assumptions) than downside beta β_i^{BL} is equal to classical beta coefficient. Otherwise, when($\alpha_i < 0; \alpha_i > 0$) the CAPM beta underestimates (overestimates) beta β_i^{BL}.

Relationships Between Beta Coefficients in the Mean-Semivariance Framework

In the context of mean-semivariance framework a data generating process consistent with the CAPM is the downside market model and it can be written as

$$R_{it} - R_f = \alpha_i^d + \beta_i^d min\left(R_{Mt} - R_f,\ 0\right) + \xi_{it}. \tag{4}$$

The relationships between classical and downside beta coefficient, taking into account the above generating process and making some modifications can be presented as

$$\beta_i = \beta_i^d \underbrace{\left(1 - \frac{E\left[(R_{Mt} - E(R_M))max\left(R_{Mt} - R_f, 0\right)\right]}{E(R_{Mt} - E(R_M))^2}\right)}_{K_2(R_M)} = K_2(R_M)\beta_i^d. \quad (5)$$

It is apparent that $K_2(R_M)$ is a function of market portfolio return Galagedera (2007). If the data generating process is the relation (4) holds, the relationship between the Bawa and Lindenberg beta coefficient and the classical beta is determined as follows

$$\beta_i^{BL} = \alpha_i^d \frac{E\left[min\left(R_{Mt} - R_f, 0\right)\right]}{E\left[min\left(R_{Mt} - R_f, 0\right)\right]^2} + \beta_i^d = \alpha_i^d K_1(R_M) + \frac{1}{K_2(R_M)}\beta_i. \quad (6)$$

The relevant question from the point of view of the assumption about the validity of a given data generation process is how the estimation of these processes approximates the CAPM beta. It was shown that the differences between these estimates will depend on the expressions $K_1(R_M)$ and $K_2(R_M)$, that are functions of the market portfolio returns and indirectly functions of the basic characteristics of the market returns distribution. These relationships will be the subject of empirical research, that results will be presented in subsequent sections of this paper.

Data

A dataset for empirical analyses of the relationships between the classical and downside beta coefficients were a time series of daily logarithmic returns of 11 sub-indices quoted on the Warsaw Stock Exchange, belonging to the industrial, financial and service macrosectors. The sample period is from January 2009 to December 2015 what it represents 1751 observations. Exceptions are sub-indices of WIG-energy (1500 observations) and WIG-mineral resources (1207 observations), which are quoted less than the sample period. The WIG index is used as the market portfolio approximation and the proxy for the risk-free rate is 10-year bond rate. The list of the sub-indices and their summary statistics is given in Table 1.

Entries results in Table 1 reveal that for sub-indices the minimum daily return ranges from −24.57% to −6.18%, while the maximum ranges from 4.93% to 10.35%. In the case of four sub-indices. The average daily rate of return in the considered period was negative. The skewness coefficients of return distributions indicated for most sub-indices the left-hand asymmetry and ranges from −2.401 to 0.112. Excess kurtosis is positive in all sub-indices return distributions.

Table 1 Descriptive statistics of sector indices daily return

Sector	Mean	Min	Max	S.D.	Skewness	Kurtosis
Banking	0.0347	−13.44	9.29	1.694	−0.050	5.568
Construction	−0.0142	−8.04	4.93	1.283	−0.599	3.933
Chemical	0.1412	−9.86	8.92	1.699	−0.129	3.114
Developers	0.0206	−8.19	8.11	1.436	0.112	4.344
Energy	−0.0105	−6.50	6.39	1.262	−0.243	2.764
IT	0.0401	−6.18	6.44	1.252	−0.109	2.545
Media	0.0361	−7.01	6.60	1.435	−0.121	1.914
Fuels	0.0654	−8.32	10.35	1.698	0.008	2.381
Food	0.0662	−11.17	7.31	1.528	−0.215	3.365
Mineral resources	−0.0486	−14.84	9.54	2.001	−0.751	4.865
Telecommunication	−0.0042	−24.57	8.19	1.574	−2.401	37.369
WIG	0.0391	−6.65	5.97	1.171	−0.234	3.805

Results

In the third part of this paper it is theorised that the expressions $K_1(R_M)$. $K_2(R_M)$. showing differences between standard beta and downside beta are functions of the rates of return on the market portfolio. The aforesaid expressions were determined for all of the sub-indices and for the WIG Index (Warsaw Stock Exchange Index) and are shown in Table 2.

When comparing $K_1(R_M)$ to the standard deviations of a given sub-index. A positive relation between those measures may be noted. Sub-indices with high standard deviations are characterised by high $K_1(R_M)$ on average and vice versa. The correlation is statistically significant at a level of 0.01 and $r = 0.901$. as shown in Fig. 1.

The values of $K_2(R_M)$ are positive and lower than a unity. These values show a strong negative correlation with skewness of the rates of return distributions on the sub-indices (r = –0.815) and a positive correlation. significant when $\alpha = 0.10$ with kurtosis (r = 0.599).

To sum up, the relation between standard beta and downside beta, expressed by functions $K_1(R_M)$ and $K_2(R_M)$ depend on statistics of the distribution of rates of return on a given sub-index such as standard deviation, asymmetry and kurtosis. Thus, selection of a particular risk measure depends on statistical measures of the return distribution in a given market.

Further in the research, the parameters were estimated for data-generating processes in standard and downside risk-return framework. The results of the estimation of models (2) and (4) are presented in Tables 3–4. The values of the standard beta parameters and the downside beta ones were positive and statistically significant at a level of 0.01. On average, the downside beta parameters were higher than the standard beta ones. Intercept α_i in the mean-variance process was statistically significant only for the chemical sector (significance at a level of 0.01) and the

Table 2 Estimates of sector specific terms in the relationships between classical and downside beta coefficients

Sector	$K_1(R_M)$	$K_2(R_M)$
Banking	−0.450	0.488
Construction	−0.510	0.552
Chemical	−0.428	0.476
Developers	−0.500	0.482
Energy	−0.563	0.521
IT	−0.572	0.494
Media	−0.512	0.498
Fuels	−0.442	0.483
Food	−0.471	0.492
Mineral resources	−0.319	0.572
Telecommunication	−0.369	0.578
WIG	−0.581	0.506

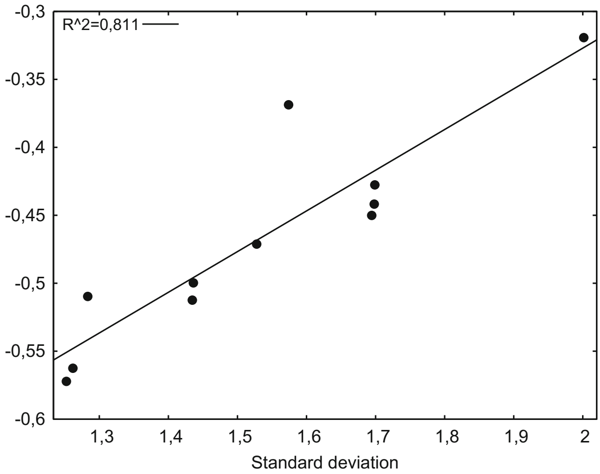

Fig. 1 Association between term $K_1(R_M)$ and standard deviation of sector indices distributions

construction sector (significance at a level of 0.1). Contrarily, the mean-semivariance process generated estimates where all α_i parameters were statistically significant. On average R-square (0.463) was higher in the standard model than R-square (0.324) in the downside model.

According to the estimates shown in Tables 3–4. One should conclude that assessments of estimator $\widehat{\beta}_i$ precisely approximate standard beta (β_i) and with slightly less precision downside beta computed from the Bawa and Lindenberg formula (β_i^{BL}). Two measures will be of similar value. However, if rates of return are generated in the mean-semivariance process, assessments of estimator $\widehat{\beta}_i^d$ overestimate standard beta by $1/K_2(R_M)$. Additionally, in case of statistically significant assessments of parameter α_i^d. β_i^{BL} is also overestimated by the expression $\alpha_i^d K_1(R_M)$. It follows that the values of

Table 3 Estimates of data generating process $R_{it} - R_f = \alpha_i + \beta_i(R_{Mt} - R_f)] + \xi_{it}$

Sector	$\widehat{\alpha}_i$	Stat. t	$\widehat{\beta}_i$	Stat. t	R^2
Banking	−0.017	−1.03	1.322	94.13[a]	0.835
Construction	−0.042	−1.83[b]	0.721	36.53[a]	0.432
Chemical	0.106	3.31[a]	0.885	32.22[a]	0.372
Developers	−0.013	−0.56	0.874	42.47[a]	0.508
Energy	−0.025	−1.53	0.847	36.88[a]	0.476
IT	0.012	0.55	0.704	36.60[a]	0.433
Media	0.005	0.21	0.782	34.73[a]	0.408
Fuels	0.021	0.83	1.140	53.24[a]	0.618
Food	0.040	1.27	0.673	25.18[a]	0.266
Mineral resources	−0.059	−1.51	1.431	38.14[a]	0.547
Telecommunication	−0.027	−0.81	0.595	20.65[a]	0.196
Mean	0.00009	−0.10	0.907	40.97	0.463

[a, b]Indicates significance respectively at the 1%, 10% level

Table 4 Estimates of data generating process $R_{it} - R_f = \alpha_i^d + \beta_i^d min\left(R_{Mt} - R_f.0\right) + \xi_{it}$

Sector	$\widehat{\alpha}_i^d$	Stat. t	$\widehat{\beta}_i^d$	Stat. t	R^2
Banking	0.705	22.22[a]	1.701	44.14[a]	0.527
Construction	0.393	13.18[a]	1.035	30.05[a]	0.340
Chemical	0.632	16.12[a]	1.245	26.16[a]	0.281
Developers	0.472	14.76[a]	1.144	29.49[a]	0.332
Energy	0.386	12.84[a]	1.108	27.83[a]	0.341
IT	0.421	14.90[a]	0.967	28.17[a]	0.312
Media	0.451	13.64[a]	1.054	26.22[a]	0.282
Fuels	0.664	18.84[a]	1.519	35.49[a]	0.419
Food	0.435	11.67[a]	0.936	20.68[a]	0.196
Mineral resources	0.625	12.34[a]	1.863	28.28[a]	0.399
Telecommunication	0.308	7.72[a]	0.792	16.36[a]	0.132
Mean	0.499	14.38	1.215	28.44	0.324

[a]Indicates significance at the 1% level

parameters β_i^{BL} should be approximated with the slope coefficient estimator used in the mean-variance process rather than the one used in the mean-semivariance process. Approximation of standard beta values by estimators both processes is shown in Fig. 2.

For sectors where standard beta values are low (β_i) (in this study, lower than 0.8), the mean-semivariance process allows for a relatively good estimation of beta values. Significant discrepancies in estimates produced with the use of both processes occur for sub-indices where beta values are high (solid line in Fig. 2). The

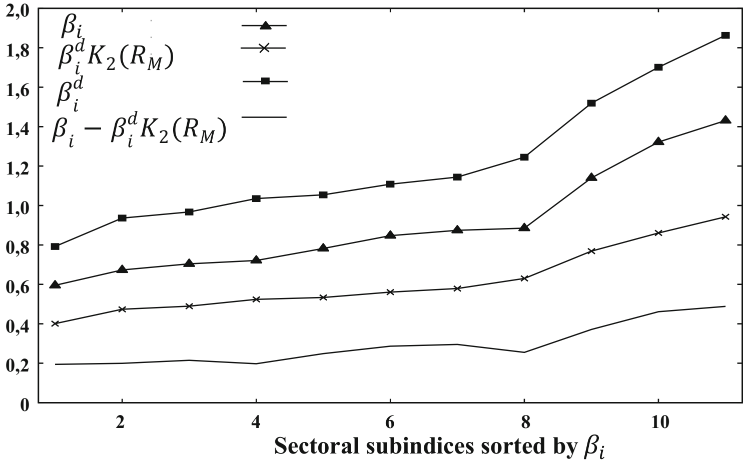

Fig. 2 Estimates of classical beta coefficients with mean-variance and mean-semivariance data generating processes

underestimation increases to the rising beta values. Consequently, the beta values determined using relation (5) are considerably underestimated.

Conclusions

This paper presents the theoretical relations between standard beta and two different variants of downside beta in the framework of the standard and the downside data-generating processes. The existence of those relations leads to underestimation of beta values. which could contribute to discrepancies in the results of CAPM tests based on standard and downside measures.

The findings of empirical research reveal that the relations between standard and downside systematic risk measures are determined by the basic distribution parameters of the rates of return on the given index as a proxy of a market portfolio. It has been proven that there are statistically significant correlations between measures demonstrating the relations between examined beta values and standard deviation, asymmetry and kurtosis of the market portfolio. The research also indicates that slope coefficients of the mean-variance data-generating process are better estimators of true beta values than slope coefficients of the mean-semivariance process.

Furthermore, it has been revealed that the downside measures of systematic risk should be included in financial instrument pricing if the assumption of normality of returns distributions (postulated in the traditional CAPM) are not holds.

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Intraday Trading Patterns on the Warsaw Stock Exchange

Paweł Miłobędzki and Sabina Nowak

Abstract We estimate linear regressions with dummy variables for the rates of return, spreads and volumes of stocks included in the main Warsaw Stock Exchange index WIG 20 to reveal the intraday trading patterns after the Universal Trading Platform was introduced in April 2013. In doing so we use the data rounded to nearest second and aggregated into that of 1 h frequency. The analysis shows that the spreads and volumes exhibit either the day of the week or the hour of the day effect or both. The spreads resemble the reversed J and the volumes are U-shaped. The rates of return are mostly positive but eventually decline at the end of the trading day. Some of them exhibit the hour of the day but not the day of the week effect.

Introduction

In this paper we shed light on the intraday trading patterns on the Warsaw Stock Exchange (WSE) after the Universal Trading Platform (UTP) was launched in April 2013 which many times speeded the processing of market orders, lowered the transaction costs and may attract large institutional investors who are involved in the algorithmic trading. To this end we first characterize empirical distributions of the rates of return, spreads and volumes of the most liquid stocks from the main WSE index WIG 20. Then we run regressions for the rates of return, spreads and volumes on dummies to test for whether they exhibit the day of the week and the hour of the day effects and if they do we evaluate their magnitude. In doing so we use the data on trade rounded to the nearest second from 15 April 2013 to 31 December 2016. The data comes from the Bank Ochrony Środowiska (BOS, Bank for Environmental

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Protection) brokerage house.[1] To the best of our knowledge this is the first report on the issue for the period covering operation of the new trading system.[2]

The analysis shows that the spreads are shaped as the reverse J or close to that while the volumes remain U-shaped. They all exhibit the day of the week and the hour of the day effects. Most of the rates of return are positive and elevated at the beginning of daily trade and become negative as the trade continues during the day. They also rise and end positive at the Fridays' close. Many of them exhibit the hour of the day effect but not the day of the week effect. These findings are in line with those of Wood et al. (1985), Smirlock and Starks (1986), Jain and Joh (1988), McInish and Wood (1991, 1992), Foster and Viswanathan (1993), Chan et al. (1995a, 1995b), Lee et al. (1993) as well as Chung and Zhao (2003) to name few who first have documented their patterns on the NYSE, NASDAQ and CBOE. They also accord with those on the stock market patterns in the UK (Kleidon and Werner 1995; Levin and Wright 1999; Chelley-Steeley and Park 2011; Ibikunle 2015), Canada (Mclnish and Wood 1990), Australia (Kalev and Pham 2009; Viljoen et al. 2014), France (Louhichi 2011; Tilak et al. 2013), Italy (Gerace and Lepone 2010), Spain (García-Machado and Rybczyński 2017); Greece (Panas 2005), Japan (Ohta 2006), South Korea (Ryu 2011), Taiwan (Chiang et al. 2006; Huang et al. 2012), Brazil (Da Costa et al. 2015), and Turkey (Bildik 2001; Köksal 2012).

We argue that wider spreads and elevated volumes during the first and the last trading hours on the WSE are due to an interplay between informed and liquidity traders and may be explained on the asymmetric information [(Madhavan 1992) and the inventory imbalance (Amihud and Mendelson 1987)] basis.

The remainder of the paper proceeds as follows. In Sect. "Model" we introduce a model to capture the intraday trade patterns on the WSE and sketch the way it is estimated and validated for stocks included in the WIG 20 index. In Sect. "Results" we discuss the results we arrived to. Section "Conclusion" briefly concludes.

Model

Since the trade at the main WSE market is continuingly effected from 9 a.m. through 4.50 p.m. we split each trading day into 8 time spells of the equal 1 h length but the last which we equal to 50 min. Then we fix variables exhibiting the intraday trade as follows. We compute the rate of return on stock for time spell t as its log difference of the close and the open. The spread for time spell t is a difference between the spell's high and low. The volume for time spell t is equal to the aggregated volume of all

[1]We extract the relevant information on stocks included in the main WSE index WIG 20 from the BOS brokerage house data bank at http://bossa.pl/notowania/, accessed on 15 Jan 2017.

[2]The earlier papers report on the WIG 20 intraday returns and the stealth trading (Będowska-Sójka 2010, 2014), the volatility smile (García-Machado and Rybczyński 2015) as well as on the intraday variability of stock market activity (Gubiec and Wiliński 2015) but for the antecedent trading system Warset.

within 1 h transactions. The model we use to reveal the intraday trade patterns becomes

$$y_t = \alpha + \sum_i \beta_i d_{it} + \sum_j \gamma_j h_{jt} + \sum_i \sum_j \theta_{ij} d_{it} h_{jt} + \epsilon_t, \quad (1)$$

where: y_t—time spell t rate of return (spread, volume) on the stock in question, $d_{it} = 1$ for day i of the week and 0 otherwise ($i = 1$ for Tuesday, . . ., $i = 4$ for Friday), $h_{jt} = 1$ for time spell j of the trading day and 0 otherwise ($j = 1$ for 10–11 a.m., . . ., $j = 7$ for 4–4.50 p.m.), α, β_i, γ_j, θ_{ij}—structural parameters, ϵ_t—random error, $t = 1$, 2, . . ., T. As the sample observations begin on 15 April 2013 at the 9–10 a.m. time spell and run through 31 December 2016 until the 4–4.50 p.m. time spell $T = 7414$. For each time spell from Monday through Wednesday we have 187 observations, and for those of Thursday and Friday we have as much as 183 observations. Thus model (1) is the analogue to a 2-factor unbalanced ANOVA with interactions.

Our decisions regarding the specification of model (1) are undertaken both on the empirical and theoretical basis. Having sorted the aggregated data by the day of the week and the hour of the trading day accordingly we reveal for nearly all stocks from the WIG 20 index the inverted J intraday spreads as well the U-shaped volumes, and for many of them the elevated rates of return at the market open and close. We plot the exemplary intraday patterns for KGHM on Fig. 1.

We argue that the observed intraday trade patterns on the WSE can be explained on the asymmetric information and the inventory imbalance basis. Following Madhavan (1992) we assume that informed traders can benefit from the informational handicap at the onset of trading. As the trading continues and private information is impounded into prices the handicap declines and the spreads narrow. Moreover, wider spreads at the open and close, as pointed by Amihud and Mendelson (1987), enable traders to avoid overnight inventory imbalances. It is also noticed that high trading volume at the open and close can be attributed to portfolio holders who attempt to unwind positions at the start and end of the trading day (Chelley-Steeley and Park 2011).

In order to ascertain that model (1) properly exhibits the DGP for the stocks of interest we test for whether errors ϵ_t are normally distributed and homoscedastic. To this end we use the Jarque-Bera and the Brown-Forsythe tests.[3] Since for all stocks we find strong departures from normality (see Table 1)[4] we decide to estimate our model by the OLS but on transformed y_t variables. In doing so we apply the logarithmic (rate of return, spread) and the Box-Cox transformations (volume). Additionally, despite we transform variables accordingly the variances of ϵ_t's for most stocks remain unequal across the days of the week and the hours of the trading day. In such circumstance to correct the OLS estimator for heteroscedasticity we use

[3]See Jarque and Bera (1987) and Brown and Forsythe (1974). The latter test provides good robustness against many types of non-normal data while retaining good power.

[4]The departures from normality are mainly due to the extremely fat tails and the right skew.

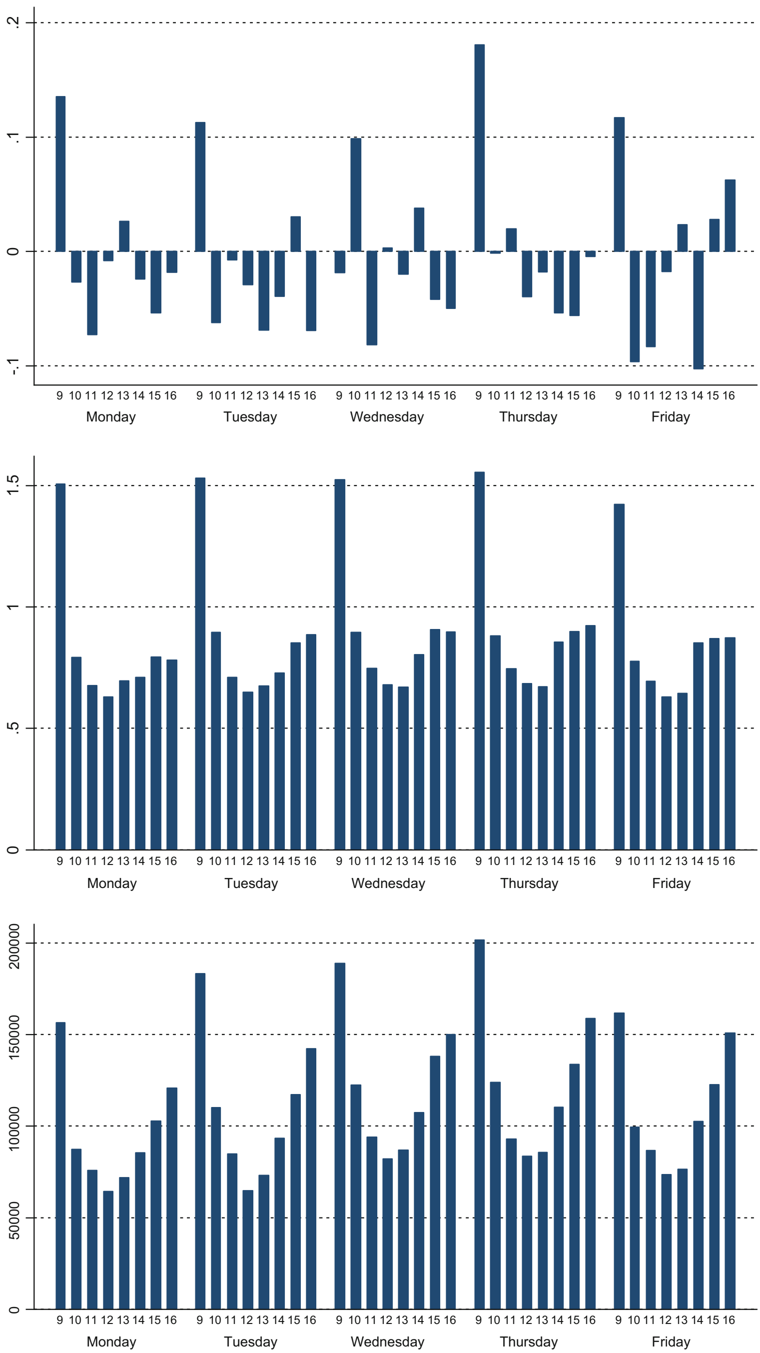

Fig. 1 Mean of the KGHM 1 h rate of return (top panel), spread (middle panel) and volume (bottom panel), 15 Apr 2013–31 Dec 2016

Table 1 Main characteristics of the 1 h rates of return, spreads and volumes for stocks of interest, 15 Apr 2013–31 Dec 2016

Stock	Var	Statistic								
		Min	Max	Mean	St dev	Skew	Kurt	JB	BF-d	BF-h
ORLEN	R	−5.26	3.58	0.01	0.62	−0.22	7.90	7.4×10^3	4.38	120.00
	S	0.01	11.95	0.47	0.36	6.22	146.58	6.4×10^6	2.27	3.94
	V	2094.00	19.2×10^5	11.1×10^4	92.5×10^3	3.31	32.40	2.8×10^5	2.89	4.42
PKO BP	R	−8.67	6.28	0.00	0.58	−0.30	17.83	6.8×10^4	2.56	107.22
	S	0.02	2.50	0.24	0.15	2.96	26.28	1.8×10^5	0.57	11.55
	V	11.4×10^3	80.1×10^5	31.8×10^4	33.0×10^4	5.76	74.21	1.6×10^6	4.72	7.40
PZU	R	−8.28	4.01	−0.00	0.55	−1.64	29.95	2.3×10^5	3.32	103.70
	S	0.01	2.79	0.26	0.17	2.52	18.03	7.8×10^4	0.53	5.41
	V	324.00	5.5×10^5	85.3×10^3	18.9×10^4	8.91	156.69	7.4×10^6	4.39	4.68
KGHM	R	−7.02	11.57	−0.01	0.77	0.37	24.47	1.4×10^5	2.02	191.19
	S	0.09	12.2	0.87	0.62	3.61	38.67	4.1×10^5	1.40	8.95
	V	5222.00	17.3×10^5	11.2×10^4	94.4×10^3	3.61	31.10	2.6×10^5	2.76	4.28
ORANGE	R	−6.15	7.09	0.00	0.63	−0.28	13.35	3.3×10^4	0.50	96.84
	S	0.00	0.74	0.07	0.05	2.54	16.36	6.3×10^4	1.92	3.07
	V	2767.00	22.4×10^6	29.4×10^4	56.6×10^4	18.97	565.60	9.8×10^7	2.82	9.56

Var — variable, *R* — rate of return, *S* — spread, *V* — volume. Statistics: *JB* — Jarque-Bera, under H_0 of normality distributed as $\chi^2(2)$, crit. value $\chi^2_{0.05}(2) = 5.99$; *BF-d (h)* — Brown-Forsythe on transformed variables for day (hour), under H_0 of Monday through Friday (9–10 a.m. through 4–4.50 p.m. time spells) equality of variances distributed as F(4,7411) (F(7,7408)), crit. value $F_{0.05}(4,7411) = 2.37$ ($F_{0.05}(7,7408) = 2.01$). All estimates are rounded to 2 decimal digits the Huber-White structural parameters variance-covariance estimator. Then we test for the following hypotheses of interest:

(A) Nonexistence of all effects including the day of the week effect, the hour of the trading day effect and the joint effect, $\forall_{ij}\beta_i = \gamma_j = \theta_{ij} = 0$
(B) In case hypothesis (A) is rejected the hypotheses of nonexistence of the day of the week effect and the joint effect, (Ba) $\forall_{ij}\beta_i = \theta_{ij} = 0$, the hour of the trading day and the joint effect, (Bb) $\forall_{ij}\gamma_j = \theta_{ij} = 0$, as well as the hypothesis of nonexistence of both effects, (Bc) $\forall_{ij}\beta_i = \gamma_j = 0$, are tested for
(C) In case either hypothesis (Ba), hypothesis (Bb), or hypothesis (Bc) is rejected the hypotheses of nonexistence of the joint effect, (Ca) $\forall_{ij}\theta_{ij} = 0$, and individual effects, (Cb) $\forall_i\beta_i = 0$ and (Cc) $\forall_j\gamma_j = 0$, are tested for
(D) Monday through Friday averages of y_t are equal

$$\beta_1 + \frac{1}{8}(\theta_{11} + \ldots + \theta_{17}) = 0$$
$$\beta_1 - \beta_2 + \frac{1}{8}[(\theta_{11} + \ldots + \theta_{17}) - (\theta_{21} + \ldots + \theta_{27})] = 0$$
$$\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots$$
$$\beta_3 - \beta_4 + \frac{1}{8}[(\theta_{31} + \ldots + \theta_{37}) - (\theta_{41} + \ldots + \theta_{47})] = 0$$

(E) 9–10 a.m. through 4–4.50 p.m. time spell averages of y_t are equal

$$\gamma_1 + \frac{1}{5}(\theta_{11} + \ldots + \theta_{41}) = 0$$
$$\gamma_1 - \gamma_2 + \frac{1}{5}[(\theta_{11} + \ldots + \theta_{41}) - (\theta_{12} + \ldots + \theta_{42})] = 0$$
$$\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots$$
$$\gamma_6 - \gamma_7 + \frac{1}{5}[(\theta_{16} + \ldots + \theta_{46}) - (\theta_{17} + \ldots + \theta_{47})] = 0$$

(F) 9–10 a.m. and 4–4.50 p.m. time spell averages of y_t are equal

$$\gamma_7 + \frac{1}{5}(\theta_{17} + \ldots + \theta_{47}) = 0.$$

The test statistics we use to test for hypotheses (A)–(F) are of the Wald type. Under the relevant null they are all distributed as χ^2 variates with the number degrees of freedom equal to 39 (A), 32 (Ba), 35 (Bb), 11 (Bc), 28 (Ca), 4 (Cb), 7 (Cc), 4 (D), 7 (E) and 1 (F), respectively. We perform all computations in Stata 14.2.

Results

The estimation results for model (1) are similar in kind for all stocks included in the WIG 20 index.[5] We visualize the results for KGHM on Fig. 2 displaying the 1 h rate of return (top panel), spread (middle panel) and volume (bottom panel) predictive margins with 95% confidence intervals for the consecutive trading days. They resemble in shape those exhibited on Fig. 1. While the predictive margins for the rate of return for all trading days are almost the same across the 1 h time spells, the confidence intervals for the open are the widest and those around the lunch time are the narrowest. The predictive margins for the spread are like the inverted J. They are elevated at the open, fall as the trade continues during the day, reach their minima around the lunch time and then rise towards the end of the trading day. The predictive margins for volume behave similarly. Nonetheless, they almost equate those of the open.

We gather the testing results for hypotheses (A)–(F) for 5 most liquid stocks from the WIG 20 index in Table 2. The estimates from column A indicate that for all stocks we are to reject hypothesis (A) stating the nonexistence of all effects for the spreads and volumes but not for the rates of return. This is to say that the spreads and volumes of stocks of interest exhibit at least one such effect. The opposite applies to the rates of return except for ORLEN and PZU. More interestingly, the volumes show both effects, while the spreads display the hour of the day effect alone (see the estimates in columns Ca–Cc). The estimates from column D yields that the Monday through Friday averages of spreads and volumes are unequal, while those from column E indicate the same for the 9–10 a.m. through 4–4.50 p.m. time spells. Finally, the estimates from column F show that the spreads and volumes at the open and those at the close differ from each other. In sum, the testing results are supportive for the ad hoc conclusions we arrived to while we plot the aggregated data on the rates of return, spreads and volumes against time on Fig. 1.

Conclusion

We aggregate the data rounded to the nearest second on stocks included in the main WSE index WIG 20 from the period 15 April 2013–31 December 2016 into that of 1 h frequency. Then we run regressions for the rates of return, spreads and volumes on dummy variables to reveal their intraday patterns in times the Universal Trading Platform is operated. The analysis shows that the spreads resemble reverse J while the volumes remain U-shaped. They all exhibit the day of the week and the hour of the day effects. The rates of return behave differently being positive and elevated at the beginning of daily trade. They eventually become negative as the trade continues during the day. Many of them exhibit the hour of the day but not the day of the week

[5]They are available from the authors upon a request.

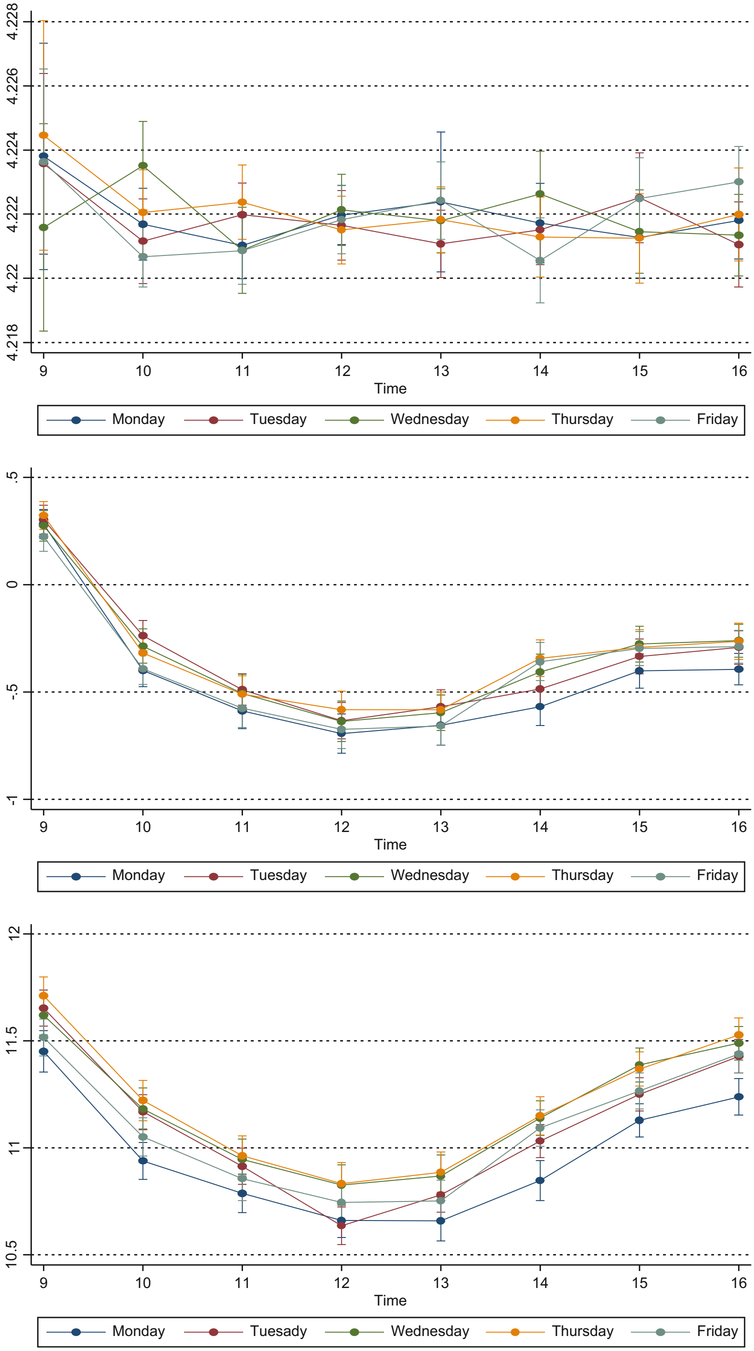

Fig. 2 The KGHM 1 h rate of return (top panel), spread (middle panel) and volume (bottom panel) predictive margins with 95% confidence intervals, 15 Apr 2013–31 Dec 2016

Table 2 Testing results for hypotheses (A)–(F)

Stock	Variable	Hypothesis									
		A	Ba	Bb	Bc	Ca	Cb	Cc	D	E	F
ORLEN	R	58.65	45.39	56.34	28.80	43.25	9.95	21.68	5.08	14.55	4.66
		[0.02]	[0.06]	[0.01]	[0.00]	[0.03]	[0.04]	[0.00]	[0.28]	[0.04]	[0.03]
	S	1258.87	37.72	1234.14	725.04	18.86	3.64	250.94	18.09	1209.88	229.85
		[0.00]	[0.22]	[0.00]	[0.00]	[0.90]	[0.46]	[0.00]	[0.00]	[0.00]	[0.00]
	V	1154.21	202.54	955.04	321.13	24.20	36.97	209.31	179.48	928.32	121.86
		[0.00]	[0.00]	[0.00]	[0.00]	[0.67]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
PKO BP	R	36.26	32.44	32.36	11.66	28.75	5.12	3.12	2.73	3.23	1.67
		[0.60]	[0.44]	[0.60]	[0.39]	[0.43]	[0.27]	[0.87]	[0.60]	[0.86]	[0.20]
	S	2053.90	48.31	2034.55	1202.32	26.74	3.17	515.12	24.65	2001.09	418.13
		[0.00]	[0.03]	[0.00]	[0.00]	[0.53]	[0.53]	[0.00]	[0.00]	[0.00]	[0.00]
	V	1148.56	184.34	954.75	414.25	14.49	18.95	202.73	168.33	932.62	24.80
		[0.00]	[0.00]	[0.00]	[0.00]	[0.98]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
PZU	R	54.26	32.64	51.70	21.62	30.39	6.48	7.31	6.07	23.35	6.77
		[0.06]	[0.44]	[0.03]	[0.03]	[0.34]	[0.17]	[0.40]	[0.19]	[0.00]	[0.01]
	S	1677.87	60.04	1627.65	1044.29	22.89	7.18	352.84	36.92	1608.97	332.07
		[0.00]	[0.00]	[0.00]	[0.00]	[0.74]	[0.13]	[0.00]	[0.00]	[0.00]	[0.00]
	V	1020.48	192.07	836.48	351.95	22.50	26.88	133.77	163.98	805.53	11.60
		[0.00]	[0.00]	[0.00]	[0.00]	[0.76]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
KGHM	R	46.29	38.41	44.97	9.71	37.29	1.63	4.15	0.47	7.74	3.93
		[0.20]	[0.20]	[0.12]	[0.56]	[0.11]	[0.80]	[0.76]	[0.98]	[0.36]	[0.05]
	S	2199.59	62.45	2173.52	1328.05	29.05	4.59	493.80	33.06	2130.62	607.27
		[0.00]	[0.00]	[0.00]	[0.00]	[0.41]	[0.33]	[0.00]	[0.00]	[0.00]	[0.00]
	V	1803.24	169.66	1612.53	827.07	25.03	20.42	271.54	142.41	1575.96	35.80
		[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]

(continued)

Table 2 (continued)

Stock	Variable	Hypothesis									
		A	Ba	Bb	Bc	Ca	Cb	Cc	D	E	F
ORANGE	R	27.96	25.19	22.26	8.82	19.87	3.95	5.48	5.53	2.61	0.03
		[0.91]	[0.80]	[0.95]	[0.64]	[0.87]	[0.41]	[0.60]	[0.24]	[0.92]	[0.86]
	S	1338.52	22.69	1329.98	751.46	16.38	4.06	286.60	6.61	1303.48	235.75
		[0.00]	[0.89]	[0.00]	[0.00]	[0.96]	[0.40]	[0.00]	[0.16]	[0.00]	[0.00]
	V	825.31	122.52	720.80	197.30	24.12	21.66	128.89	100.45	696.72	75.31
		[0.00]	[0.00]	[0.00]	[0.00]	[0.68]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]

R—rate of return, *S*—spread, *V*—volume. All estimates and *p*-values (in brackets) are rounded to 2 decimal digits effect. These findings are in line with those for the US, UK, Canada and other mature stock markets as well as for Turkey and Brazil.

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Testing Stability of Correlations Between Liquidity Proxies Derived from Intraday Data on the Warsaw Stock Exchange

Joanna Olbryś

Abstract The aim of this paper is to investigate relationships based on correlations between alternative liquidity measures derived from intraday data on the Warsaw Stock Exchange (WSE). Analyses of correlations help to find an answer to important question whether different liquidity proxies capture various sources of market liquidity/illiquidity or not. The main research hypothesis states that correlations are stable in specified periods. The hypothesis is verified by applying equality tests of correlation matrices computed over non-overlapping subsamples. The dataset consists of daily proxies of four liquidity measures for 53 WSE-traded companies divided into three size groups. The whole sample covers the period from January 3, 2005 to June 30, 2015, and it includes three adjacent subsamples, each of equal size: the pre-crisis, crisis, and post-crisis periods. To calculate several liquidity measures based on intraday data it is essential to recognize a side initiating the transaction and to distinguish between buyer- and seller-initiated trades. In this paper, the Lee and Ready (J Financ 46(2):733–746, 1991) trade classification algorithm is employed to infer trade sides. The obtained empirical results concerning the stability of correlations between liquidity proxies in the whole group of companies are not homogeneous.

Introduction

Stoll (2000) emphasizes that examining relations between liquidity proxies is an important issue because some estimates (such as relative or effective spreads) are total measures of liquidity, while others reflect primarily informational or non-informational components of liquidity. Analyses of correlations help to find an answer to important question whether different liquidity proxies capture various sources of market liquidity/illiquidity or not. The goal of this paper is to investigate

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K. Jajuga et al. (eds.), *Contemporary Trends and Challenges in Finance*,
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relationships based on correlations between alternative liquidity measures derived from high-frequency data on the Warsaw Stock Exchange (WSE). The main research hypothesis states that correlations are stable in the specified sub-periods. The hypothesis is verified by applying equality tests of correlation matrices computed over non-overlapping subsamples. The dataset consists of daily proxies of four liquidity measures for 53 WSE-traded companies divided into three size groups. The high-frequency intraday data 'rounded to the nearest second' covers the period from January 3, 2005 to June 30, 2015, and it includes three adjacent subsamples, each of equal size: pre-crisis, crisis, and post-crisis periods. The global financial crisis on the WSE is formally set based on the paper by Olbrys and Majewska (2015). As the raw data set does not identify a trade direction on the WSE, the trade classification Lee and Ready (1991) algorithm is employed to infer trade sides and to distinguish between the so-called buyer- and seller-initiated trades, e.g. Olbryś and Mursztyn (2015). The obtained results concerning the stability of correlations between liquidity proxies in the whole group of companies are not homogeneous.

The remainder of the study is organized as follows. Section "Selected Liquidity Proxies Derived from Intraday Data" describes the methodological background concerning the measurement of liquidity using intraday data. Section "Testing Stability of Correlations Between Liquidity Proxies" presents a formal statistical procedure for testing stability of correlations between liquidity proxies. Section "Data Description and Empirical Results on the WSE" reports and discusses the empirical results on the WSE. The last section recalls the main findings and presents the conclusions.

Selected Liquidity Proxies Derived from Intraday Data

There is a growing body of empirical literature concerning direct measurement of liquidity based on intraday data. The literature is far too vast to give a complete citation list. In this research, four liquidity proxies are employed: (1) percentage relative spread, (2) percentage realized spread, (3) percentage price impact, and (4) percentage order ratio.

The literature has shown that percentage relative spread (sometimes referred to as inside bid/ask spread or as proportional quoted spread) is the proper measure for stock illiquidity because it approximates the cost of immediate execution of a trade, e.g. Lin et al. (1995), Levin and Wright (1999), Corwin (1999), Chordia et al. (2000, 2001), Van Ness et al. (2000), Theissen (2001), Chung and Van Ness (2001), Acker et al. (2002), Peterson and Sirri (2003), Piwowar and Wei (2003), von Wyss (2004), Korajczyk and Sadka (2008), Goyenko et al. (2009), Hameed et al. (2010), Olbrys and Mursztyn (2017).

Bid/ask spreads can be decomposed into permanent (informational) and transitory (immediacy-related) components, e.g. Glosten (1987), Hasbrouck and Seppi (2001). Realized spread is a temporary component of the effective spread, which is defined as the amount earned by a dealer or other supplier of immediacy, e.g. Huang and Stoll (1996), Theissen (2001), Fong et al. (2017). Realized spread is sometimes referred to as a price reversal component since a dealer takes profit only if price reverses.

According to the literature, a proxy of price impact measures the sensitivity of a stock's price to trades (Stoll 2000, p. 1495), and most of researchers derive price impact from intraday transaction data, e.g. Chakrabarty et al. (2007), von Wyss (2004), Coppejans et al. (2004), Fong et al. (2017). Kyle (1985) provides a theoretical model for such a measure based on the adverse information conveyed by a trade. Price impact could be defined as an increase (decrease) in the quote midpoint over a time interval beginning at the time of the buyer- (seller-) initiated trade. This is a permanent price change of a given transaction, or equivalently, a permanent (informational) component of the effective spread, e.g. Goyenko et al. (2009, p. 156).

Order ratio as an order imbalance indicator is utilized in this research. Order imbalance has important influence on stock liquidity, considerably even more important than volume. Therefore, order imbalance indicators could be employed among other liquidity and trading activity measures to estimate liquidity. The literature proposes various proxies of order imbalance, e.g. Chan and Fong (2000), Ranaldo (2001), Chordia et al. (2002, 2005), von Wyss (2004), Korajczyk and Sadka (2008), Pukthuanthong-Le and Visaltanachoti (2009), Nowak (2017), Olbrys and Mursztyn (2017), Olbryś (2017). Table 1 presents definition of four liquidity proxies used in the study.

The midpoint price P_t^{mid} at time t is calculated as the arithmetic mean of the best ask price $P_t(a)$ and the best bid price $P_t(b)$ at time t. Considering that bid and ask prices are not made public on the WSE, the midpoint price at time t is rounded by the arithmetic mean of the lowest price P_t^L and the highest price P_t^H at time t, which approximate the best ask price and the best bid price respectively, e.g. Olbryś and Mursztyn (2015, p. 43):

$$P_t^{mid} = \frac{P_t^H + P_t^L}{2}, \tag{1}$$

The transaction price P_t at time t is approximated by the closing price.

To calculate several liquidity measures based on intraday data it is essential to distinguish between the so-called buyer- and seller-initiated trades. The initiator of a transaction is the investor (buyer or seller) who placed his/her order last, chronologically. In other words, the initiator is the person who caused the transaction to occur (Odders-White 2000, p. 262).

The WSE is an order-driven market with an electronic order book, but information of the best bid and ask price is not publicly available. As a consequence, the researchers rely on indirect trade classification rules to infer trade sides. There are some trade side classification procedures described in the literature, but the Lee and Ready (1991) algorithm (LR) remains the most frequently used (Chakrabarty et al. 2012, p. 468). In this study, the LR method is employed because Olbryś and Mursztyn (2015) indicated that this algorithm performs quite well on the WSE, the empirical results turn out to be robust to the choice of the sample and do not depend on firm size. Three alternative estimates of liquidity, supported by the trade side classification

Table 1 Definition of liquidity proxies used in the study

Liquidity measure	Symbol	Definition
Panel A: Spread proxy		
Percentage relative spread	%RS	$\%RS_t = \frac{100 \cdot \left(P_t^H - P_t^L\right)}{P_t^{mid}}$
Panel B: Liquidity proxies supported by the trade side classification algorithm		
Percentage realized spread	%RealS	$\%\mathrm{RealS}_t = \begin{cases} 200 \cdot \ln \frac{P_t}{P_{t+5}}, & \text{when the trade } t \text{ is classified as buyer-initiated} \\ 200 \cdot \ln \frac{P_{t+5}}{P_t}, & \text{when the trade } t \text{ is classified as seller-initiated} \end{cases}$
Percentage price impact	%PI	$\%PI_t = \begin{cases} 200 \cdot \ln \frac{P_{t+5}^{mid}}{P_t^{mid}}, & \text{when the trade } t \text{ is classified as buyer-initiated} \\ 200 \cdot \ln \frac{P_t^{mid}}{P_{t+5}^{mid}}, & \text{when the trade } t \text{ is classified as seller-initiated} \end{cases}$
Percentage order ratio	%OR	$\%OR = 100 \cdot \frac{\left\lvert \sum_{i=1}^{m} VBuy_i - \sum_{j=1}^{k} VSell_j \right\rvert}{\sum_{n=1}^{N} V_n}$

The subscript $t + 5$ means the fifth trade after the trade t. The sums $\sum_{i=1}^{m} VBuy_i$, $\sum_{j=1}^{k} VSell_j$, $\sum_{n=1}^{N} V_n$ denote daily cumulated trading volume related to transactions classified as buyer- or seller-initiated trades, and daily cumulated trading volume for all transactions within a day. Remaining notation is specified in the text algorithm, are employed: (1) percentage realized spread, (2) percentage price impact, and (3) percentage order ratio as an order imbalance indicator (see Table 1). Both the realized spread and price impact proxies are treated as the effective spread components, and they are calculated over a time interval beginning at the moment of the buyer- or seller-initiated transaction. For example, Goyenko et al. (2009, p. 156) employ a 5 min interval and the subscript $t + 5$ means the trade 5 min after the trade t. Chakrabarty et al. (2007, p. 3820) use the subscript $t + 10$ which means the trade ten minutes after the trade t. Theissen (2001, p. 159) proposes more general approach and the subscript $t + \tau$. In this study, the subscript $t + 5$ means the fifth trade after the trade t. Such framework is more appropriate on the WSE as Nowak and Olbryś (2016) documented that a large number of the WSE-traded companies exhibit substantial non-trading problem, i.e. the lack of transactions over a particular period when the WSE is open for trading. The non-trading problem may be treated as a special case of the "nonsynchronous trading effect I" which occurs when the analysis of one selected domestic market is conducted (Olbrys 2013).

Percentage Relative Spread (%RS) is in fact a measure of illiquidity. A wide percentage relative spread value denotes low liquidity. Conversely, a narrow percentage relative spread value denotes high liquidity. The %RS at time t is equal to zero when $P_t^H = P_t^L$. Daily percentage relative spread value is calculated as a volume-weighted average of percentage relative spreads computed over all trades within a day.

Percentage Realized Spread (%RealS) is a temporary component of effective spread. The %RealS at time t is equal to zero when $P_t = P_{t+5}$. The post-trade revenues earned by a dealer (or other supplier of liquidity) are estimated on the basis of actual post-trade prices. Daily percentage realized spread value is calculated as a volume-weighted average of percentage realized spreads computed over all trades within a day. Daily percentage realized spread value is defined as equal to zero when all transactions within a day are unclassified.

Percentage Price Impact (%PI) focuses on the change in quote midpoint after a signed trade. Price impact could be defined as an increase (decrease) in the midpoint over a five-trade interval beginning at the time of buyer- (seller-) initiated transaction. The %PI at time t is equal to zero when $P_t^{mid} = P_{t+5}^{mid}$. Daily proxy of percentage price impact is calculated as a volume-weighted average of percentage price impact estimates computed over all trades within a day. Daily percentage price impact value is defined as equal to zero when all transactions within a day are unclassified.

Percentage Order Ratio (%OR) serves as daily order imbalance indicator. Order ratio captures imbalance in the market since it rises as the difference in the numerator becomes large. According to the literature, a high order ratio value denotes low liquidity. Conversely, a small order ratio value denotes high liquidity. The %OR indicator is equal to zero when the numerator is equal to zero. It happens when daily cumulated trading volumes related to transactions classified as buyer- and seller-initiated trades are equal. Moreover, daily order ratio value is defined as equal to zero in two cases: (1) when all transactions within a day are unclassified, or (2) when total daily trading volume in the denominator is equal to zero.

Testing Stability of Correlations Between Liquidity Proxies

To verify the research hypothesis that correlations between alternative liquidity proxies presented in the study are stable in the specified periods, we employ a methodology for testing equality of correlation matrices computed over non-overlapping subsamples. This is evaluated by testing the hypotheses:

$$\begin{array}{l} H_0 : P_C = P_{PC} \\ H_1 : P_C \neq P_{PC} \end{array}, \tag{2}$$

where P_C, P_{PC} are true (population) correlation matrices in the crisis and pre-crisis (post-crisis) periods, respectively. Let $\widehat{P}_C = \left(\widehat{\rho}_{ij}^C\right)$ and $\widehat{P}_{PC} = \left(\widehat{\rho}_{ij}^{PC}\right)$ be sample correlation matrices in the crisis and pre-crisis (post-crisis) periods of sample size n_C and n_{PC}, respectively.

Different test statistics have been proposed in the literature to test the problem (2). The most popular is the test introduced by Jennrich (1970). However, Larntz and Perlman (1985) pointed out that this test is basically a large sample test and can perform poorly for small samples. Therefore they proposed a test statistic T_{LP} which determined a test with reasonable small sample properties and with power comparable to that of the Jennrich test for large samples. The basic idea is to apply the Fisher (1921) z-transformation to each sample correlation coefficient in the symmetric correlation matrices $\widehat{P}_C = \left(\widehat{\rho}_{ij}^C\right)$ and $\widehat{P}_{PC} = \left(\widehat{\rho}_{ij}^{PC}\right)$, and to consider the $p(p-1)/2$-dimensional random column vectors consisting of the off-diagonal z-transformations $(1 \leq i < j \leq p)$ arranged in lexicographic order. In the case of two subsamples of equal size $n_C = n_{PC} = n$, we have:

$$T_{LP} = \sqrt{\frac{n-3}{2}} \cdot \max_{1 \leq i < j \leq p} \left| \widehat{z}_{ij}^C - \widehat{z}_{ij}^{PC} \right|, \tag{3}$$

where $\widehat{z}_{ij}^C$ and $\widehat{z}_{ij}^{PC}$ are the Fisher z-transformations of sample correlation coefficients $\widehat{\rho}_{ij}^C$ and $\widehat{\rho}_{ij}^{PC}$, respectively. Larntz and Perlman propose the significance level α test under which the null (2) is rejected if $T_{LP} > b_\alpha$, where $b_\alpha > 0$ is chosen such that $[\Phi(b_\alpha) - \Phi(-b_\alpha)]^{p(p-1)/2} = 1 - \alpha$, and Φ is the cumulative distribution function of the standard normal distribution.

In this research, the modified version of the test statistic (3) for non-symmetric matrices of dimensions $p_1 \times p_2$ is employed (Nowak and Olbryś 2015, p. 77). The modified test statistic T is defined as:

$$T = \sqrt{\frac{n-3}{2}} \cdot \max_{\substack{1 \leq i \leq p_1 \\ 1 \leq j \leq p_2}} \left| \widehat{z}_{ij}^C - \widehat{z}_{ij}^{PC} \right|. \tag{4}$$

Under the significance level α, the null (2) is rejected if $T > b_\alpha$, where $b_\alpha > 0$ is chosen such that $[\Phi(b_\alpha) - \Phi(-b_\alpha)]^{p_1 \cdot p_2} = 1 - \alpha$, and Φ is the cumulative distribution function of the standard normal distribution.

Data Description and Empirical Results on the WSE

In this research, we utilize the high-frequency data 'rounded to the nearest second' (available at www.bossa.pl) for 53 WSE-traded stock divided into three size groups, in the period from January 2, 2005 to June 30, 2015. When forming the database, we included only those securities which existed on the WSE for the whole sample period since December 31, 2004, and were not suspended. All companies entered into the database (147) were sorted according to their market capitalization at the end of each year. Next, the stocks were divided into three size groups based on the breakpoints for the bottom 30% (small companies), middle 40% (medium companies), and top 30% (big companies) (Fama and French 1993). The companies that remained in the same group during the investigated period were selected. Finally, the 53 WSE-listed companies were entered into separate groups, specifically: 27 firms into the BIG group, 18 firms into the MEDIUM group, and 8 firms into the SMALL group (Nowak and Olbryś 2016).

The dataset is large and it contains the opening, high, low and closing prices, and volume for a security over one unit of time. For example, on the trading days during the whole sample period there are 3,959,406 transactions in the most liquid Polish company KGH dataset. Therefore, special programs in the C++ programming language have been implemented to reduce the time required for calculations.

To verify the robustness of obtained empirical results, the research is provided over the whole sample (2626 trading days) and three adjacent subsamples, each of equal size (436 trading days): (1) the pre-crisis period September 6, 2005 to May 31, 2007, (2) the crisis period June 1, 2007 to February 27, 2009, and (3) the post-crisis period March 2, 2009 to November 19, 2010 (Olbrys and Mursztyn 2015, 2017). The global financial crisis on the WSE is formally set based on the paper (Olbryś and Majewska 2015).

Summarized Results of Basic Correlation Analyses on the WSE

Table 2 summarizes the results of correlation analyses and it reports basic statistics of correlations for three size groups in the whole sample period (P_1), the pre-crisis period (P_2), the GFC period (P_3), and the post-crisis period (P_4). The correlations (except the RealS/PI values) are the Fisher's (1921) *z*-transformation of sample correlation coefficients. Only the RealS/PI values are the Pearson's sample correlations because all of them are very strong and the Fisher's *z*-transformation is not appropriate in these cases.

Table 2 Summarized statistics of correlations for three size groups

		BIG (27 companies)				MEDIUM (18 companies)				SMALL (8 companies)			
		P_1	P_2	P_3	P_4	P_1	P_2	P_3	P_4	P_1	P_2	P_3	P_4
RS/RealS	Min	−0.03	−0.002	−0.05	−0.09	0.04	0.004	−0.03	−0.03	0.08	0.17	0.05	−0.05
	Max	0.31	0.48	0.47	0.39	0.31	0.37	0.43	0.36	0.27	0.40	0.16	0.20
	Median	0.16	0.13	0.14	0.15	0.14	0.19	0.13	0.14	0.13	0.32	0.09	0.12
	Mean	0.16	0.16	0.17	0.16	0.14	0.19	0.14	0.15	0.15	0.29	0.09	0.11
	St. Dev.	0.08	0.13	0.14	0.14	0.06	0.11	0.13	0.12	0.06	0.08	0.04	0.09
RS/PI	Min	−0.11	−0.25	−0.22	−0.16	−0.15	−0.15	−0.13	−0.08	−0.08	−0.16	−0.04	−0.06
	Max	0.11	0.15	0.14	0.24	0.08	0.22	0.09	0.25	0.05	0.06	0.11	0.15
	Median	0.02	0.01	−0.01	0.03	−0.002	0.004	−0.001	0.04	−0.02	−0.07	−0.01	0.01
	Mean	0.01	−0.001	−0.01	0.02	−0.01	0.000	−0.01	0.03	−0.02	−0.06	0.02	0.03
	St. Dev.	0.05	0.10	0.08	0.10	0.05	0.07	0.06	0.09	0.04	0.07	0.05	0.07
RS/OR	Min	−0.15	−0.13	−0.16	−0.18	−0.10	−0.09	−0.20	−0.17	0.08	−0.05	−0.02	−0.01
	Max	0.17	0.23	0.17	0.23	0.14	0.17	0.12	0.11	0.25	0.38	0.11	0.20
	Median	−0.02	0.04	−0.06	−0.08	0.02	0.06	−0.02	−0.04	0.13	0.07	0.03	0.02
	Mean	−0.003	0.05	−0.04	−0.04	0.01	0.06	−0.03	−0.03	0.14	0.12	0.03	0.07
	St. Dev.	0.08	0.09	0.09	0.10	0.07	0.07	0.10	0.08	0.05	0.16	0.05	0.09
PI/OR	Min	−0.15	−0.16	−0.21	−0.14	0.01	−0.05	−0.05	−0.05	−0.004	−0.02	−0.02	0.02
	Max	0.09	0.18	0.16	0.15	0.22	0.26	0.09	0.15	0.09	0.26	0.15	0.17
	Median	0.01	0.02	0.002	0.003	0.05	0.10	0.04	0.06	0.03	0.04	0.09	0.06
	Mean	−0.01	0.01	−0.01	0.01	0.07	0.09	0.03	0.06	0.03	0.08	0.07	0.07
	St. Dev.	0.06	0.09	0.07	0.07	0.05	0.07	0.04	0.06	0.03	0.10	0.06	0.05
RealS/OR	Min	−0.08	−0.19	−0.16	−0.18	−0.16	−0.25	−0.10	−0.18	−0.11	−0.25	−0.19	−0.20
	Max	0.13	0.15	0.19	0.12	−0.04	0.06	0.06	0.04	0.01	0.11	−0.01	−0.03
	Median	−0.02	−0.01	−0.01	−0.003	−0.07	−0.08	−0.06	−0.07	−0.003	−0.04	−0.09	−0.08
	Mean	0.000	−0.01	0.000	−0.02	−0.07	−0.08	−0.04	−0.08	−0.03	−0.05	−0.10	−0.09
	St. Dev.	0.05	0.09	0.07	0.07	0.03	0.07	0.04	0.05	0.04	0.12	0.06	0.05

RealS/PI	Min	−0.99	−0.99	−0.99	−0.99	−0.99	−0.99	−0.99	−0.99	−0.98	−0.97	−0.99	−0.98
	Max	−0.94	−0.95	−0.93	−0.89	−0.94	−0.85	−0.93	−0.88	−0.96	−0.93	−0.96	−0.95
	Median	−0.98	−0.98	−0.98	−0.97	−0.97	−0.97	−0.98	−0.97	−0.96	−0.96	−0.97	−0.96
	Mean	−0.97	−0.98	−0.98	−0.97	−0.97	−0.96	−0.98	−0.96	−0.97	−0.95	−0.97	−0.96
	St. Dev.	0.01	0.01	0.02	0.03	0.01	0.03	0.02	0.03	0.01	0.01	0.02	0.01

The table is based on: (1) the whole sample period P_1, (2) the pre-crisis period P_2, (3) the Global Financial Crisis period P_3, and (4) the post-crisis period P_4. The RS/RealS, RS/PI, RS/OR, PI/OR and RealS/OR correlations are the Fisher's z-transformed correlation coefficients, while the RealS/PI values are the Pearson's correlation coefficients

Table 3 Percentage of statistically significant correlation coefficients

	P_1	P_2	P_3	P_4	P_1	P_2	P_3	P_4
	RS/RealS				RS/PI			
BIG	92.6%	62.9%	70.4%	70.4%	33.3%	29.6%	22.2%	37.0%
MEDIUM	100%	77.8%	61.1%	61.1%	38.9%	11.1%	11.1%	22.2%
SMALL	100%	100%	37.5%	62.5%	50%	25%	25%	12.5%
	RS/OR				PI/OR			
BIG	66.7%	29.6%	40.7%	51.8%	48.1%	37%	11.1%	22.2%
MEDIUM	50%	33.3%	44.4%	33.3%	77.8%	50%	0%	22.2%
SMALL	100%	25%	12.5%	37.5%	25%	37.5%	50%	12.5%
	RealS/OR				RealS/PI			
BIG	44.4%	33.3%	11.1%	22.2%	100%	100%	100%	100%
MEDIUM	88.9%	44.4%	5.6%	38.9%	100%	100%	100%	100%
SMALL	37.5%	62.5%	50%	37.5%	100%	100%	100%	100%

See Table 2 for explanation

As expected, we observe very strong negative relation among daily percentage realized spread (%RealS) and daily percentage price impact (%PI) values. The value of correlation coefficient varies between −0.99 (Min) and −0.85 (Max), and it does not depend on a firm size. This evidence confirms that these two components of the effective spread are complementing each other and they capture various sources of liquidity/illiquidity.

Table 3 reports the percentage of statistically significant correlation coefficients between daily percentage relative spread, daily percentage realized spread, daily percentage price impact, and daily percentage order ratio values for 53 WSE-traded companies in the whole sample, pre-crisis, crisis, and post-crisis periods. In the case of the whole sample period (P_1) the correlation critical value is equal to 0.038 at the 5% significance level (2626 daily observations) while for the other periods (P_2, P_3, P_4) the correlation critical value is equal to 0.094 at the 5% significance level (436 daily observations).

Stability of Correlations Between Liquidity Proxies Based on Intraday Data on the WSE

Table 4 presents empirical results of stability tests performed on the whole group containing 53 WSE-traded companies. The equality of correlation matrices computed over non-overlapping subsamples is verified at the 5% level of significance. The statistic (4) tests the null hypothesis (2) which states that the correlation matrix is constant over two adjacent sub-periods of an equal number of observations: (1) the crisis (P_3) and pre-crisis (P_2) periods, and (2) the crisis (P_3) and post-crisis (P_4) periods, respectively. The matrices are in fact the vectors and they have $p_1 = 1$ row and $p_2 = 53$ columns. They are calculated for each pair of liquidity proxies, separately.

Table 4 Results of the modified version (4) of the Larntz and Perlman (1985) test

Test periods	Test statistic T	b_α critical value (5%)		Test statistic T	b_α critical value (5%)	
	RS/RealS			RS/PI		
P_3, P_2	4.94	3.30	H_1	4.35	3.30	H_1
P_3, P_4	5.80	3.30	H_1	4.35	3.30	H_1
	RS/OR			PI/OR		
P_3, P_2	5.58	3.30	H_1	3.15	3.30	H_0
P_3, P_4	2.63	3.30	H_0	2.90	3.30	H_0
	RealS/OR			RealS/PI		
P_3, P_2	3.69	3.30	H_1	2.00	3.30	H_0
P_3, P_4	3.01	3.30	H_0	1.67	3.30	H_0

See Tables 2 and 3 for explanation

As one can observe in Table 4, the obtained empirical results concerning the stability in correlations between liquidity proxies in the whole group of companies are mixed. We have no reason to reject the null hypothesis (2) of equality of correlation matrices for the PI/OR and RealS/PI correlations in both cases, while for the RS/OR and RealS/OR only in the case of comparison between the P_3 and P_4 periods.

However, it is important to note that various correlation analyses of liquidity measures might be biased by a non-trading problem on the WSE, e.g. Nowak and Olbryś (2016). Specifically, a consequence of non-trading might be extraordinarily many zeros appearing simultaneously in daily time series of liquidity proxies for some WSE-traded companies regardless of a size group.

Conclusion

In this study, relations based on correlations between four liquidity proxies derived from high-frequency data have been investigated on the WSE. The main research hypothesis that correlations are stable in the specified periods was tested by applying equality tests of correlation matrices computed over non-overlapping subsamples. Although the empirical findings are not homogeneous, the results indicate that some of presented liquidity estimates seem to capture various sources of market liquidity, which is in accord with the existing literature. Specifically, the results confirmed that daily percentage realized spread and daily percentage price impact proxies are strongly inversely correlated.

In our opinion, the application of presented liquidity proxies might be twofold. Firstly, they could be employed as factors in asset pricing models on the WSE, e.g. Olbryś (2014), Nowak (2017). Secondly, the liquidity estimates derived from intraday data would be indispensable in further investigation concerning commonality in liquidity on the WSE. It is important to note that empirical market microstructure research has recently shifted its focus from the examination of liquidity of individual securities towards analyses of the common determinants and components of liquidity. The identification of commonality in liquidity emerged recently as a fast growing strand of the literature on liquidity.

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Validating Downside Accounting Beta: Evidence from the Polish Construction Industry

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Abstract This paper applies a method for measuring market risk called Downside Accounting Beta (DAB), previously developed by Rutkowska-Ziarko and Pyke (Econ Bus Rev 3(4):55–65, 2017). DAB shows how changes in the profitability of a sector affect the profitability of a company in that sector. DAB can also be applied to whole market. Empirical evidence is presented using the data from companies listed in the Polish construction sector of the Warsaw Stock Exchange. The analysis concludes that there are significant similarities between market betas and accounting betas. It also demonstrates that accounting betas using Return on Assets (ROA) and Return on Sales (ROS) are positively correlated with market betas and that there is a significant correlation between accounting betas with variance and semi-variance approaches. In addition, the paper identifies that the systematic risk on the Warsaw Stock Exchange is connected with the sensitivity of the company's profitability of assets (ROA) and sales (ROS) in comparison with profitability for the whole sector. The practical implication of this research is that investors, owners and managers can apply DAB using ROA to calculate the systematic risk of companies that are not listed on stock markets and consequently to identify the levels of risk associated with companies within the sector.

Introduction

This paper is an extension of previous published research by Rutkowska-Ziarko and Pyke (2017), where the concept of *Downside Accounting Beta* (DAB) was developed and presented as a new method for measuring market risk.

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The aim of the paper is to analyse the relationship between market betas and accounting betas using the variance and semi-variance approach. In the previous research, DAB was applied to food companies listed on the Warsaw Stock Exchange and it was found that there are significant similarities between market betas and accounting betas. In this study we analyse whether DAB can be usefully applied to the construction industry.

Accounting betas measure the sensitivity of the profitability ratio of a given company caused by changes in the profitability of the whole sector or market (Hill and Stone 1980).

A common approach to calculating accounting beta is by using variances as a risk measure (Hill and Stone 1980; Campbell et al. 2009; Mensah 1992; Nekrasov and Shroff 2009; Sarmiento-Sabogal and Sadeghi 2015; Konchitchki et al. 2016). However, one of the drawbacks of using this measure of risk is that negative and positive variances from the expected rate of return are treated in the same manner. In fact, negative variances are undesirable while positive ones create an opportunity for a higher profit (Pla-Santamaria and Bravo 2013; Rutkowska-Ziarko 2013, 2015; Klebaner et al. 2017). Others, (Harlow and Rao 1989; Estrada 2002; Post and Vliet 2006; Galagedera and Brooks 2007; Markowski 2015) argue that downside market beta is a better measure of risk than the mean-variance model.

Teplova and Shutova (2011) proposed a mean semi-variance framework for the Russian Stock Market which estimates systematic risk. They identified that the negative volatility of returns is a concern for investors, therefore the semi-variance is more useful than the variance when the underlying distribution of returns is asymmetric, or when the underlying distribution is symmetric. They used the downside co-skewness and the downside kurtosis coefficient.

Charles et al. (2004) analysed success and failure of 24 large international construction firms originating in the United States, Europe, and Japan. They concluded that construction firms must consistently check the downside risks of all financial indicators.

Konchitchki et al. (2016) analysed accounting-based risk and downside risk. The research analysed the implications of downside risk for a company and to the cost of capital. They looked at the role of earnings volatility in risk assessment, by analysing the influence of volatile accounting figures on company risk. In the same way they stressed that downside volatility is more important in risk analysis than the upside states. They analysed how a firms' fundamentals relate to investment decisions in context of downside risk.

The most important aspect of this study was earnings downside risk. The ROA profitability ratio was used as a measure of earnings. The earnings downside risk was understood in that study as the ratio of the lower and upper partial moments for ROA where the target point was the expected value of ROA. They applied different models and a huge range of accounting and economic variables to find out the factors that influence earning downside risk. They also used accounting beta for ROA and the standard deviation of ROA as measures in a mean-variance approach. Our research is connected with this analysis and the concept of DAB (Rutkowska-Ziarko and Pyke 2017) provides a new tool to analyse earning downside risk.

The research undertaken by Konchitchki et al. (2016) is an important contribution to research in accounting and finance area. It provides new knowledge about the link between accounting information and risk on capital market. Our research also contributes to this subject area.

Downside Accounting Beta

The market beta (β_i) is the slope coefficient used in Sharpe's CAPM (Sharpe 1964):

$$\beta_i = \frac{COV_{iM}}{S_M^2}, \tag{1}$$

where COV_{iM}—covariance of the rate of return for stock i and market portfolio rates of return, S_M^2—variance of market portfolio rates of return.

The downside market beta (β_i^{LPM}) is calculated similar to Price et al. (1982) proposition:

$$\beta_i^{LPM} = \frac{CLPM_i^2}{dS_M^2(f)}, \tag{2}$$

where $CLPM_i^2$—asymmetric mixed lower partial moment of second degree for stock exchange listed company i, $dS_M^2(f)$—semi-variance of the market portfolio determined in relation to the risk-free rate of return.

The asymmetric mixed lower partial moment of second degree is calculated as follows (Price et al. 1982):

$$\begin{aligned} CLPM_i^2 &= \frac{1}{T-1}\sum_{t=1}^{T}\left(R_{it} - R_{ft}\right)^* lpm_{Mt}, \\ lpm_{Mt} &= \begin{cases} 0 & for \quad R_{Mt} \geq R_{ft} \\ R_{Mt} - R_{ft} & for \quad R_{Mt} < R_{ft} \end{cases} \end{aligned} \tag{3}$$

where R_{Mt}—market portfolio rate of return in the period t, R_{ft}—risk-free rate.

In a similar way the semi-variance of the market portfolio is calculated:

$$dS_M^2(f) = \frac{\sum_{t=1}^{T} lpm_{Mt}^2}{T-1}. \tag{4}$$

The accounting Beta coefficient for Return on Assets ($\beta_i(ROA)$) could be calculated as follows (Hill and Stone 1980):

$$\beta_i(ROA) = \frac{COV_{iM}(ROA)}{S_M^2(ROA)}, \tag{5}$$

where $COV_{iM}(ROA)$—covariance of the profitability ratio of company i and market portfolio ratios (market indices of profitability ratios), $S_M^2(ROA)$—variance of market or sector profitability ratios. In this way we can calculate the accounting beta for different profitability ratios.

We used the methodology from our previous work to calculate the downside accounting beta, for ROA (Rutkowska-Ziarko and Pyke 2017):

$$\beta_i^{LPM}(ROA) = \frac{CLPM_i^2(ROA)}{dS_M^2\left(\overline{ROA_M}\right)}, \tag{6}$$

where $\overline{ROA_M}$—average level of ROA for all analysed companies in the sector,

$$\overline{ROA_M} = \frac{1}{T}\sum_{t=1}^{T} ROA_{Mt}, \tag{7}$$

$$ROA_{Mt} = \frac{\sum_{i=1}^{k} MV_i{}^* ROA_{it}}{\sum_{i=1}^{k} MV_i}, \tag{8}$$

where MV_i—market value of company i, $dS_M^2\left(\overline{ROA_M}\right)$—semi-variance of the market portfolio determined in relation to the average level of ROA.

$$\begin{aligned} CLPM_i^2(ROA) &= \frac{1}{T-1}\sum_{t=1}^{T}\left(ROA_{it} - \overline{ROA_M}\right)^* lpm_{Mt}(ROA), \\ lpm_{Mt}(ROA) &= \begin{cases} 0 & for \quad ROA_{Mt} \geq \overline{ROA_M} \\ ROA_{Mt} - \overline{ROA_M} & for \quad ROA_{Mt} < \overline{ROA_M} \end{cases}. \end{aligned} \tag{9}$$

Similarly the semi-variance of the ROA for the whole sector is calculated:

$$dS_M^2\left(\overline{ROA_M}\right) = \frac{\sum_{t=1}^{T} lpm_{Mt}(ROA)}{T-1}. \tag{10}$$

The downside accounting beta (DAB) for each profitability ratio could also be defined in a similar way.

Application of DAB to the Construction Company Sector

To test the application of DAB the data for 27 construction companies listed on the Warsaw Stock Exchange was collected and analysed during the period 1 January 2012–30 June 2017. In addition, quarterly financial statements during the period between Quarter 4 2011 and Quarter 1 2017 were also analysed for the 27 construction companies.

Table 1 Correlation between market beta and accounting betas for the mean-variance approach

	β_i	$\beta_i(ROS)$	$\beta_i(ROA)$	$\beta_i(ROE)$
β_i	1			
$\beta_i(ROS)$	0.302	1		
$\beta_i(ROA)$	0.374	0.949	1	
$\beta_i(ROE)$	0.170	0.595	0.688	1

The quarterly financial reports used by investors always refer to a company's performance in the previous quarter. Therefore, in this study a quarter back-shift is applied to the financial data so that it matches with the market share prices. A time series of quarterly rates of return and profitability ratios: ROA,[1] ROE[2] and ROS[3] were determined for every company. In this study we decided to use sector index (WIG-construction) instead of the wide market index as WIG. In calculating the accounting betas we took into account the sensitivity of the company's profitability to the profitability in the sector. Therefore, it is reasonable to compare accounting betas with market beta. The Warsaw Interbank Offer Rate (WIBOR 3M) for three-month investment was used as the risk-free rate. For each construction company the market betas and accounting betas were calculated using two different approaches: the risk measured by variance and downside risk. The calculations begin with market betas and accounting beta for risk measured by variance. The correlation between market beta and accounting betas for the mean-variance approach were estimated (Table 1). In all presented tables, critical value of Pearson coefficient is 0.38 at significance level of 0.05 and 0.32 at significance level of 0.1. There is a positive correlation between market beta and accounting betas. This correlation is relatively weak, but statistically significant for the *accounting beta coefficient* for ROA. The statistically significant correlation arises between all kinds of accounting betas.

In Table 2 the correlation matrix is shown between the market beta and accounting betas for the mean downside risk. There is a positive correlation between market beta and accounting betas for downside risk. However, there is no significant correlation between downside beta for ROE and downside market beta. The strong and statistical significant correlation arises between almost all kinds of downside accounting betas. It can be seen that the correlations between market beta and accounting betas are a little stronger for the downside approach. It was also found that the correlation between different accounting betas is higher and stronger than in the variance approach.

Finally, the correlation coefficients between the different kinds of betas for the variance approach and downside risk are calculated (Table 3). There is a positive relationship between betas for variance and for downside risk. However, for ROE the correlation is statistically insignificant, but the correlation between accounting betas for ROA is quite strong. The accounting betas for the construction companies

[1]ROA is calculated by dividing the net profit a company earns by its overall resources.

[2]ROE is calculated by dividing the net profit a company earns by the shareholder's equity.

[3]ROS is calculated by dividing the net profit a company earns by its sales (revenue).

Table 2 Correlation between market beta and accounting betas for mean-downside risk approach

	β_i^{LPM}	$\beta_i^{LPM}(ROS)$	$\beta_i^{LPM}(ROA)$	$\beta_i^{LPM}(ROE)$
β_i^{LPM}	1			
$\beta_i^{LPM}(ROS)$	0.383	1		
$\beta_i^{LPM}(ROA)$	0.430	0.945	1	
$\beta_i^{LPM}(ROE)$	0.276	0.819	0.908	1

Table 3 Correlation between betas for risk variance approach and downside risk

Variables		Correlation
β_i	β_i^{LPM}	0.671
$\beta_i(ROS)$	$\beta_i^{LPM}(ROS)$	0.566
$\beta_i(ROA)$	$\beta_i^{LPM}(ROA)$	0.717
$\beta_i(ROE)$	$\beta_i^{LPM}(ROE)$	0.143

based on ROA and ROS are correlated with market beta. In comparison with our previous research on Polish food companies there was a significant correlation between market beta and accounting betas for ROA and ROE; and a stronger correlation for downside risk approach compared to the mean-variance approach (Rutkowska-Ziarko and Pyke 2017).

Comparing these results, we would argue that the DAB for ROA is a good additional or alternative measure of risk for Polish companies. This is consistent with the findings of Sarmiento-Sabogal and Sadeghi (2015) who found a link between accounting betas and market betas for US-listed firms. Their results showed that the accounting betas based on assets instead of equity have a stronger link with market beta. However, in their research only the mean-variance approach was applied, they didn't consider the accounting beta for ROS.

Conclusions

This is our second paper that applies the new concept of *Downside Accounting Beta* (DAB) as a measure of risk. The market betas and accounting betas were calculated for each company using two different approaches: the risk when measured by variance and downside risk.

Our data shows that there is a positive correlation between market beta and accounting betas. It is also stronger for the downside risk approach than the mean-variance approach. The analysis also shows that accounting betas using ROA and ROS are positively correlated with market betas and that there is a significant correlation between accounting betas with variance and semi-variance approaches. However, for ROE the correlation is not statistically significant. This research supports previous research that ROA is the most relevant profitability ratio in risk analysis. Based on these results we conclude that DAB is a reliable alternative measure of risk for Polish companies.

The practical implications of our research is that investors, owners and managers can apply DAB using ROA to calculate the systematic risk of companies that are not listed on stock markets and consequently to identify the levels of risk associated with companies within the sector. This might be particularly helpful where a company is about to be listed for the first time on an open stock market. In future research, we will use a larger sample of companies from other sectors and stock exchanges. We plan to compare DAB with other approaches that combine accounting and risk analysis.

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Part III
International Finance

Application of S-curve and Modified S-curve in Transition Economies' GDP Forecasting. Visegrad Four Countries Case

Rafał Siedlecki, Daniel Papla, and Agnieszka Bem

Abstract S-curve is usually used to describe economic or natural phenomena, which follow the rule of the logistic growth. In this paper we propose to use the modified S-curve, due to the "unlimited growth" phenomenon. The aim of this research is to show the application of the S-curve as well as the modified S-curve in GDP growth forecasting, using data from transition economies. This paper presents also the proposal of numerical estimation of the modified S-curve parameters. According to paper's aims, we have posed the following research hypotheses: (H1) the S-curve and the modified S-curve are effective tools of economic development forecasting for transition economies; (H2) the modified S-curve is more efficient than ordinary S-curve in GDP forecasting for transition economies.

Introduction

According to the theory of economy, each economic activity is subjected to the logistic growth law, what means, that growth rate decreases with time. We can observe this phenomenon on almost every front: the law of decreasing income from farming or the law of relatively decreasing efficiency of expenditure, or, according to the company finance, the law of limited growth of interest, limited growth of sale (product life cycle), or limited growth of a market share (Siedlecki 2014). We can conclude, that, in a given economic process, after an early stage, characterized by slow growth, we can observe dynamic growth—up to some maximum level. From that moment, a growth ratio is definitely smaller, until total disappearance. After that period, in some cases, rapid decrease can occur (Kuznets 1971; Metcalfe 2001; Mar-Molinero 1980; Siedlecki and Papla 2013).

Nowadays global economy is particularly sensitive to various types of disturbances which are the effect of increasing globalization (Siedlecki and Papla 2013;

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Brunnermeier 2009; Coffee 2009; Guillen 2009; Kolb 2010; Shiller 2008). These events cause GDP shocks, or even breaks, that interrupt economies' growth trend. As a result, the growth rate of GDP have to find a new development' trajectory. Similar effects, but on a larger scale, can be observed in the case of economies of countries, that carried out a process of economic transition. After shorter, or longer period of economic slowdown, a span of dynamic growth can be reported, which gets slower along with time. Those processes could be successfully analyzed using the rule of logistic growth.

The S-curve is a tool, which allow to forecast, and analyze, economic processes which follow the rule of logistic growth (Robertson 1923). This function allows to identify three growth phases like slow, accelerated and stable (Kuznets 1971; Siedlecki and Papla 2013). Despite undeniable advantages, the S-curve is characterized by several disadvantages, above all, limited growth (an asymptote). This disadvantage can be avoided by employing the modified S-curve, which assumes elastic and unlimited growth. The problem is, that parameters of the modified S-curve are relatively difficult to estimate.

The aim of this research is to show the application of the S-curve, as well as, the modified S-curve in GDP growth forecasting, using data from transition economies. This paper presents also the proposal of numerical estimation of the modified S-curve parameters. According to paper's aims, we have posed the following research hypotheses:

H1 *the S-curve and the modified S-curve are effective tools of economic development forecasting for transition economies; it can be used to recognize all phases of development (or business) cycle: slow, accelerated and stable growth.*

H2 *the modified S-curve is more efficient than ordinary S-curve in GDP forecasting for transition economies.*

The H1 hypothesis refers to the law of logistic growth. After the economic/structural transformation, the economy suffers from a dramatic breakdown, characterized by a strong GDP' decrease, a new growth cycle opens. The initial phase of the growth goes through a phase of rapid growth, which leads to the stabilization phase. The H2 hypothesis refers to the characteristic of the modified S-curve, which do not have any saturation level, in contrast to the regular S-curve. That's way the modified S-curve better reflects the nature of business processes.

The paper is organized as follow: after the introduction, we have shortly characterized the transformation process, which took place in Visegrad Four (Czech Republic, Hungary, Poland, Slovakia—V4) countries in the 1990s. In the next parts we have presented the mathematical form of the S-curve and the modified S-curve and their application in economic forecasting, based on the data from V4 countries.

Economic transition resulted in the launch of a quite new development cycle for CEE economies. Instead of relatively short J-shaped adjustment, those countries were faced to the extremely deep recession (Fidrmuc 2003), followed by short phase of slow growth, and, after the end of the period of consolidation, they experienced the phase of dynamic growth (Siedlecki and Papla 2016a, b). This process can be successfully modeled using the logistic law of growth, and expressed by the S-curve, or the modified S-curve.

This paper contribute to the science in several way. First, we have proved, that the S-curve, as well as the modified S-curve, can be effectively used in economic forecasting, especially in the case of transition economies. We have shown, that modified S-curve better fits and explains GDP p.c. time series, because it has no upper asymptote, and shows infinity growth with rate tending to zero.

S-curve is a mathematic expression of the law of logistic growth, presented, for the first time, by P.F. Verhulst (1838), which takes the following form:

$$f(t) = \frac{a}{1 + e^{b-ct}}. \tag{1}$$

where: $a > 0$, $b > 0$, $c > 0$.

The modification of the S-curve, which takes into account the character of economic and financial data, assumes that:

$$f(t) = \frac{a}{1 + e^{b-ct}} \phi(t) \tag{2}$$

The best function should have first derivative of the following form:

$$\phi'(t) = \alpha t^p, \quad \text{for} - 1 \leq p < 0 \tag{3}$$

Assuming that $p = -1$ and omitting α, we get:

$$\varphi(t) = \ln(t). \tag{4}$$

The way to eliminate the defect of limited growth of the S-curve, is to modify the function by introducing the ln(t) factor. The modified function is called the modified S-curve. The function is expressed by the following formula (Hellwig and Siedlecki 1989):

$$f(t) = \frac{a \ln t}{1 + e^{b-ct}}, \tag{5}$$

where $a > 0$, $b > 0$, $c > 0$.

When examining the function variability graph, we can show its basic properties:

$$\lim_{t \to \infty} \frac{a \ln t}{1 + e^{b-ct}} = \infty, \tag{6}$$

$$\lim_{t \to 0} \frac{a \ln t}{1 + e^{b-ct}} = -\infty \tag{7}$$

and for $t_1 < t_2$

$$\frac{a \ln t_2}{1 + e^{b - ct_2}} > \frac{a \ln t_1}{1 + e^{b - ct_1}} \tag{8}$$

$$\frac{dy}{dt} > 0, \quad \text{for } t \geq 1 \tag{9}$$

As we can observe, that the modified S-curve is the function of constant growth. It doesn't have extreme points and is always negative:

$$\frac{dy}{dt} > 0, \quad \text{for } \ t \geq 1. \tag{10}$$

The S-curve has one point of inflection which is often close to the middle of intensive growth phase. The modified S-curve has usually two points of inflection, where the first point is of a less importance, from a point of view of economic and the second point, which, by analogy to the S-curve, usually indicates the middle of the intensive growth phase. Both points of inflection, in both analysed functions, indicate the change of function convexity (from convex into concave) which is means the change of growth rate.

Empirical Application: Smoothing and Forecasting

In order to present the practical application of the S-curve and the modified S-curve, we used data coming from V4 countries. Data were obtained from Reuters DataStream and OECD database, and cover the years 1991–2015.

The analysis is based on annual data—GDP per capita (Purchasing power parity—PPP), from the period after the communism fall (1991–2015) (for Slovakia from 1992). The linear trend and the S-curve, as well as, the modified S-curve, is estimated.

In the first step of our study, we estimate the GDP per capita growth rate, for all analyzed countries, assuming that this ratio is the best to describe countries' development and wealth. This trajectory of development is quite similar to other ratios, calculated for GDP or GNI (Siedlecki and Papla 2013), despite demographic decrease, which can be observed in CEE countries (compare: (Siedlecki and Papla 2016a, b)). In order to compare obtained results we decide to use data for Germany, for the same period.

The analysis of the rates of growth of GDP per capita and GDP per capita, PPP for V4 countries and Germany (as the example of the developed economy) suggest, that the growth rate for V4 countries is significantly higher than for Germany, what suggests, that V4 countries can be still in the phase of intensive growth (development). On the other hand, although relatively high growth rate, which can be observed during last 24 years, the level of GDP per capita in V4 group is still very low, comparing to Germany, or other developed countries. The highest growth rate were reported in the case of Poland and Slovakia, but Poland started with the lowest

Table 1 Results of KPSS test for GDP per capita, PPP

Country	Test statistic	Interpolated *p*-value
Czech_Republic	0.920821	Less than 0.01***
Hungary	0.920544	Less than 0.01***
Poland	0.900706	Less than 0.01***
Slovak Republic	0.878544	Less than 0.01***
Germany	0.911477	Less than 0.01***

*Significance level $\alpha = 0.1$, ** significance level $\alpha = 0.05$, *** significance level $\alpha = 0.01$

Interpolated *p*-value (critical values): $\alpha = 0.1(0.355)$; $\alpha = 0.05$ (0.462); $\alpha = 0.01(0.704)$

Table 2 Linear trend estimation for GDP per capita, PPP

Trend analysis	Czech Republic	Hungary	Poland	Slovakia
KPSS test for residuals (test statistic p-value)	0.17155 (0.035)	0.186922 (0.024)	0.235147 ($p < 0.01$)	0.193272 (0.020)

GDP per capita and this growth rate was too small to reach Czech or Slovakia level. This is the result of the most difficult initial conditions.

In the next stage of the study, we have tested the hypothesis of time-series stationarity of GDP per capita, which allow us to prove, that there is some tendency (trend) in analyzed process. We employ the Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test, for which a null hypothesis is that the time series is stationary around a deterministic trend, against the alternative of a unit root. According to the KPSS test results we are forced to reject the null hypothesis, and adopt the alternative hypothesis, which assumes non-stationarity. For all examined countries we receive significance level under 0.01, that means, that there is some tendency (trend) in the GDP per capita growth (Table 1).

Than we examine the hypothesis of stationarity of residuals for analyzed time-series. Based on KPSS test, we reject the null hypothesis of stationarity for all V4 countries. That implies, that we cannot use the linear trend to smoothing and forecasting (Table 2)—non-stationarity of linear trend residuals suggest presence of nonlinear trend. Concluding, there is a trend in analyzed process, but it doesn't have a linear form.

Those findings encouraged us to use the S-curve, and the modified S-curve. We estimate the parameters of both curves (Tables 3 and 4). Analogously we test the stationarity of residuals for estimated functions, using, again, the KPSS test. Results strongly confirm, that the logistic trend exist. For all examined countries residuals are stationary and estimated functions are perfectly fitted (R^2 higher than 0.98 for all countries)

It proves, that both S-curve and modified S-curve are very good tools to estimate non-linear trend. *Those results allow us to adopt the H1 hypothesis, which assumes, that S-curve and modified S-curve are effective tools in analyzing growth and phases of development cycle for transition economies*. Moreover, on the same time, we can

Table 3 S-curve estimation for GDP per capita, PPP

Analysis	Czech Republic	Hungary	Poland	Slovakia
Coefficients	$a = 23.0988$ $b = 3.6915$ $c = 0.2365$ $d = 11.5426$	$a = 18.8074$ $b = 3.9048$ $c = 0.2486$ $d = 8.2830$	$a = 28.6976$ $b = 3.6455$ $c = 0.1868$ $d = 5.9121$	$a = 25.3169$ $b = 3.8184$ $c = 0.2458$ $d = 7.1313$
R^2	**0.9898**	**0.9913**	**0.9956**	**0.9940**
KPSS test for residuals (test statistic *p*-value)	0.0652604 ($p > 0.1$)	0.20691 ($p > 0.1$)	0.129886 ($p > 0.1$)	0.0557791 ($p > 0.1$)

Table 4 Modified S-curve estimation for GDP per capita, PPP

Analysis	Czech Republic	Hungary	Poland	Slovakia
Coefficients	$a = 7.2893$ $b = 2.9029$ $c = 0.2057$ $d = 11.5426$	$a = 5.8708$ $b = 3.1875$ $c = 0.2246$ $d = 8.2830$	$a = 9.9721$ $b = 2.8752$ $c = 0.1427$ $d = 5.9121$	$a = 8.0763$ $b = 3.0524$ $c = 0.2146$ $d = 7.1313$
R^2	**0.9909**	**0.9948**	**0.9967**	**0.9940**
KPSS test for residuals (test statistic *p*-value)	0.0473997 ($p > 0.1$)	0.139748 ($p > 0.1$)	0.072742 ($p > 0.1$)	0.0917317 ($p > 0.1$)

confirm the *H2 hypothesis, assuming, that our the modified S-curve is a better tool, than the S-curve*. Firstly, the modified S-curve is better fitted for data (R^2 are a little bit higher) and KPSS test's parameters are lower.

Secondly, as we can observe on Fig. 1, the forecasts prepared using the modified S-curve are not limited by saturation level, as in the case of the S-curve. This can be a source of better estimation's results, especially in case of developing (transition) economies. It can be concluded, that V4 countries are quite close to slow growth rate phase, but based on the S-curve forecast, those countries will never reach the level of German's GDP per capita, or other highly developed countries. The maximum level of GDP per capita (PPP), estimated using the S-curve, based on parameters $a + d$, are equal to: 34.614 USD for the Czech Republic, 27.090 USD for Hungary, 34.610 USD for Poland and 32.448 USD for Slovakia (Table 3, Fig. 1).

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In our research we successfully confirm, that, in the case of V4 countries, after the economic transition, the development trajectory can be shaped using the S-curve or the modified S-curve shape. We can observe all phases of development (or business) cycle: slow, accelerated and stable growth. Based on presented empirical examples, we can form some concluding remarks:

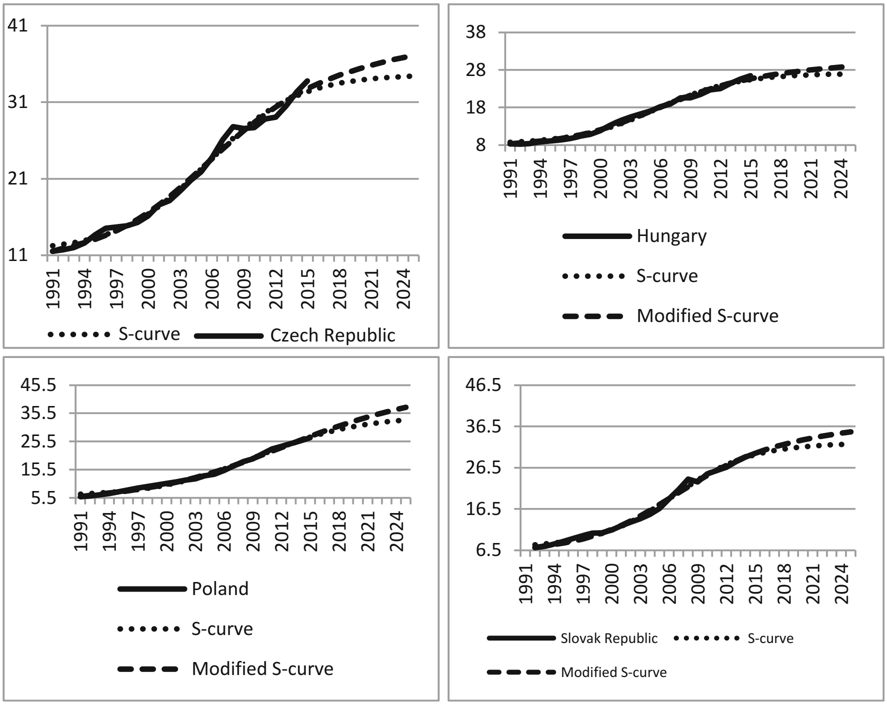

Fig. 1 GDP per capita (PPP), estimated values of the S-curve and the modified S-curve (1991–2015) and forecasts (2016–2025)

- in the case of transition economies the S-curve, and the modified S-curve can be successfully employed in the analysis of economic development and forecasting. Linear trend could not be applied;
- the modified S-curve allows far extrapolation of economic and financial time series (especially for transition economies) because it doesn't have a saturation level;
- this findings are important for forecasting, or modelling of economic processes, which follow the rule of the logistic growth law.

Main limitations of our study are: small sample (it is caused by small number of similar countries), validity of data, we do not have explained yet modified S-curve with differential equation which help us to describe unlimited growth law, we still looking for.

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Financialization of Commodity Markets

Bogdan Włodarczyk and Marek Szturo

Abstract The meaning of commodity markets and raw material trading is very important for the shape of the world economy. In recent years, commodity markets, similarly to economics or financial markets, have been transformed. In the first decade of the twenty-first century significant fluctuations of raw material prices were observed. Moreover, many investors originating from financial markets started to be more and more active on commodity markets. Cheapening and easily accessible capital encouraged investors to seek alternative ways to multiply their assets, and one of the solutions was an increased exposure on commodity markets. The purpose of this article was the consideration of market financialization based on our own and other empirical studies as well as chosen theoretical concepts. A hypothesis was formed which reads: The result of the financialization of the commodity markets process is the increasing fluctuation levels of prices. The verification of this hypothesis is based on comparison analysis of the changeability of prices of chosen materials and the positioning of the investors groups in the period of 2007–2017. Furthermore other empirical studies conducted by other authors were analysed. Understanding the impact of financialization on the prices of goods requires an evaluation of its influences on the economic mechanisms shaping the situation on commodity markets. It was concluded that the financialization of the commodity markets has an effect on the increased fluctuation of chosen materials.

Introduction

The inflow of portfolio capital was stimulated both by the events in the regulation sphere and the publication of the study results in scope of the portfolio theory. In the first sphere, it was of particular importance to pass in the USA in 2000 the Commodities Futures Modernization Act which excluded the extra-exchange

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derivatives market from the supervision of the Commodities Futures Trading Commission (CFTC) and Securities and Exchange Commission (SEC), enabling huge commercial banks and hedge funds a free usage of commodity derivatives to diversify the investment portfolios (OECD-FAO Agricultural Outlook 2011). A particular increase of the usage of commodity markets to diversify portfolios was noted since the middle of the first decade of the twenty-first century when the publication of the study results of the portfolio theory showed essential diversification benefits resulting from including the commodity investments into the financial assets portfolios.

The purpose of this article was to consideration about the financialization of the commodity markets based on our own and other empirical studies and chosen theoretical concepts. A research hypothesis was formed which reads: As an effect of the commodity market financialization process, the price fluctuation levels are increasing. The hypothesis verification was based on comparison analysis of the changeability of prices of chosen materials and the value of positioning of the investors group between the period of 2007 and 2017. The empirical data was sourced from databases such as Reuters, Bank for International Settlements, IMF as well as Market Voice. Furthermore the conclusions of studies conducted by other authors were also analysed.

Financial Investors' Activity on Commodity Markets

It is worth noticing that the financial investors' activity on commodity markets is very rare in the spot commodity market segment (the precious metals markets are an exclusion). In the majority of cases the commodity prices' exposure to risk is obtained by taking a position on the commodity derivatives market. Since the beginning of the twenty-first century, especially since 2005, an explosion of the global commodity derivatives scale has been taking place, which was illustrated in Tables 1 and 2.

Financial investors also showed a particular interest in the investments on the agricultural products and energy raw materials markets.

A change of the investors' structure accompanied the increase of the transaction scale. The data from the futures exchange Chicago Mercantile Exchange show that on the futures key contract on wheat the speculators' participation in the total volume of sales grew from 12% in 1996 to 61% in the middle of 2011.[1]

Except for fundamental macroeconomic factors, changes in the structure of the market entities group interested in futures contracts for goods help to foresee the fluctuations resulting from the interaction between the commodity market and the stock market (Büyüksahin and Robe 2014).

It is also worth pointing out that the global financial crisis did not stop the increase of the amount of transactions made on the exchange commodity derivatives markets

[1] https://www.cmegroup.com/company/membership.html (access 20.01.2017)

Table 1 The value of the global timely commodity transaction in the years 1998–2016 (billion USD)

Year	Nominal value (notional amounts outstanding)	Market value (Gross market value)
2005	5434	871
2006	7115	667
2007	8455	1898
2008	4427	955
2009	2944	545
2010	2922	526
2011	3091	466
2012	2587	347
2013	2204	264
2014	1869	318
2015	1320	297
2016	1392	202

Source: BIS, http://stats.bis.org/statx/srs/table/d5.2?p=20161 (access 24.01.2017)

Table 2 The amount of futures contracts made on particular segments of commodity markets

	Agricultural products	Energy, energy resources	Base metals	Precious metals
2005	378,897,206	280,133,406	98,494,236	72,532,719
2006	486,903,948	384,723,413	115,001,033	102,279,416
2007	640,678,206	496,770,611	150,975,562	106,821,904
2008	894,620,553	582,115,347	198,715,367	157,395,388
2009	927,738,831	657,043,981	462,823,525	151,451,722
2010	1,305,528,728	723,618,122	643,646,061	174,946,553
2011	996,794,332	814,826,810	435,115,597	342,134,687
2012	1,254,427,430	901,916,482	554,253,755	319,434,323
2013	1,211,397,795	1,315,403,564	646,353,600	433,708,193
2014	1,387,993,407	1,160,869,956	872,626,126	371,064,966
2015	1,639,668,492	1,407,235,307	1,280,935,517	321,272,201

Source: Market Voice http://marketvoicemag.org/sites/default/files/data/March16VolumeCommodityBoom.xlsx (access 24.01.2017)

(Table 2). The decrease of the value of sales was mainly the result of a break of commodity prices after the outbreak of crisis.

The financial crisis played a vital role, stressing the connections between the commodity and financial markets and also bringing out the financialization of the commodity exchange. The evolution on the level of correlations between the commodity and financial markets limits the substitutability potential of financial goods and instruments in the investment portfolios. From the perspective of the idiosyncratic risk the main exceptions are gold, coffee and cocoa, for which the effective risk management strategies are possible, with a greater risk diversification, which is enabled by their negative correlation in reference to financial markets in the downward price periods.

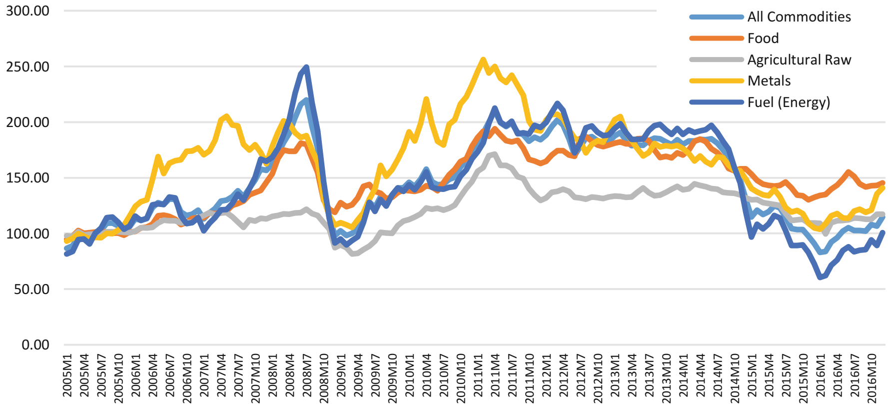

Fig. 1 The spot prices indices of the global commodity market (for 2005 = 100). Source: IMF, http://www.imf.org/external/np/res/commod/External_Data.xls (access 24.01.2017)

Together with the increase of the financial investors' activity on commodity markets, the beginning of the twenty-first century was the time of a long-term trend of prices increase on the majority of commodity markets.

A characteristic feature of the trend of the agricultural commodity prices increase at the beginning of the twenty-first century was a fact that it happened after the decade of a great price stability in the 1990s of the twentieth century. The break of the increase trend was the result of the global financial crisis at the beginning of 2008, but in the years 2010–2011 another phase of rapid increase in commodity prices was noted (Fig. 1).

The prices of the industrial, agricultural and energetic raw materials have been decreasing incessantly since 2011. Currently, they are at the levels where the potential to a further decrease is greatly limited. Investing in raw materials, one may invest in raw materials contracts. In that case, however, the contango effect occurs, which influences the financial result.

The Phenomenon of Financialization in the Research Context

A rapid increase in the financial investors' activity on commodity markets in the years 2004–2008 is coherent with the definition of the process of economy financialization, that is why the price and price risk increase accompanying the inflow of the portfolio capital started to be interpret as its consequence. Such a theory was first introduced by a well-known manager administrating hedge funds, M. Masters, who in 2008 claimed that the financial investors investing in instruments based on the commodity market indices are responsible for the rapid growth of commodity prices and, by "taking away" market liquidity also for the increase in price volatility (Masters and White 2011). A year later, the US Senate subcommittee on investigations proved that the excessive index investors' speculations on the market of the futures contracts on wheat, destabilizes the market, causing the creation of significant differences between the level of spot and futures prices on the dates of carrying out a series of futures contracts. Consequently, prices of certain commodities stopped being shaped by traditional demand and supply factors, and become prone to changes of aggregated "appetite" for risk among the financial investors deciding about the composition of their investment portfolios. Also Hernandez and Torrero, analysing the prices of wheat, corn and soy in the years 1998–2009 claimed that the futures prices which level is shaped by the financial investors' activity determine the level on the spot market (Hernandez and Torrero 2010).

Some authors, however, show a greater restraint in pointing out the source of the 2000–2008 hossa on commodity markets. Girardi, basing on the market research of 16 agricultural goods concludes that the growth of agricultural product prices and financial assets correlation is a result of the financial investors' activity and economic crises combination. A high participation of the financial investors in the commodity markets sale favours the transfer of shocks from financial markets on commodity markets (Girardi 2012).

Irwin and Sanders confirm the rapid scale growth of the derivatives market on agricultural products in the years 2004–2011. However, they pay attention to the fact that besides the undoubted increase of the portfolio investors' activity, including the index funds, the increase of sales was also the result of two different changes of structural character—the first one was a total abandonment of the open-outcry trading system by American stock exchanges and moving on to a more effective system of electronic transaction associations, and the second was a rapid facilitation of access to the market for outside investors in the conditions of sales electronization and the spread of modern channels of information transmission (Irwin and Sanders 2012).

A huge inflow of financial capital on commodity markets will probably influence the risk distribution through the integration of futures raw material markets with outside financial markets. A lot of research results confirm the likelihood of such integration.

Analysing the daily return rate of certain goods, Tang and Xiong pointed out that the correlation among different goods increased after 2004 from the levels close to zero to a significantly positive level. They especially point out that the increase of correlation is particularly important for the goods being in popular futures commodity indices (Tang and Xiong 2012).

Many researches, such as Büyükşahin and Robe show that the correlation of return rates between goods and stock became positive after 2008, in contrast to the earlier negative correlation. They deliver further evidence linking the positive correlation between goods and financial instruments in reference to the hedge fund activity. They found a small influence of speculative transactions on the goods and stock correlations. It also seems that the correlations between the futures commodity contracts have significantly increased since 2004, in parallel to the development of the speculative trading (Büyüksahin and Robe 2014).

Finally, Hamilton and Wu evaluating the structural model of the futures contract prices on oil observed a significant reduction of bonuses for the futures contracts risk on oil, which corresponds to a lower level of the hedge pressure in recent years (Hamilton and Wu 2013).

The results of many researches, such as Etula (2010) as well as Acharya et al. (2013), stress that the risk taken by the financial investors, and consequently, the bonus for the risk and the level of risk distribution, change in time. It was found that at one moment a group of participants with the strongest transactional stimuli reacts on the price offers of a group of traders. In spite of that the theory of hedge pressure assumes that commercial entities searching for securities are included in the group, the above studies stress that financial investors, according to the intermediary pricing theory, may sometimes complement the composition of the group. According to that theory, at the moments of crises, the reduced appetite for risk causes enlargement of positions by the financial intermediaries (Brunnermeier and Pedersen 2009).

Etula in his studies points out that the relative leverage in the financial intermediaries sector (measure of the financial investors' risk capacity) has a significant predictive ability in reference to futures return rates for certain commodity groups, especially energetic raw materials (Etula 2010). Acharya, Lochstoer and Ramadorai used the energy producers' solvency risk level in order to estimate their demand on security. Thanks to that they proved that the risk bonus for the futures contracts on the energetic raw materials connected with their manufacturers increased together with a given manufacturer's demand on security (Acharya et al. 2013).

Financialization and Commodity Prices

Do financial speculators on futures markets lead to loosening of commodity spot prices? After the price boom in 2008, many economists such as Krugman (2008), Hamilton (2009), pointed out at the lack of reaction of commodity reserves on the futures prices of goods as a reason for doubt as to the impact of the effect of speculative behaviours on the spot prices. It complies with the storage theory. If a speculation raised the futures price of an article, the increased spread between the futures and spot prices would cause a bigger amount of commodity reserves, which, on the other hand, would increase the spot price, due to a smaller amount of articles available for current consumption. Knittel and Pindyck analyze the USA data referring to oil and they found a little piece of evidence to confirm the phenomenon in the years 1998–2012 (Knittel and Pindyck 2013).

Although no one doubts the storage theory, the rapid increase of oil prices in the first half of 2008 constitutes a research challenge, which assign it to the real growth of economy demand. Despite a great oil demand of the emerging markets, which uplifted the prices to a high level before 2008, the oil prices were still growing by 40% in the first half of 2008 until they reached the top of 147 USD for a barrel in July 2008. In that period the reserves of oil did not grow leading to a conclusion that the increase of prices in the first half-a-year was also caused by the demand strengthening.

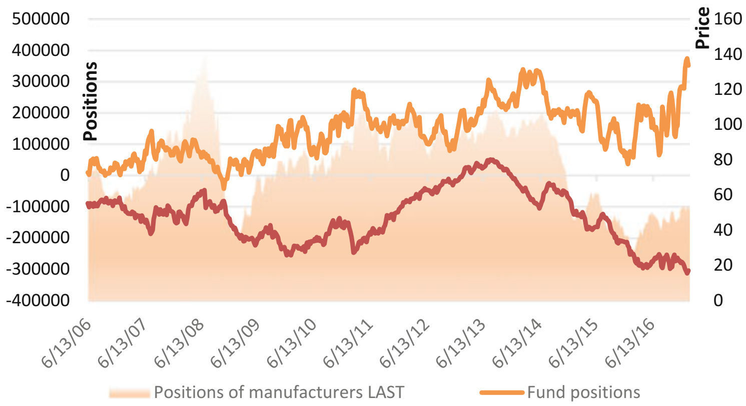

Fig. 2 Crude oil—the position of funds and manufacturers. Source: own elaboration on the basis of http://www.reuters.com

However, the greatest world economies, such as the USA, entered recession at the end of 2007. The S & P 500 index, FTSE 100, DAX and Nikkei reached the top in October 2007. Together with the collapse of Bear Stearns in March 2008 the world financial system faced the inevitable problems. The increase in China also slowed down, the GDP increase in China in the year to year perspective reached the top in the middle of 2007. From perspective, it is hard to argue that the weakening growth of the emerging economies was strong enough to replace the developed economies in propelling the oil prices with the result of 40% during half a year.

Therefore, how the perception of oil demand could influence the strengthening of its prices in the first half of 2008? Taking into consideration the informative function of commodity prices helps to solve the puzzle. At the beginning of 2008 economic entities could reasonably interpret the huge increase of oil and other merchandise futures prices as a reaction to a strong demand from China and other emerging economies. In reality, a great amount of commodity price increase forced even the European Central Bank to raise the basic interest rate in March 2008. The increase of raw material prices at the beginning of 2008, whose significant part can be explained by the resource inflow on commodity markets from the real estate market, could temporarily distort the society's expectations as to the condition of global economy and the demand on goods (through a distortion of price signals) (Caballero et al. 2008).

The confirmation of the thesis discussed is the position of funds and manufacturers on the crude oil commodity market (Fig. 2).

Based on our research and conducted studies observed positions an essential impact of the financial market on the oil contracts turnover can be clearly concluded and consequently, the final price of crude oil such a situation can be observed in all goods that are the subject of sale on commodity market. Similarly the corn market (Fig. 3) the high level of price fluctuation was influenced by significant differences in the positioning of the investments funds and the producers.

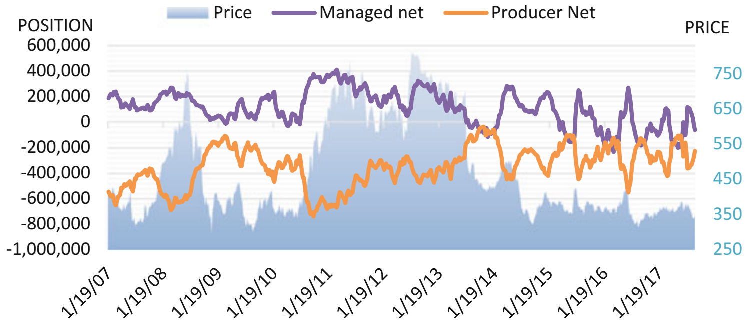

Fig. 3 Corn—the position of funds and manufacturers. Source: own elaboration on the based on http://www.reuters.com

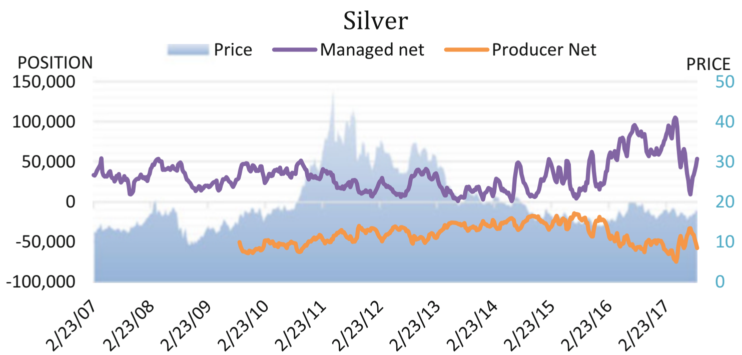

Fig. 4 Silver—the position of funds and manufacturers. Source: own elaboration on the based on http://www.reuters.com

In reference to the silver market (Fig. 4) the increased fluctuation between the 2011 and 2013 also took place during the period of increased differences between the position of funds and producers. What is significant is the clear correlation between decreasing prices and the increase of funds during the decrease of producers in years 2015–2017.

It can be clearly said that the differences in position of funds and producers has a clear impact on the increasing price fluctuation, the stronger the move to the negative direction it can be interpreted as increased producer supply with decreased demand of funds.

In the face of real information turbulence encountered by the market participants, the use of the observed commodity demand in order to justify the increase of raw material prices and exclude the speculative effects is insufficient. Although it is hard, structural models should clearly include the informative function of raw material prices.

Stock market shocks did not translate into the commodity market situation before the financial crisis, however, a significant side effect risk of the connections between the markets revealed itself in September 2008. The economic theory foresees that the side effects caused by financialization should be especially important in the great fluctuation markets (Basak and Pavlova 2015). Empirical tests found evidence for the fact that if uncertainty leads investors to commodity transactions of great fluctuation, the goods show an increased exposure to the risk factors connected with the shakes (shocks) in stock markets (Adams and Glück 2015).

The financial crisis could initiate and intensify the appearance of such risk factors. However, there is a different factor, which could occur except for the crisis. It is a result of the investing style. It reflects the reaction of the investors using the commodity market indices. Usually, as a reaction to a change in the portfolio value, they violently and in parallel sell out stocks and goods. Because of that, the problem of financialization risk factors does not restricts itself to the financial crisis period but still influences the portfolio risk.

A question arises: does the propagation of risk factors to commodity and financial markets caused by their penetration is already fixed or is there a possibility that the factors shaping the raw material prices return to the frames specified in the pre-crisis period? The answer could be as follows: in the case when investors, taking into account their investing style, eliminate the fundamental factors' influence on prices, they hence contribute to the possibility of inverted effects occurrence in a longer period. The inverted effect, however, can be expected only when the index investors cease playing an active role in the futures commodity markets.

Conclusion

The customary look at the issue of financialization is too simplified to catch the complexity of its influence on commodity markets. Understanding the impact of financialization on the raw material prices requires to evaluate its impact on the economic mechanisms shaping the situation on commodity markets. In that case, the issue of the risk distribution mechanism among the market participants and the market information perception seem to be crucial. Despite this, our conducted analysis comparing the changeability and the position of transactions on chosen materials markets as well as the analysis of other author's studies allowed for confirmation of our initially given hypothesis that the result of financialization process of the commodity markets is the increasing levels in price fluctuation.

The following problems will probably be especially important for future researches. Firstly, future researches should update their practice of transaction categorization on commodity markets. A systematic modelling of various transaction motives for the participants seeking securities and speculators in various periods seems to be essential for the identification of the process of risk distribution dynamics on the futures commodity market.

Secondly, the development of the issue of market information flow and the informative function of raw material prices in the theoretical empirical framework, will significantly improve the understanding of raw material prices changes cycles. Moreover, in the range where commodity markets are an indispensable element of the world economy, it is important to understand the way the risk distribution and commodity markets information flow influence the real economy and the global financial markets.

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Part IV
Banking

The Production or Intermediation Approach?: It Matters

Martin Boďa and Zuzana Piklová

Abstract The study builds upon the philosophical discrepancy between the production and intermediation approach to interpretation of banking business, but it brings up the issue of comparability of results that arise from application of both approaches in practical efficiency measurement of banking institutions. Its goal is to assess comparability or congruence of efficiency scores yielded by these two competitive approaches in a framework of data envelopment analysis (DEA), which is undertaken empirically in a case study of Slovak commercial banks for a period of 11 years from 2005 until 2015. The study finds that the main point of departure between the approaches that rests in treatment of deposits is an insuperable obstacle to comparability of their results, and that it does matter whether deposits are placed upon the input or output side of banking production. It is therefore safer to reconcile both approaches in a two-stage manner and to avoid black-box descriptions of banking production.

Introduction

In the past two or three decades, banking institutions have been very meticulously reviewed in terms of their technical and (less frequently) allocative efficiency, which arises on account of importance of the banking sector to a national economy. It goes probably without saying that the leading methodology at present in the field of efficiency measurement in banking is data envelopment analysis (DEA), and its popularity is not thwarted or diminished despite there being some alternative methodologies such as stochastic frontier analysis (SFA) or thick frontier analysis (TFA). Its primary role is testified by the bibliographies of Emrouznejad and Yang (2017) and Liu et al. (2013a, 2013b). Regardless of a method chosen for efficiency measurement, an inescapable task at the very beginning is to identify and specify the

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production model of analyzed units, and this is not a pure technical ingredient to the efficiency analysis, but an economic assessment of the situation. The task of choosing the production model, which actually reduces to an enumeration of inputs and outputs of the production process, is imperative for banking applications for no less than two reasons. First, it is generally required for meaningful application of a DEA methodology (see e.g. Cook et al. 2014); and, second, there are two leading competitive approaches in banking literature that interpret the production role of commercial banks in completely different manners. By emphasizing different aspects of banking undertaking, they set up completely diverse input–output sets, and this specification at the initial stage of an efficiency measurement project then gravely affects the results of the analysis. Although there are disputes amongst practitioners and the debate between theorists of banking business continues on and off about the validity of one approach over another (see Banerjee 2012, Table 1; Duygun Fethi and Pasiouras 2010, Table 2), there will scarcely be any resolution in a near future. Alarming as it may be, what has been neglected and not properly appreciated is that each of the approaches pre-ordains its own final results and perhaps shows analyzed banks in different light. The question to which extent different approaches to banking business lead to identical or comparable results have not been investigated. In an effort to repair this overlook, the goal of the present study is to provide an assessment of comparability or congruence of efficiency scores yielded by two leading approaches of interpreting banking production, i.e. the production approach and the intermediation approach. Notwithstanding, this task can be coped with only in an empirical context, and this context is here specialized to a case study of Slovak commercial banks for a period of 11 years between 2005 and 2015. Therefore, the study uses production data for several banking institutions of the Slovak banking sector for the specified historical period and examines whether the choice of either the production or the intermediation approach affects the final results so that some guidelines for selection of inputs and outputs can be established.

The study focuses purely on the Slovak banking sector for a number of reasons mostly methodological. The banking sector of every country possesses its own peculiarities and is affected by political, economic, demographic and many other factors, in consequence of which it is extremely difficult, if not impossible, to find mutually similar or comparable banking systems throughout the world, albeit it is true that in the recent period globalization has paced also in the area of banking. Even in the group of the V4 countries that should theoretically be closest to the Slovak Republic in terms of their economic and political conditions, banking systems are considerably disparate. This is the reason why a larger international comparison of banks compiled from different countries might not lead to reliable results.

Having in mind that the focus of the study is somewhat limited and specialized to historical Slovak banking conditions, it must be admitted that it is difficult to generalize the findings, although they shed some light about how an input–output set for efficiency measurement in banking based on DEA should be selected. In addition, only technical efficiency, as is customary to most studies, is considered here.

The remainder of the paper is organized into three other sections. Section "Production and intermediation approach in banking" gives a brief summary of the production and intermediation approach in banking. Section "Methodology and results" depicts the set-up of the study and present results. Eventually, the last section draws useful conclusions and discusses.

Production and Intermediation Approach in Banking

Conceptual views on efficiency of commercial banks differ and depart in the issue whether commercial banks should be imputed the role of either mere production facilities that utilize traditional and perhaps banking-specific factors of production in rendering an assortment of banking services, or agent of financial intermediation that act as links between surplus and deficit economic agents. The authority in these two polar interpretations goes to the production approach and the intermediation approach that are currently two main-stream treatments of the core essence of banking business.

The primary source of difference between them is the treatment of deposits, which have both input and output characteristics. The production approach fathered by Benston (1965) construes deposits as outputs. It assumes that the aim of commercial banks is to produce deposits (liabilities) as well as loans (assets) and other services. The intermediation approach interprets deposits as inputs, and was introduced and published by Sealey and Lindley (1977). The intermediation approach assumes that the main aim of a commercial bank is to create output, defined as loans and investment, whilst using liabilities (including deposits), labour, and capital as inputs.

As stated above, various concepts to efficiency of commercial banks favour the use of different inputs and outputs. The most commonly used approach in the banking industry is probably the intermediation approach (see e.g. Ahn and Le 2014, pp. 9, 18). In the published studies applying even the same approach, different inputs and outputs can be recognized, which is taken advisement in the building of the methodological part of the paper.

Methodology and Results

The present examination employs data of a yearly frequency and covers a time frame of 11 years from 2005 to 2015. The data set was compiled by a corporate analytics agency, News and Media Holding, a. s., Bratislava, from annual balance sheet figures and other information disclosed in annual financial statements prepared under IAS/IFRS by organizational units of the Slovak banking sector. The term "organizational unit" is meant to designate a commercial bank per se, a branch office of a foreign bank or a special financial institution (a state-owned banking institution assisting in export–import activities). The effective number of organizational units ranges in individual years from 16 to 26 and represents an overwhelming majority of the Slovak banking sector (as the sample in each year amounted to at least 90% of assets in the sector). The effective number of production data points totals 241 bank-years.

The inputs and outputs for the analysis were chosen in step with the normative outlook of both the production and intermediation approach as discussed afore. Whereas the full input–output set under the production approach is as follows: AS + EM + OF [inputs] and D + L [outputs], the full production set under the intermediation approach is made up of these variables: AS + EM + EQ + D [inputs] and L [outputs]. The meaning of the adopted coding is as follows: AS—tangible and intangible fixed assets (in thousands €), EM—average number of employees in full equivalents, OF—number of branch offices, EQ—equity (in thousands €), D—total deposits (without ARDAL and the State Treasury, in thousands €), and L—total loans (in thousands €). Balance sheet production variables (AS, EQ, D, L) and the number of branches were considered at year-ends, whereas the number of employees was expressed as a full-year average.

The purpose of AS and EM is to represent physical capital and labour force, whereas D and L capture volumes of services rendered or funds intermediated. In addition, OF captures territorial serviceability of banks and EQ is an additional resource that—from the standpoint of the intermediation approach—facilitates transmutation of "available" funds into creditory services. Most of these inputs and outputs are typical of efficiency studies focused on Czecho-Slovak commercial banks (e.g. Boďa and Zimková 2015; Kočišová 2012; Palečková 2015; Zimková 2014), but OF as well as AS has not been considered so far, although these two variables are not fairly uncommon (e.g. Kazan and Baydar 2013; Nitoi 2009). As prescribed by the conceptual discordance between the approaches, the chief distinction is in the identification of deposits. Under the production approach D is identified as an output, as opposed to the intermediation approach where it constitutes an input. A relatively unusual input recognized in the present examination under the intermediation approach is equity, which has been yet incorporated into the input–output set by none of the cited Czecho-Slovak studies, but the arguments *pro et contra* are aptly discussed by Berger and Mester (1997, p. 910).

The choice of production variables outlined earlier answer to the full input–output sets for the production approach (AS + EM + OF [inputs], D + L [outputs]) and the intermediation approach (AS + EM + EQ + D [inputs] and L [outputs]), respectively. Both specifications are most informative for these particular approaches; yet, in practical applications there is a variety of selections (see e.g. Duygun Fethi and Pasiouras 2010) and the analyst may come with a modified input–output specification. In recognition of this circumstance, these full (benchmark) input–output selections were expanded into partial subsets that arise as combinations of respective inputs and outputs. It was possible to generate 21 input–output specifications for the production approach and 15 for the intermediation approach. All the possible combinations of inputs and outputs under either of the approaches are declared in Table 1. Individual input–output specifications are listed using the adopted notation, but with additional underscores and plus signs. Whereas an underscore separates inputs from outputs, a summation sign connects variables on a particular side of the production process. For instance, “EM+AS_D” denotes the specification, where there are two inputs (EM and AS) and one output (D).

Other methodological choices were associated with the assumption on scalability of banking operations necessary for DEA and with the models chosen for examination. In respect of the former, the entire analysis was accomplished under the assumption of variable returns to scale insomuch as they answer to empirical technology and allows also benchmarking against production units that do not operate at their optimum scale size. This also corresponds to the findings of Boďa (2015) who claims that Slovak commercial banks operate prevalently at variable returns to scale. As far as the latter is concerned, a total of five DEA models were considered: two BCC models (input and output oriented, BCC-I and BCC-O) and three SBM models (input and output oriented, SBM-I and SBM-O, as well as non-oriented, SBM-N). The tags of these DEA models are constructed as acronyms of its authors (Banker–Charnes–Cooper) or of the underlying efficiency measure (slacks-based-measure). The advantage of the SBM model over the BCC model is that it is non-radial and may be considered non-oriented. As forewarned, these models were applied in a framework of technical efficiency measurement, and the allocative component of overall efficiency is not permitted into considerations.

Separately for the production and intermediation approach, all five DEA models (BCC-I, BCC-O, SBM-I, SBM-O and SBM-N) were used in conjunction with all possible input–output sets as enumerated in Table 1. For the production approach, there were as many as $5 \times 21 = 105$ configurations of model & input–output set, and for the intermediation approach, as many as $5 \times 15 = 75$ possible such configurations emerged. For each configuration of approach & model & input–output set, DEA programs were run in a usual manner, and scores of technical efficiency were computed for the available data set of 241 bank-years. Technical efficiency scores are restricted to interval (0, 1] and a value of one is attained at estimated full technical efficiency.

Table 1 All input–output specifications considered

Production approach							
AS_D	AS_L	EM_D	EM_L	OF_D	OF_L	AS_L+D	EM_L+D
OF_L+D	AS+OF_D	AS+OF_L	EM+AS_D	EM+AS_L	EM+OF_D		
EM+OF_L	AS+OF_L+D	EM+AS_L+D	EM+OF_L+D	EM+AS+OF_D			
EM+AS+OF_L	EM+AS+OF_L+D						
Intermediation approach							
AS_L	D_L	EM_L	EQ_L	AS+EQ_L	D+AS_L	D+EM_L	
D+EQ_L	EM+AS_L	EM+EQ_L	D+AS+EQ_L	D+EM+AS_L			
D+EM+EQ_L	EM+AS+EQ_L	D+EM+AS+EQ_L					

Table 2 Descriptive summary of correlation coefficients depicting congruence between the production and intermediation approach

Model	Minimum	Maximum	Average	StDev	% CC $\leq$ 0.3	% CC $\leq$ 0.7
BCC-I	0.144	1.000	0.601	0.152	3.1	76.2
BCC-O	0.190	1.000	0.652	0.179	3.3	54.9
SBM-I	0.147	1.000	0.683	0.153	1.4	48.8
SBM-O	0.182	1.000	0.626	0.196	6.4	58.5
SBM-N	0.305	1.000	0.679	0.151	NA	54.8

Note: "StDev"—standard deviation, "% CC $\leq$ 0.3"—relative frequency of correlation coefficients lower than or equal to 0.3 (frequency of cases of weak correlation), "% CC $\leq$ 0.7"—relative frequency of correlation coefficients lower than or equal to 0.3 (frequency of cases of moderate correlation), "NA"—datum not available

Comparability and congruence between the approaches was measured and appraised by means of Pearson correlation. In order to avoid violating the internal logic of technical efficiency measurement that is suggested by a particular model, Pearson correlation coefficients were computed whilst fixating upon a single DEA model between technical efficiency scores emerging from all possible input–output sets of the production approach and technical efficiency scores emerging likewise for the intermediation approach. In other words, for each of the five DEA models, congruence between the production and intermediation approach was captured by $21 \times 15 = 315$ correlation coefficients that were closely examined and described. To this end is dedicated Table 2 that provides a descriptive overview of these correlation coefficients (315 coefficients per model).

The analysis was performed by using application DEA Solver Pro^{TM}, version 12.0 (Saitech 2014) and functionalities and scripts of program R, version 3.2.2 (R Core Team 2014).

Table 2 reports first for each model the range of correlation coefficients, their average value and standard deviation and then shows the percentages of correlation coefficients with values of 0.3 and 0.7 at most, respectively. Since all the correlation coefficients measured are positive, these percentages coincide with relative frequencies of cases when weak and moderate correlation was detected, respectively. First thing to note is that the correlation coefficients in Table 2 are positive and so only positive correlation was detected between the production and intermediation approach. Of course, in some relatively rare cases, the degree of comparability or congruence is extremely faint as is readable from the minimum values of correlation coefficients and as is attested by the percentages of cases in which correlation coefficients are lower than or equal to 0.30. For the five DEA models considered, minimal correlation coefficients vary between 0.144 and 0.305 and weak correlation is found for 1.4–6.4% cases. It is apparent at first glance that there are marked differences between the production and intermediation approach, which inevitably comes from the economic underpinning of these approaches that is translated into the specification of the input–output set. Moreover, the results for different models are much alike. The minimum value of correlation for the SBM-N model might be suggestive that this model might perhaps owing to its non-orientedness

Table 3 Input–output specifications with the weakest congruence between the production and intermediation approach

Input–output set		Correlation coefficient				
Production approach	Intermediation approach	BCC-I	BCC-O	SBM-I	SBM-O	SMB-N
OF_D	D_L	0.165	0.430	0.147	0.418	0.448
AS+OF_D	D_L	0.144	0.328	0.195	0.182	0.305
OF_D	D+EM+EQ_L	0.396	0.270	0.459	0.212	0.431
OF_D	D+EQ_L	0.353	0.251	0.389	0.203	0.383

(in combination with non-radiality) help best preserve compatibility between the approaches, but this impression disappears when inspecting the average value or calculating the relative frequency of cases when strong correlation was found, i.e. 100% – 54.8% = 45.2%.

It escapes the reporting capability of Table 2, but a detailed check of the correlation coefficient reveals that the smallest values of the correlation coefficient between the approaches occur when deposits D are present as both an output under the production approach and an input under the intermediation approach. If it is not present in one of the approaches (on the opposite side of the production process), correlation coefficients tend to be overall higher. The smallest correlation coefficients happen when inputs and outputs sets are completely different and they have no overlap of variables on the input or output side and when D appear on the opposite sides. Such cases are reported in Table 3. These results are just confirmative of insurmountable economic differences of these two approaches that primarily sprout form the manner they treat deposits.

On the other hand, with each DEA model there are input–output pairs when correlation coefficients are one and when these approaches concur ideally. At any rate, such situations are rare and happen with identical input–output specifications shared by both approaches. There are only three such situations, AS_L, EM_L, EM+AS_L. Of course, it is then unnecessary to point out which theoretical approach is put to use in describing bank production.

Conclusions

Since the philosophies of the production and intermediation approaches impute banking institutions different primary roles and imply different input–output sets, there should be a difference between these approaches in how they measure and assess technical efficiency in a practical situation. The said discord also arises in the present situation, in which a case study focusing on institutions of the Slovak banking sector is conducted and their technical efficiency scores as yielded by either approach and computed on a yearly basis for each year of the 11-year period between 2005 and 2015 are drawn for comparison. The results established by the study attest that the position of the production variable deposits has an indisputable role in assessing technical efficiency of (perhaps not only) Slovak commercial banks. Although not frequently conceded and recognized anyhow in empirical studies, this is not a surprising conclusion insofar as the same observation that deposits are a factor of crucial importance is shared also by Boďa and Zimková (2015), Kočišová (2013) or Drake et al. (2009). All these three studies found, by simultaneous ad hoc employment of input–output specifications of the production approach (deposits represented on output the side) and the intermediation approach (deposits represented on the input side), that a different technical efficiency assessment ensues or may ensue. From a practitioner's point of view, the fact that the scope of the study is turned solely to the Slovak banking sector and to a particular case study is not limiting at all. The lesson learnt is that there may exist a significant difference between an input–output specification of the production approach and an input–output specification of the intermediation approach, although this difference need not arise in every possible situation. The reason being, the complicated nature of technical efficiency score measurement based on DEA makes it impossible to tell beforehand to which extent treatment deposits on the opposite side of production may be a trigger of entirely different results.

There are contexts in which either the production approach or the intermediation approach should preferred and put to exclusive use, perhaps depending on whether the study emphasizes the importance of providing banking services as such (a micro-economic perspective) or the significance of a financial intermediation to a national economy (a macro-economic treatment). Yet, commercial banks do not fulfil the sole roles of deposit maker or financial intermediation agents, but they are posited into both roles simultaneously. Therefore the decision to favour one approach over another is difficult to take. Of course, there exist almost data-mining approaches that help decide whether a production variable with uncertain characteristics should be treated as an input or an output to a production process (see Cook and Zhu 2007), but these defy the economic rationale of a technical efficiency measurement undertaking. Basically, there are two possible options to solve this problem.

One option is inclusion of deposits into both sides of the production process simultaneously, i.e. consideration of deposits simultaneously as an input and output. Naturally, these would necessitate utilization of two different measures of deposits. In this regard, it is not straightforward to state which metric of deposits should be used on the input side and which metric should be employed on the output side. The input side should be most appropriately represented by the deposits that are available to commercial banks in active operations, whereas the output side should be represented by the deposits that are reported in balance sheets of commercial banks as these are a result of banking production. An alternative option is application of a two-stage DEA modelling approach that would better describe the characteristic features of both theoretical approaches of banking business and would make it possible to handle both financial intermediation and banking production as separate processes and decompose them into interconnected stages. A good description of a two-stage DEA method is provided by Yang (2012, p. 2008) who models banking production as the first stage that is connected to financial intermediation as the second stage.

As suggested by the result, deposits have an undeniable role in the entire process of technical efficiency measurement. An input is a production characteristic that serves production of outputs, that is used in or throughout production, and that is reduced (depleted) or impaired (worn-out). Simultaneously, an input should be desired minimum and in portrayals of efficiency its minimum value should be visualized as suitable. Nonetheless, with deposits, it is not clear whether commercial banks should minimize or maximize deposits. If a bank aspires at deposit maximization, it suggests that it posits itself as a producer of deposits, but by the same token, if it strives after deposit minimization, the bank sees its primary role as a financial intermediary. To decide which of these two orientations is more appropriate remains a topic for further research. In this respect, this study can be reasonable extended not only to study the congruence between the production and intermediation approach (which is the content of the present study), but also to evaluate the congruence between differently oriented technical efficiency assessments (input oriented, output oriented and non-oriented).

Nonetheless, the results of this study are fully relevant for several target groups. Starting with commercial banks themselves, they can utilize the knowledge that the choice of the approach is a key factor in their technical efficiency assessment in monitoring their competitiveness in relation to other subjects of the banking market. It is obviously essential to be aware that the results of a technical efficiency assessment may change if one approach is favoured at the cost of the other. The importance of this knowledge for commercial banks stems also from the fact that many banks have adopted DEA as a tool for benchmarking of their branches. The second target group to which the highlights of the study will have information value is financial market regulatory bodies that review banking systems for stability and resilience. Also with them DEA has become a popular term of assessment. Needless to say, deposits are an important ingredient of regulatory models as quality and speed of financial intermediation are attributes relevant from a macroeconomic perspective. Yet, they are also produced by banks, not merely accepted and maintained for customers. The last target group is academic researchers who also appear to understate the importance of this issue.

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Competitiveness and Concentration of the Banking Sector as a Measure of Banks' Credit Ratings

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Abstract The aim of the paper is to verify the impact of the competitiveness of the banking sector and concentration on banks' credit ratings. A literature review was prepared and as a result the following hypothesis was put: the bigger the banks from the countries where the banking sector is more concentrated and more competitive, the higher the banks' credit ratings. The analysis has been prepared by using ordered panel data models on banks' credit ratings with the use of quarterly data on a European banks' sample. Long-term issuer credit ratings given to banks by the three largest credit rating agencies (S&P, Fitch and Moody) were used as a dependent variable. Banks' notes are especially sensitive to the capital adequacy, the assets quality and the earnings factors. The concentration of the banking sector has got a significant impact on the notes proposed by Fitch and Moody's, but the direction of the impact has been varied. Fitch notes are positively correlated with concentration indicators. According to their opinion, bigger banks on more concentrated markets can receive the financial support from the government, because in the case of default problems will have an influence on the whole financial system. Fitch ratings also react negatively to a higher competition on the financial market. Moody's puts attention to insolvency problems of the financial market, and as a result its notes are negatively correlated with the concentration of the banking sector. A positive relationship between the competition and banks' credit ratings has been observed in the case of Moody's and S&P's.

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Introduction

The problem of determinants of credit ratings is quite popular in literature. In most cases there are verified factors influencing countries' notes and companies' credit ratings. There are only some researches about the impact of determinants on banks' notes.

There are three approaches proposed for measuring competition (Claessens 2009). The first one relies on the measure of the mentioned phenomenon as a concentration of the financial system with Herfindahl indices or the number of banks. The second one is based on regulatory indicators, like entry requirements, formal and informal barriers to entry for domestic and foreign banks, activity, etc. The third set uses formal competition measures, such as the so-called H-statistics. The mentioned group of factors take into consideration the relation of output to input prices. There are a lot of researches, where the degree of competition is measured with the Panzar and Rosse (1987) methodology (Bikker and Spierdijk 2007). Evidence of monopolistic competition has been found (Wong et al. 2008; Gutiérrez de Rozas 2007; Hempell 2002; Bikker and Haaf 2000), also for emerging markets (Nakane 2001; Prasad and Ghosh 2005; Yildirim and Philippatos 2007). Using the Lerner Index, Kick and Prieto (2013) found that market power tends to reduce banks' default probability. In contrast, having used the Boone Indicator, they suggested that an increased competition lowers the riskiness of banks.

The larger banks receive higher ratings than the smaller ones. It can be connected with the opinion in the finance world that larger banks receive financial support from the government in the case of a crisis (Hawkins and Mihaljek 2001; van Loon and de Haan 2015).

The analysis prepared by Harris et al. (2014) suggests that banks' credit ratings are determined by the level of regulation restrictiveness. One of the most significant measures are capital requirements. They found that an increase of the mentioned indicator can never decrease welfare if the banking sector's aggregate equity capital does not constrain its ability to fund profitable projects.

In most researches the financial indicators that can influence banks' notes have been verified. According to the research prepared by Karminsky and Khromova (2016) CAMEL indicators explain from 62% to 95% of credit rating changes. Cole and White (2012) also put attention to CAMEL indicators. For the mentioned group of factors the impact of the capital adequacy, liquidity and earnings factors (Shen et al. 2012; Bissoondoyal-Bheenick and Treepongkaruna 2011; Chodnicka-Jaworska 2016; Pagratis and Stringa 2007) has been presented. Less popular have been the determinants connected with assets' quality (Poon et al. 1999; Chodnicka-Jaworska 2016), or management quality (Chodnicka-Jaworska 2016). In the previous researches macroeconomic factors and their impact on banks' notes have also been verified. Bellotti et al. (2011a, b) found that a country's condition has got a significant influence on banks' default risk. Poon et al. (1999) received opposite results. The macroeconomic influence on banks' credit ratings has also been verified by Bissoondoyal-Bheenick and Treepongkaruna (2011).

As a result the aim of this paper is to verify the impact of the competitiveness of banking sectors and concentration on banks' credit ratings. It has been put the following hypothesis: the bigger the banks from the countries where the banking sector is more concentrated and more competitive, the higher the banks' credit ratings.

Methodology and Data Description

The analysis of the impact of the competitiveness and concentration of the banking sector on banks' credit ratings has been made by using the long-term issuer credit ratings given by the three biggest credit rating agencies, i.e., S&P's, Fitch and Moody's during 1995–2016. The research has been prepared on quarterly data for 118 banks from European countries. The data used for the estimation process have been collected from the Thomson Reuters Database. The linear decomposition proposed by Ferri et al. (1999) has been used for the estimation. Taking the mentioned method of decomposition has been strictly connected with the lack of banks' CDS spreads that are needed to make a nonlinear method.

To analyse the impact of the competitiveness and concentration of the banking sector on banks' credit ratings the ordered logistic panel data models have been used. The final version of the model is given by the Eq. (1) below:

$$y_{it}^* = \beta F_{it}' + \alpha M_{it}' + \gamma Z_{it} + \delta (F * Z)_{it} + \varepsilon_{it} \tag{1}$$

where:

y_{it}^* is the Fitch Long-term Issuer Rating, Standard & Poor's Long-Term Issuer Rating, Moody's Long-Term Issuer Rating given for i European banks for t period of time.

F_{it}' is a vector of explanatory variables, i.e.:

$$F_{it}' = \left[tier_{i,j}, lev_{i,j}, llp_{i,j}, sec_{i,j}, nii_{i,j}, roa_{i.j}, opl_{i.j}, lg_{i.j}, dg_{i,j}, \\ dep_{i,j}, sht_{i,j}, liq_{i,j}, ass_{i,j}, dep_{i,j}, gdp_{i,j}, cpi_{i,j}, cr_{i,j} \right]$$

where:

$tier_{i,j}$ is the Tier 1 ratio; $lev_{i,j}$ is the leverage ratio; $llp_{i,j}$ is the loan loss provisions as a percentage of average total loans; $sec_{i,j}$ is the value of securities as a percentage of earnings assets; $roa_{i.j}$ is the return on assets; $opl_{i.j}$ is the operating leverage; $lg_{i.j}$ is the loan growth; $dg_{i,j}$ is the deposit growth; $dep_{i,j}$ is the ratio of loans to deposit; $sht_{i,j}$ is the value of short-term borrowing to total liabilities, $liq_{i,j}$ is the value of liquid assets to total assets; $ass_{i,j}$ is the logarithm of the total assets; $gdp_{i,j}$ is the GDP growth; $cpi_{i,j}$ is the inflation and $cr_{i,j}$ is the country's credit rating given by a particular credit rating agency (Fitch Long-Term Issuer Rating, S&P's Long-Term Issuer Rating, Moody's Long-Term Issuer Rating);

M_{it}' is one of the explanatory variables, i.e.:

$$M'_{it} = \left[con_{i,j}, bankcon_{i,j}, reg_{i,j}, boone_{i,j}, hstat_{i,j}, lerner_{i,j}\right]$$

where:

$con_{i,\ j}$ is the 5-bank assets concentration; $concentr_{i,\ j}$ is the bank concentration; $reg_{i,\ j}$ is the regulatory capital to risk weighted assets; $boone_{i,\ j}$ is the Bonne indicator; $hstat_{i,\ j}$ is the H-statistic indicator; $lerner_{i,\ j}$ is the Lerner indicator;

T_t is a vector of year-dummies;

μ_j is an unobservable time-invariant bank's effect.

Findings About the Impact of the Concentration and the Competitiveness of Banks on Their Credit Ratings

The analysis of the impact of the concentration and the competitiveness of banks on their credit ratings was started from the analysis of the impact of the financial indicators on banks' credit ratings. Results of estimation have been presented in the Table 1 for Fitch, Table 2 for S&P and Table 3 for Moody. The first group of measures taken into consideration were capital adequacy indicators. The Tier 1 has got a statistically significant impact on banks' credit ratings. If the mentioned factor rises, the banks' notes are higher. The strongest reaction to this variable has been noticed in the case of Fitch notes (Table 1), and the lowest—for S&P's credit ratings (Table 2). It can be strictly connected with the quality of portfolio of the rated entities. The leverage ratio influences statistically positively significantly Moody's credit ratings (Table 3). For the rest of notes the mentioned variable is unimportant.

The next group of determinants was assets quality indicator, the loan loss provisions as a percentage of the average total loans. In the case of Moody's (Table 3) and S&P's (Table 2) credit ratings a positive impact of the mentioned variable on banks' notes has been observed. As the Table 1 indicates, only Fitch credit ratings react negatively to the changes of this factor. The mentioned relationship can be connected with the same reason as in the previous case. Management quality indicators comprise the value of securities as a percentage of earning assets. The impact of this factor is statistically significant but the coefficient equals nearly zero, so the sensitive of credit ratings is weak.

From the group of earnings indicators the operating leverage has got a minor impact on banks' credit ratings. The prepared analysis suggests that a significant influence has been noticed in the case of all types of notes. A strong relationship has been observed in the case of the return on assets indicator. The most sensitive ones are the notes presented by Moody's. Fitch ratings are free of any influence of the return on assets, according to the presented estimations. These results are connected with the risky decisions and lower creditworthiness of the rated institutions than in the case of issuers whose ratings are given by Moody's and S&P's. As the Table 2 indicates S&P's does not take into consideration the loans growth and the deposits growth. Other credit ratings agencies have different opinions about the impact of the

Table 1 The results of the estimation of factors influencing on the banks' Fitch Long-Term Issuer Credit Ratings

Fitch	Coef.	P > z	Coef.	P > z	Coef.	P > z	Coef.	P > z	Coef.	P > z	Coef.	P > z
opl	0.01	0.12	0.01	0.12	0.01	0.16	0.01	0.11	0.01	0.10	0.01	0.09
lev	−0.01	0.76	−0.01	0.61	−0.02	0.53	−0.01	0.63	−0.01	0.62	−0.01	0.77
llp	−2.59	0.00	−2.29	0.00	−2.41	0.00	−2.55	0.00	−2.40	0.00	−2.65	0.00
tier1	−0.32	0.00	−0.29	0.00	−0.28	0.00	−0.31	0.00	−0.30	0.00	−0.37	0.00
dep	−1.15	0.02	−1.50	0.03	−1.56	0.03	−1.45	0.04	−1.27	0.06	−1.43	0.04
sec	0.06	0.01	0.05	0.01	0.05	0.01	0.05	0.01	0.05	0.02	0.06	0.01
roa	−1.85	0.17	−1.88	0.21	−1.59	0.26	−1.93	0.18	−2.26	0.11	−2.36	0.12
liq	−5.99	0.07	−3.06	0.34	−2.58	0.41	−6.20	0.08	−2.93	0.40	−6.60	0.07
lg	0.70	0.07	0.63	0.11	0.68	0.08	0.74	0.05	0.72	0.06	0.74	0.06
dg	−0.13	0.90	−0.41	0.70	−0.51	0.64	−0.34	0.75	−0.35	0.74	−0.25	0.81
sht	4.77	0.00	3.95	0.00	4.14	0.00	4.69	0.00	4.18	0.00	4.90	0.00
ass	0.82	0.03	0.78	0.02	0.81	0.01	0.80	0.04	0.93	0.01	0.96	0.05
cr_fitch	0.05	0.00	0.05	0.00	0.05	0.00	0.05	0.00	0.05	0.00	0.05	0.00
gdpg	0.45	0.00	0.49	0.00	0.48	0.00	0.45	0.00	0.48	0.00	0.45	0.00
cpi	−0.01	0.14	−0.01	0.12	−0.01	0.08	−0.01	0.16	−0.01	0.15	−0.01	0.16
con			0.08	0.01								
concentr					0.06	0.00						
reg							0.01	0.92				
boone									−0.57	0.47		
lerner											5.77	0.03
/cut1	−22.71	0.02	−14.74	0.09	−17.61	0.03	−22.73	0.02	−24.97	0.01	−26.34	0.04
/cut2	−22.45	0.02	−14.51	0.10	−17.37	0.04	−22.46	0.02	−24.73	0.01	−26.08	0.04
/cut3	−21.84	0.02	−13.93	0.11	−16.79	0.04	−21.83	0.03	−24.14	0.01	−25.46	0.04
/cut4	−21.40	0.02	−13.48	0.12	−16.34	0.05	−21.37	0.03	−23.69	0.01	−25.01	0.05
/cut5	−19.60	0.04	−11.73	0.18	−14.57	0.08	−19.55	0.05	−21.92	0.02	−23.23	0.06

(continued)

Table 1 (continued)

Fitch	Coef.	P > z	Coef.	P > z	Coef.	P > z	Coef.	P > z	Coef.	P > z	Coef.	P > z
/cut6	−16.20	0.08	−8.44	0.33	−11.16	0.17	−16.26	0.10	−18.48	0.05	−19.76	0.11
/cut7	−14.69	0.12	−6.93	0.43	−9.65	0.24	−14.75	0.14	−16.97	0.07	−18.25	0.15
no obs	1272		1123		1138		1150		1138		1065	
no gr	53		51		51		51		51		48	
Wald	0		0		0		0		0		0	
LM	0		0		0		0		0		0	

Notes: *Fitch*—Fitch Long-Term Issuer Rating given for European banks; *tier1*—the Tier 1 ratio; *lev*—the leverage ratio; *llp*—the loan loss provisions as a percentage of average total loans; *sec*—the value of securities as a percentage of earnings assets; *roa*—the return on assets; *opl*—is the operating leverage; *lg*—the loan growth; *dg*—deposit growth; *dep*—the ratio of loans to deposit; *sht*—value of short-term borrowing to total liabilities, *liq*—the value of liquid assets to total assets; *ass*—the logarithm of the total assets; *gdp*—the GDP growth; *cpi*—the inflation; *cr_fitch*—country's Fitch Long-Term Issuer Rating; *con*—the 5-bank assets concentration; *concentr*—the bank concentration; reg—is the regulatory capital to risk weighted assets; *boone*—the Bonne indicator; *hstat*—H-statistic indicator; *lerner*—the Lerner indicator; no *obs*—number of observations; *no gr*—number of groups; *Wald*—Wald test; *LM*—Breusch-Pagan test

Table 2 The results of the estimation of factors influencing on the S&P's notes

sp	Coef.	P > z	Coef.	P > z	Coef.	P > z	Coef.	P > z	Coef.	P > z	Coef.	P > z	Coef.	P > z
opl	0.00	0.24	0.00	0.16	0.00	0.12	0.00	0.04	0.00	0.13	0.00	0.36	−0.01	0.00
lev	0.01	0.47	−0.01	0.76	0.00	0.92	0.00	0.99	0.00	0.78	0.00	0.92	−0.02	0.33
llp	0.37	0.18	0.57	0.07	0.59	0.09	0.64	0.05	0.55	0.08	1.35	0.00	1.11	0.01
tier1	−0.05	0.03	−0.13	0.00	−0.12	0.00	−0.02	0.64	−0.12	0.00	−0.10	0.00	−0.09	0.11
dep	−0.39	0.09	−0.83	0.12	−0.76	0.16	−0.24	0.66	−0.76	0.16	−0.47	0.40	−1.25	0.31
sec	0.00	0.62	0.00	0.98	0.00	0.97	0.00	0.92	0.00	0.94	0.00	0.71	0.04	0.00
roa	0.62	0.07	1.15	0.00	1.05	0.02	1.11	0.01	0.94	0.02	2.32	0.00	2.13	0.00
liq	−5.06	0.00	−4.51	0.01	−4.52	0.01	−2.81	0.11	−4.51	0.01	−3.11	0.09	1.61	0.71
lg	−0.36	0.12	−0.19	0.46	−0.23	0.37	−0.26	0.32	−0.22	0.39	−0.23	0.41	0.26	0.66
dg	0.11	0.86	−0.34	0.62	−0.34	0.63	−0.10	0.88	−0.30	0.67	−0.18	0.80	−1.72	0.16
sht	−0.42	0.41	−0.83	0.16	−0.88	0.16	−0.98	0.09	−0.81	0.16	−2.23	0.01	−8.73	0.09
ass	2.03	0.00	2.47	0.00	2.72	0.00	2.49	0.00	2.66	0.00	2.48	0.00	1.84	0.09
cr_sp	0.43	0.00	0.48	0.00	0.49	0.00	0.48	0.00	0.49	0.00	0.46	0.00	1.01	0.00
gdpg	0.00	0.88	0.03	0.19	0.03	0.19	0.01	0.72	0.04	0.11	0.03	0.26	0.10	0.16
cpi	0.00	0.14	0.00	0.06	0.00	0.05	0.00	0.33	0.00	0.05	0.00	0.19	0.00	0.98
con			−0.02	0.29										
concentr					0.02	0.23								
reg							−0.20	0.00						
boone									1.00	0.09				
lerner											−3.90	0.00		
hstat													−6.96	0.01
/cut1	52.01	0.00	74.98	0.00	82.16	0.00	73.47	0.00	78.93	0.00	77.14	0.00	75.42	0.00
/cut2	62.10	0.00	76.30	0.00	85.49	0.00	76.88	0.00	82.44	0.00	79.61	0.00	82.57	0.00
/cut3	65.39	0.00	78.71	0.00	86.59	0.00	78.73	0.00	83.70	0.00	81.85	0.00	86.52	0.00
/cut4	66.89	0.00	80.71	0.00	88.90	0.00	80.79	0.00	86.03	0.00	85.09	0.00	89.43	0.00

(continued)

Table 2 (continued)

sp	Coef.	P > z	Coef.	P > z	Coef.	P > z	Coef.	P > z	Coef.	P > z	Coef.	P > z	Coef.	P > z
/cut5	69.07	0.00	83.85	0.00	90.91	0.00	82.75	0.00	87.99	0.00	87.62	0.00	92.60	0.00
/cut6	70.85	0.00	86.80	0.00	94.11	0.00	86.01	0.00	91.37	0.00	89.77	0.00	97.88	0.00
/cut7	73.78	0.00	88.91	0.00	97.12	0.00	88.95	0.00	94.39	0.00	92.38	0.00	102.2	0.00
/cut8	76.37	0.00	91.37	0.00	99.27	0.00	90.92	0.00	96.53	0.00	96.45	0.00	109.3	0.00
/cut9	78.16	0.00	95.36	0.00	101.7	0.00	93.38	0.00	98.95	0.00	98.68	0.00	113.6	0.00
/cut10	80.36	0.00	98.16	0.00	105.6	0.00	97.21	0.00	102.8	0.00	103.2	0.00	118.7	0.00
/cut11	83.54	0.00	102.7	0.00	108.5	0.00	100.1	0.00	105.7	0.00	105.5	0.00	124.3	0.00
/cut12	86.13	0.00	104.9	0.00	113.1	0.00	104.8	0.00	110.3	0.00	109.9	0.00	136.1	0.00
/cut13	90.39	0.00	109.5	0.00	115.3	0.00	107.2	0.00	112.5	0.00	116.5	0.00	140.4	0.00
/cut14	92.58	0.00	115.8	0.00	119.9	0.00	111.7	0.00	117.1	0.00			148.8	0.00
/cut15	97.07	0.00			126.8	0.00	118.4	0.00	124.2	0.00				
/cut16	103.0	0.00												
no obs	1065		932		949		966		953		871		541	
no group	48		46		47		47		47		44		44	
Wald	0		0		0		0		0		0		0	
LM	0		0		0		0		0		0		0	

Notes: *sp*—S&P's Long-Term Issuer Rating given for European banks; *tier1*—the Tier 1 ratio; *lev*—the leverage ratio; *llp*—the loan loss provisions as a percentage of average total loans; *sec*—the value of securities as a percentage of earnings assets; *roa*—the return on assets; *opl*—is the operating leverage; *lg*—the loan growth; *dg*—deposit growth; *dep*—the ratio of loans to deposit; *sht*—value of short-term borrowing to total liabilities, *liq*—the value of liquid assets to total assets; *ass*—the logarithm of the total assets; *gdp*—the GDP growth; *cpi*—the inflation; *cr_sp*—country's S&P's Long-Term Issuer Rating; *con*—the 5-bank assets concentration; *concentr*—the bank concentration; reg—is the regulatory capital to risk weighted assets; *boone*—the Bonne indicator; *hstat*—H-statistic indicator; *lerner*—the Lerner indicator; no *obs*—number of observations; *no gr*—number of groups; *Wald*—Wald test; *LM*—Breusch-Pagan test

Table 3 The results of the estimation of factors influencing on the Moody's notes

Moody	Coef.	P > z	Coef.	P > z	Coef.	P > z	Coef.	P > z	Coef.	P > z	Coef.	P > z	Coef.	P > z
opl	−0.01	0.03	−0.01	0.01	−0.01	0.01	−0.01	0.02	−0.01	0.02	−0.01	0.01	0.00	0.99
lev	0.13	0.00	0.13	0.00	0.13	0.00	0.11	0.00	0.11	0.00	0.09	0.00	0.32	0.00
llp	0.36	0.05	0.48	0.01	0.48	0.01	0.39	0.04	0.40	0.03	0.43	0.02	7.33	0.03
tier1	−0.24	0.00	−0.36	0.00	−0.37	0.00	−0.33	0.00	−0.36	0.00	−0.32	0.00	−0.20	0.00
dep	0.04	0.45	0.05	0.38	0.05	0.36	0.10	0.10	0.09	0.11	0.08	0.20	0.02	0.86
sec	0.02	0.16	0.02	0.05	0.02	0.04	0.02	0.06	0.02	0.07	0.02	0.12	0.05	0.12
roa	6.47	0.00	8.41	0.00	8.48	0.00	7.67	0.00	7.88	0.00	8.61	0.00	11.69	0.00
liq	−0.84	0.67	−4.10	0.05	−3.95	0.07	−2.30	0.30	−2.56	0.25	−0.47	0.83	0.41	0.91
lg	−3.07	0.09	−3.40	0.09	−3.41	0.09	−4.67	0.02	−4.45	0.03	−3.02	0.15	−0.53	0.89
dg	0.12	0.91	0.84	0.52	0.88	0.50	1.49	0.28	1.45	0.29	1.05	0.47	1.47	0.53
sht	2.97	0.00	1.94	0.07	1.82	0.10	3.59	0.00	3.40	0.00	3.62	0.00	−1.21	0.81
ass	4.51	0.00	1.54	0.01	1.62	0.03	5.53	0.00	4.92	0.00	5.30	0.00	−0.88	0.51
cr_m	0.27	0.00	0.27	0.00	0.27	0.00	0.29	0.00	0.28	0.00	0.29	0.00	0.63	0.00
gdpg	−0.08	0.03	−0.10	0.01	−0.10	0.01	−0.13	0.00	−0.12	0.00	−0.18	0.00	0.52	0.00
cpi	−0.09	0.00	0.00	0.61	0.00	0.71	−0.09	0.00	−0.08	0.01	−0.06	0.03	−0.04	0.43
con			−0.09	0.02										
concentr					−0.04	0.08								
reg							−0.06	0.34						
boonne									1.32	0.18				
lerner											−14.60	0.00		
hstat													−11.05	0.00
/cut1	116.52	0.00	44.96	0.01	51.81	0.01	139.60	0.00	125.83	0.00	135.61	0.00	7.44	0.83
/cut2	117.07	0.00	45.58	0.00	52.43	0.01	140.26	0.00	126.52	0.00	136.63	0.00	8.72	0.80
/cut3	119.99	0.00	48.66	0.00	55.63	0.00	143.75	0.00	130.05	0.00	141.47	0.00	15.94	0.64
/cut4	121.61	0.00	49.90	0.00	56.97	0.00	145.10	0.00	131.38	0.00	143.19	0.00	19.29	0.57

(continued)

Table 3 (continued)

Moody	Coef.	P > z	Coef.	P > z	Coef.	P > z	Coef.	P > z	Coef.	P > z	Coef.	P > z	Coef.	P > z
/cut5	124.35	0.00	53.37	0.00	60.42	0.00	148.54	0.00	134.87	0.00	146.81	0.00	24.43	0.47
/cut6	125.26	0.00	53.79	0.00	60.84	0.00	149.18	0.00	135.30	0.00	147.24	0.00	25.32	0.46
/cut7	127.55	0.00	56.22	0.00	63.26	0.00	151.75	0.00	137.80	0.00	149.75	0.00	28.74	0.40
/cut8	129.44	0.00	58.15	0.00	65.19	0.00	153.88	0.00	139.88	0.00	152.00	0.00	32.70	0.34
/cut9	131.98	0.00	60.56	0.00	67.59	0.00	156.67	0.00	142.54	0.00	154.87	0.00	38.44	0.26
/cut10	133.78	0.00	62.31	0.00	69.33	0.00	158.61	0.00	144.36	0.00	156.80	0.00		
/cut11	139.91	0.00	68.24	0.00	75.28	0.00	164.80	0.00	150.58	0.00	163.23	0.00		
no obs	493		449		449		452		449		449		227	
no group	14		14		14		14		14		14		14	
Wald	0		0		0		0		0		0		0	
LM	0		0		0		0		0		0		0	

Notes: *moody*—S&P's Long-Term Issuer Rating given for European banks; *tier1*—the Tier 1 ratio; *lev*—the leverage ratio; *llp*—the loan loss provisions as a percentage of average total loans; *sec*—the value of securities as a percentage of earnings assets; *roa*—the return on assets; *opl*—is the operating leverage; *lg*—the loan growth; *dg*—deposit growth; *dep*—the ratio of loans to deposit; *sht*—value of short-term borrowing to total liabilities, *liq*—the value of liquid assets to total assets; *ass*—the logarithm of the total assets; *gdp*—the GDP growth; *cpi*—the inflation; *cr_m*—country's Moody's Long-Term Issuer Rating; *con*—the 5-bank assets concentration; *concentr*—the bank concentration; reg—is the regulatory capital to risk weighted assets; *boone*—the Bonne indicator; *hstat*—H-statistic indicator; *lerner*—the Lerner indicator; no *obs*—number of observations; *no gr*—number of groups; *Wald*—Wald test; *LM*—Breusch-Pagan test mentioned variables. The deposit growth is insignificant for the default estimation process also in the case of other rating agencies. Fitch notes react positively if the loan growth rises. The increase of the mentioned variable can create an additional source of income. On the other hand, Moody's suggests that a too fast increase of the loan growth can create problems with creditworthiness of clients and in a longer time—with default risk.

From the last group of factors, i.e., liquidity indictors, the ratio of loans to deposits has got a statistically negative significant impact on banks' credit ratings given by Fitch. It confirms the previous assumption that the quality of the credit portfolio of issuers is lower than in the case of other agencies. On the other hand, the high value of this factor can create liquidity problems. The same relationship has been noticed for the liquid assets to total assets factor. The strongest impact has been observed for Fitch notes. The short-term borrowing to total liabilities has got a negative influence in the case of S&P's. An opposite reaction has been noticed for ratings proposed by other agencies.

The opinion about the impact of the size of the rated entities on credit ratings has been confirmed in this research. Bigger banks receive higher notes in the case of all three agencies. The mentioned relationship is strictly connected with the probability of the financial support from the government in the case of a crisis or insolvency problems. The mentioned relationship is strictly connected with the "too big to fail" phenomenon. A positive impact of the countries' notes on the ratings received by banks has also been observed. The higher market share credit rating agencies have, the stronger the influence of the mentioned determinant. The impact of the GDP growth is statistically significant, but the described relationship is declined according to the size of the credit rating agencies. The inflation rate is insignificant or has got a nearly zero coefficient in the analyses of default risk.

The next part of the analysis relies on the verification of the impact of the concentration and the competitiveness of the banking sector on the notes given to the rated entities. Two measures of concentration have been taken for the research. The first one is the value of the five biggest banks' assets to the total value of assets. The second one is the HHI index. In the case of Fitch notes both of these variables have got a significant impact on banks' ratings (Table 1). If the banking sector is more concentrated, the ratings presented by Fitch are higher. As the Table 3 indicates, an opposite reaction has been noticed in the case of Moody's. Ratings of this agency react negatively to a higher concentration of the banking sector. A more concentrated sector can create problems with the default risk of the whole financial system. In a monopolistic market the default of the biggest banks can create insolvency problems of the whole financial market. S&P's notes are insensitive to concentration measures.

The regulation restrictiveness indicator, that is the regulatory capital to risk weighted assets, has got a significant impact only in the case of the notes given by Moody's (Table 3). If the mentioned variable is higher, the banks' notes are decreased. The last group of factors taken into analyses were the measures of the competitiveness. This group of factors comprises the Lerner indicator, the Bonne index and the H-statistic factor. The first factor that has been taken into analysis was the Boone indicator, which measures the degree of competition, calculated as the elasticity of profits to marginal costs. This indicator suggests that higher profits are achieved by more efficient banks. As a result, the more negative the Boone indicator, the higher the degree of competition observed. This factor statistically significantly influences the notes presented by Moody's. The Lerner index is defined as the difference between output prices and marginal costs. The World Bank defines prices total bank revenue over assets, whereas marginal costs are obtained from an estimated translog cost function with respect to output. If the mentioned variable is higher, competition between banks is lower. This factor has got a statistically significant positive impact on the notes presented by Fitch (Table 1), and a negative one—for the ratings given by other agencies. The received findings suggest that Fitch puts attention to the negative effects of the competition. Higher competition can create problems with riskier investment to create additional profits. A different attitude has been presented by Moody's (Table 3) and S&P's (Table 2). The last factor the impact of which has been verified was the H-statistic indicator of the elasticity of banks revenues relative to input prices. In the case of the perfect competition, an increase in input prices raises both marginal costs and total revenues by the same amount, and hence the H-statistic equals 1. Under a monopoly, an increase in input prices results in a rise in marginal costs, a fall in output, and a decline in revenues, leading to an H-statistic less than or equal to 0. When H is between 0 and 1, the system operates under monopolistic competition. It is possible for the H-statistic to be greater than 1 in some oligopolistic markets. The received findings for Moody's and S&P' confirm the previous opinion.

Conclusions

The aim of the paper was to verify the impact of competitiveness of the banking sector and concentration on banks' credit ratings. The following hypothesis has been put: The bigger banks from the countries where the banking sector is more concentrated and more competitive, the higher banks' credit ratings are; this has been verified positively.

Financial indicators have been taken into consideration for the analysis. The received findings suggest that banks' notes are especially sensitive to the capital adequacy, the assets quality and the earnings factors. These results confirm previous research. Bigger banks receive higher notes. The mentioned relationship rises with the market share of the agencies. The impact of countries' notes is higher in the case of the ratings given by bigger CRAs. An opposite relationship has been noticed for the GDP growth.

The concentration of the banking sector has got a significant impact on the notes proposed by Fitch and Moody's, but the direction of the impact has been varied. Fitch notes are positively correlated with concentration indicators. As a result, this CRA presents an opinion that bigger banks on more concentrated markets can receive the financial support from the government, because in the case of default problems will have an influence on the whole financial system. Moody's puts attention to insolvency problems of the financial market, and as a result its notes are negatively correlated with the concentration of the banking sector.

The competition in the banking sector has got a significant impact on the described notes. Fitch ratings react negatively to a higher competition on the financial market. An opposite relationship has been observed in the case of Moody's and S&P's. The received results can be useful for supervisors, investors and entities that would like to receive ratings.

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Different Approaches to Regulatory Capital Calculation for Operational Risk

Ewa Dziwok

Abstract Changes in operational risk environment caused by globalization, information technology development and deregulations, have been significantly influencing banking industry and operational risk management process. This continuous evolution has forced to create an appropriate regulatory framework. Starting from Basel I Accord where market and credit risk were controlled, Basel II regulatory framework introduced an operational risk category and capital requirements for the losses connected with operational risk. The problem has raised during and after the financial crisis, when despite an increase in the number and severity of operational risk events, capital requirements for operational risk remained stable or even fell for the standardized approaches. As a consequence, the new Standardized Approach was proposed in 2015 and implemented by most biggest banks. The aim of the paper is to compare different approaches proposed under Basel II for modeling operational risk and to discuss new Basel IV proposals of regulatory capital charge for the operational risk.

Introduction

An increasing complication of the financial system with new products, international connections between institution, a large scale of mergers and acquisitions as well as the process of globalization have a huge influence on the process of risk measurement and management in banks. It has become more complicated and desires much more attention to identify, understand, calculate and protect against it.

Operational risk, which is one of main financial risks in the bank (together with credit and market risk) differs from the others. Widely understood as a risk associated with a daily activity of the bank is defined as the risk of loss resulting from

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inadequate or failed internal processes, people and systems, or from external events (Basel II).

A classification of operational risk is based on the nature of loss (internal versus external operational losses), expectancy (expected versus unexpected losses), association (direct versus indirect losses), and the magnitude (or severity) and the frequency of loss (low frequency and low severity, high frequency and low severity, low frequency and high severity, high frequency and high severity).

The Basel Committee on Banking Supervision (BCBS 2001) defines seven distinct types of operational risk, often interlinked: internal fraud, external fraud, employment practices and workplace safety, clients, products, and business practices, damage to physical assets, business disruption and system failures, execution, delivery, and process management.

In spite of the fact that operational risk was quite early identified (Hussain 2000; King 2001; Cruz 2002; Chernobai et al. 2007), its importance has been widely recognized only after the crisis 2007–2009. The Bank of International Settlements (BIS) provides also four major sources of operational risk: systems, processes, people and external factors. New threats connected with higher geopolitical risk, technological advances like e-banking and automated processes are the challenges for the process of operational risk measurement and management.

Operational risk has also become a topic for the Basel Committee on Banking Supervision to calculate the required capital (regulatory capital is understood as a minimum amount needed to have a license. It corresponds to expected risks and economic capital—the amount necessary to be in and stay in business), for instance, by providing a cushion at the 99% level of significance (Chorofas 2003).

A data collection, which covers operational losses, suggests to use a heavy tailed loss distribution which shows the probability of an extreme loss event (with high loss severity). Banks need to cover the expected losses (EL) that are the result of predictable failures, as well as the unexpected losses (UL) from large, one-time shocks (Fig. 1).

Different Aspects for Operational Risk Measurement

Methods and tools that let measure operational risk are significantly different from those dedicated to other types of risk. Lack of big data sources of extreme losses and their aberrant behavior lead to lower predictability and difficulties in modeling of operational risk.

There is no one valid methodology used to calculate the capital needed for protection against operational losses and those methods which are applied have both advantages and disadvantages. The most popular methods are (Haubenstock and Hause 2006): basic indicator and standardized approach, loss distribution approach, structured scenario analysis based on the opinion of experts, scorecard that uses various measures at a corporate business unit and hybrid approach—a combination of several approaches.

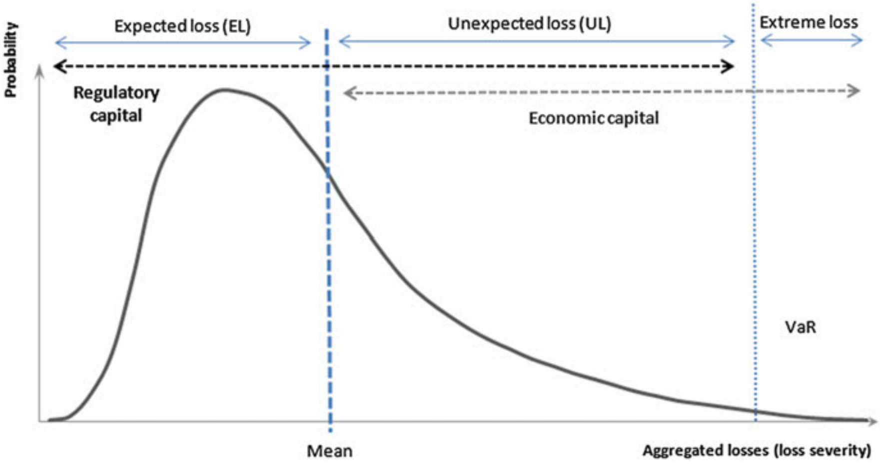

Fig. 1 Probability density function of operational losses

The ways how the risk is managed have a form of both top-down and bottom-up approaches (Chernobai et al. 2007).

A top-down approach determines the probability and magnitude of potential losses as well as identifies threats that may prevent the organization from achieving its objectives. This approach allows to measure a risk for a whole bank quite easily but is very difficult to reformulate into unit level. Top-down models include multi-factor equity price models, capital asset pricing model, income-based models, expense-based models, operating leverage models, scenario analysis and stress testing and risk indicator models.

A bottom-up approach focuses mainly on risk sources that refer to the relationship between human actions, technology and procedures in the organization as well as specific internal and external events. The risk is measured separately for each area of bank's activity (each business unit) and by summing it up the result for the whole institution is obtained. Bottom-up models encompass three main subcategories: process-based models (causal models and Bayesian belief networks, reliability models, multifactor causal factors), actuarial models (empirical loss distribution based models, parametric loss distribution based models, models based on extreme value theory) and proprietary models.

Keeping in mind that there is no right approach, institutions—that face a need to choose a successful methodology—must take into account such factors like: data availability, skills of the staff responsible for the capital calculations, organizational culture and incentives to risk management and costs.

The Basel Committee on Banking Supervision (BCBS 2001, 2011) does not directly quantify operational risk, but allows to designate the capital requirement for operational risk in the bank. In these documents there are descriptions of three basic approaches for operational risk measurement: a Basic Indicator Approach (BIA), a Standardized Approach (TSA) and Advanced Measurement Approaches (AMA).

The Basic Indicator Approach As recommended by many authors (Akkizidis and Bouchereau 2005; Gregoriou 2009), according to the basic indicator approach banks should maintain capital to cover operational risk equal to a fixed proportion of gross income. The total capital value C_{BIA} is calculated as:

$$C_{BIA} = \alpha \cdot \frac{\sum_{i=1}^{n} GI_i}{n}. \tag{1}$$

where: α—operational risk coverage ratio

GI_i—a positive gross income for i-th year

n—a number of the previous 3 years when GI is positive

This method was generally intended for a small or medium-size bank that does not operate in international markets. In addition, it does not need a set of data, a high qualified staff, the method is not time consuming and is easy to implement. On the other side it usually requires higher amount of capital as a consequence of the overestimation of operational risk.

The Standardized Approach In this approach the business activities are divided into eight subdivisions (business lines) with an individual beta factor which represents a relation between operation risk loss and gross income for selected business line. The capital requirements for the operational risk C_{STA} are calculated as:

$$C_{STA} = \frac{\sum_{i=1}^{n} \left(\sum_{j=1}^{8} GI_{i,j} \cdot \beta_j \right)}{n}. \tag{2}$$

where: β_j—beta factor for j-th business line

$GI_{i,j}$—positive gross income for i-th year and j-th business line

n—a number of previous 3 years when GI is positive

A capital required to cover operating risk is mainly determined by the method chosen by the bank for calculations. An important role plays also the size of the bank and environment in which it operates on the international markets. The standardized approach is better than the basic indicator method, because it takes into account the diversity of the bank's activity (business lines). On the other hand, the use of the same parameters beta for all banks leads to the misspecification of particular bank situation.

While the use of standard methods (BIA, TSA) usually causes the overestimation of the capital needed for the protection against the operational risk, the Basel Committee suggests to adopt an alternative version of the standardized approach. Under the alternative standardized approach (ASA) for two business lines: retail banking and commercial banking the required capital is calculated as beta factor multiplied by total loans and advances (instead of gross income) and this partial result is multiplied by 3.5%.

$$C_{RB} = \beta_{RB} \cdot 0.035 \cdot \frac{\sum_{i=1}^{n} LA_{RB,i}}{n}$$
$$C_{CB} = \beta_{CB} \cdot 0.035 \cdot \frac{\sum_{i=1}^{n} LA_{CB,i}}{n}. \tag{3}$$

where:

β_{RB}, β_{CB}—beta factors for retail banking and commercial banking respectively

$LA_{RB,\ i}$, $LA_{CB,\ i}$—total loans and advances for retail banking and commercial banking respectively for i-th year

n—number of previous 3 years when LA is positive

The Advanced Measurement Approach In this approach a bank can use its own methodology as long as it allows to calculate operational risk for 1-year period with a high confidence interval. Despite the fact that at first BIS (BCBS 2001) suggested only three approaches: the internal measurement approach (IMA), the scorecard approach (ScA) and the loss distribution approach (LDA), since 2006 banks have been using their own internal methodology (BCBS 2006).

The advanced measurement approach, as the most complex and demanding, needs both qualitative and quantitative criteria to assess the regulatory capital charge. To assess the validity and reliability of the method banks have to employ external databases as well as stress-testing.

Among banks the biggest attention was devoted to the loss distribution approach which takes into account the frequency and severity components of the loss distribution separately. The frequency shows numbers of events per time units while severity represents monetary result (loss) of the event. Bank's activities were (by BIS) divided into eight business areas (business lines) among which seven types of events could emerge. In consequence, a 56-cell matrix was created and for each cell the frequency and severity distribution has to be modeled. To determine the value of the capital needed to cover operational risk, the VaR methodology was used. The capital C_{LDA} is calculated as a simple sum of VaR measures (OpVaR).

$$C_{LDA} = \sum_{i=1}^{7} \sum_{j=1}^{8} VaR_{i,j}. \tag{4}$$

where: $VaR_{i,\ j}$—VaR measure for i-th event and j-th business line

In order to determine the distribution of operating losses, a database containing operating losses must be created at the first stage. The loss function can be created on the basis of historical data or random variables using the Monte Carlo method. The occurrence of each type of operational risk is accompanied by a probability that can be described by the Poisson distribution. As a result, operational risk is described by two random variables: loss frequency and loss size. The first is a number of events in a given period and the second is the measure of the amount of loss that arose from a given event.

The process of aggregating the frequency and severity distribution is not simple and could be done in different ways. One of the most popular method is to use Monte

Carlo simulations. The procedure may be described as follows (Esterhuysen et al. 2008):

- to generate 10,000 Poisson random variables representing the number of events for the 10,000 simulated periods.
- for each period, a required number of severity random variables is generated (understood as a probability p) using exponential distribution with $\lambda = \frac{1}{\mu}$ where μ—is an average loss. The amount of the severity loss is calculated using the generated uniform random number (described as p—probability) from the formula:

$$x = \frac{\ln(1-p)}{-1/100.000}. \tag{5}$$

where: x—the amount of severity loss

- Using the formula above, for each created uniform random number (representing the probability), the summarized amount of loss for a given period is calculated. Then by repeating this procedure many times (5000, 10,000 or 100,000 times) one can sum up the amount of losses for each run (period) and get the total loss amount for each run (potential losses during the period)
- To obtain the aggregated distribution, the numbers that represent total losses should be ordered from the highest amount (that represents highest quantile 99.99% or 1/10,000 for 10,000 runs respectively) and then the VaR for operational risk could be calculated

Calculations

The example takes into account a chosen business line (Retail banking) in one of commercial banks. Risk identification—first step in measurement process—let recognize the losses and then locate them into seven different loss categories. Then the process of risk management covers risk assessment, mitigation and finally the control. The time horizon which means the length of time over which the bank plans to calculate VaR is equal to 1 year (the period proposed by the Basel Committee). The level of confidence at which the institution will make the estimate is 99.99%.

Let's assume that for last 3 years the bank has received gross incomes equal to $X_1 = 135$ *mln*, $X_2 = 146$ *mln*, $X_3 = 161$ *mln* for a chosen business line. The collected data show that there were on average 22 fraud events during the year with an average fraud amount equals to *90,000*, which gives the aggregated value *1.98 mln* per year.

Having the data available the question arises how much capital is needed to cover the risk and maintain the bank in a good financial condition. For this article two methods will be applied—the standardized approach and the advanced measurement approach with loss distribution approach.

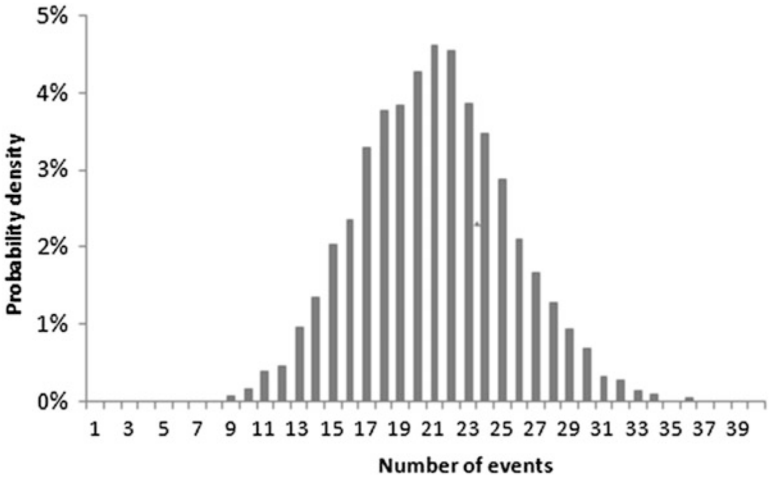

Fig. 2 Frequency of events distribution

The Standardized Approach While beta for retail banking business line is equal to *12%*, the minimum necessary capital will be equal to:

$$C_{STA(Retail\_banking)} = 0.12 \cdot \frac{135 + 146 + 161}{3} = 17.68$$

The Advanced Measurement Approach The frequency of data was generated through the Poisson process with lambda parameter equal to 22. The process delivered 10,000 random variables that represent the frequency of events (number of potential losses during 10,000 hypothetical years)

For each period (year), the required number (equals to the frequency obtained above) of severity random variables was calculated with the exponential distribution) and then sum up. By using the Monte Carlo simulation one can derive an aggregated loss distribution for a given frequency distribution and severity distribution (Fig. 2 and 3).

Having the distribution of aggregated losses one can calculate the required capital using VaR for several confidence levels (Table 1).

A comparison of both methods can claim that the use of internal methods let significantly decrease the level of required capital.

Towards Basel IV

In October 2014, the BCBS proposed some revisions to its operational risk capital framework (BCBS 2014). It noticed that all three simple operational risk approaches (basic indicator, standardized and alternative standardized) have little or no linkage

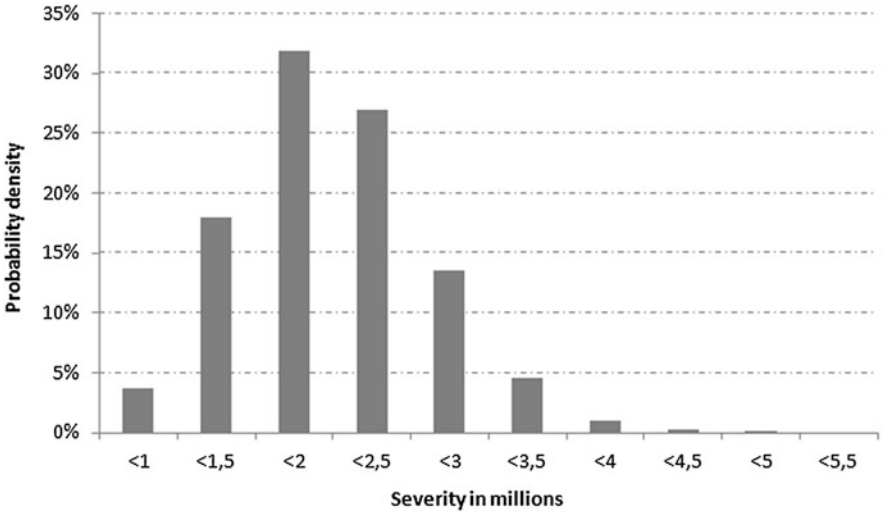

Fig. 3 Aggregated loss distribution

Table 1 Capital requirements at different confidence level

Confidence level (%)	Regulatory capital (VaR)	Expected losses	Unexpected losses
99.99	4,733,677.06	1,986,817.75	2,746,859.30
99.00	3,350,564.85	1,986,817.75	1,363,747.10
95.00	2,803,534.45	1,986,817.75	816,716.70
90.00	2,509,963.97	1,986,817.75	523,146.22

to the operational risk that they measure, except as an overall assessment of the bank's size. The proposal specified a new standardized approach (new SA) to substitute both the basic indicator approach (BIA) and the standardized approach (TSA) for calculating operational risk capital. However, the proposed new SA was widely criticized by the industry representatives for lack of risk sensitivity.

At the same time large financial institutions were obliged to assess the operational risk regulatory capital via advanced internal models that were sensitive to the quality of risk management and fit to the institution's risk profile. However, in 2014 the BCBS concluded that in case of many banks the capital requirements for operational risk were not correctly calculated. The BCBS proposed to withdraw internal modeling approaches for the calculation of minimum capital requirement for operational risks, due to excessive complexity and lack of comparability arising from a variety of different modeling practices.

In March 2016 the BCBS (BCBS 2016) has proposed a Standardized Measurement Approach, the SMA, as a single and non-model based method which is the most suitable substitution for gross income. It relies on a business indicator (based on the three main sources of income—interest component, services component and financial component) and the past performance of the financial institution.

European Commission reacted to the BCBS proposal by underlying its criticism for the plan to limit the flexibility of internal modeling. On 23 November 2016, the European Parliament adopted one resolution (European Parliament 2016) on the finalization of Basel III. The European Parliament underlined the need to consider carefully the impact of the proposed reforms, and to promote a level-playing field at global level while paying attention to the peculiarities of the EU economy and of European banking models. In consequence, the issue of further use of internal models remains in the sphere of consultation.

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Assessment of Systemic Risk in the Polish Banking Industry

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Abstract In this paper systemic risk is meant in a very narrow sense as a risk of breakdown or major dysfunction in the banking system. Some researches use the term to include the potential insolvency of a major player in or a component of the financial. In the paper, financial indicators and the approach of Conditional Value-at-Risk (CoVaR) proposed by Adrian and Brunnermeier is used to assess systemic risk. The goal is to verify the results obtained for delta CoVaR for banks by aggregate measure of their financial condition. In the paper two methods of CoVaR estimation were applied: GARCH and quantile regression. As a measure of financial condition, the composite indicator (development measure proposed by Hellwig, containing selected financial ratios, was calculated. Empirical analysis for Polish banking industry indicates a weak or insignificant relationship between values of systemic risk measure (delta CoVaR) and the values of financial condition measure (composite indicator).

Introduction

The last crisis showed that regulating financial institutions according to their idiosyncratic risk measured by Value at Risk (VaR) is not sufficient, given the loose link between their VaR level and the actual contribution to risk of the financial system. The need of new solutions caused new approaches in measurement of that risk.

There are some terms related to systemic risk such as financial stability/instability, financial system stability/instability, fragility of the financial system, financial crisis. European Central Bank defines **financial stability** as "a condition in which the financial system—intermediaries, markets and market infrastructures—can withstand shocks without major disruption in financial intermediation and in the effective allocation of savings to productive investment" ECB (2013). In turn Central Bank of

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Japan defines **financial system stability** as “a state in which the financial system functions properly, and participants, such as firms and individuals, have confidence in the system”. Both definitions concentrate on proper functioning of the financial system.

Systemic risk was defined by the International Monetary Fund as “a risk of disruption to financial services that is caused by an impairment of all or parts of the financial system and that has the potential to cause serious negative consequences for the real economy” (IMF 2009). Here, important is the stress on the negative consequences for the real economy. Different definition of systemic risk, by Kaufmann and Scott (2003), stresses the interconnectedness of financial institutions, by naming it “a risk of breakdowns in an entire system, as opposed to breakdowns in individual parts or components, and (. . .) evidenced by comovements (correlation) among most or all the parts of the system”. Wim Duisenberg (European Central Bank) elaborates: “monetary stability is defined as stability in the general level of prices, or as an absence of inflation or deflation. Financial stability does not have as easy or universally accepted a definition. Nevertheless, there seems to be a broad consensus that financial stability refers to the smooth functioning of the key elements that make up the financial system.” It is important how we define financial stability, because some definitions consider systemic risk as a lack of financial stability.

In this paper systemic risk is meant as a risk of breakdown or major dysfunction in the banking system (narrow definition of the system) and it is consistent with financial stability meaning accepted by the majority of central banks. This definition allows to approximate the financial system with banking industry index in estimation of systemic risk measure—delta CoVaR.

Systemic Risk Measures

There are many approaches to measure systemic risk (Hansen 2013), but the major distinction includes financial soundness indicators and advanced systemic risk models. Because international financial markets are susceptible to turbulence, the IMF began an initiative to identify a list of internationally comparable indicators that can be used for financial sector surveillance. Jajuga (2015) proposes two groups of systemic risk measures:

1. Indicators of financial stability—which can be treated as warning signals—here, one looks at the ‘input’ to financial instability (systemic risk);

2. More advanced models of systemic risk—which can be treated as the result—one looks at ‘output’ of financial instability (systemic risk).

In the second group, amongst the many systemic risk measures (SRMs) that have been proposed one has gained particular attraction: CoVaR (the Conditional-VaR) proposed by Adrian and Brunnermeier (2009, 2011, 2016). It is derived from VaR. The extension, MCoVaR (the Multi-Conditional-VaR) was then proposed by Cao (2013). The other important SMRs are:

- MES (Marginal Expected Shortfall)—Acharya et al. (2010); Brownlees and Engle (2012);
- SV (the Shapley value) approach—Tarashev et al. (2010);
- CES (the Component Expected Shortfall)—Banulescu and Dumitrescu (2012);
- SRISK (the Systemic RISK) measure—Acharya et al. (2012) and Brownlees and Engle (2016);
- DIP (Distress Insurance Premium)—Huang et al. (2009, 2010, 2011);
- JPoD (Joint Probability of Distress)—Segoviano and Goodhart (2009).

Conditional Value at Risk

CoVaR is the Value at Risk of the whole system conditional on financial institution being in distress. This measure stands for conditional Value at Risk, i.e. it indicates the VaR for a financial system conditional on a certain scenario at a particular bank. Adrian & Brunnermeier make the sensible point that regulators should worry about how much a financial institution contributes to systemic risk (CoVaR) more than just its own risk (VaR). CoVaR also measures the financial institution's contribution to the risk of other financial institutions. Important is the marginal contribution of that particular institution to systemic risk, which is the difference between the CoVaR and the unconditional VaR of the financial system. Key point in CoVaR result is that some institutions can have a low VaR, but a high CoVaR. This is the reason why the simple VaR is not a sufficient measure to evaluate the systemic riskiness of financial institutions. Also, CoVaR is complement to the Marginal Expected Shortfall.

Let us start with the CoVaR definition. $CoVaR_q^{j|i}$ is the VaR of the system (or institution) j conditional on institution i (bank) when the latter has reached its level ${VaR_q}^i$ at extreme quantile at tolerance level q (usually 0.05 or 0.01).

As VaR, in similar way, the CoVaR is defined as (Adrian and Brunnermeier 2011):

$$P\left(X^j \leq CoVaR_q^{j|i} \middle| X^i = VaR_q^i\right) = q.$$

The CoVaR corresponds to the VaR of the system return obtained conditionally on some event observed for institution i.

Delta CoVaR of insitution i is defined as the difference between the VaR of the system conditional on this particular institution being in financial distress and the VaR of the system conditional on institution i being in its median state (VaR at $q = 50\%$). To define the distress of an institution, various definitions of an event can be considered. Because Adrian and Brunnermeier (2009, 2011) use a quantile regression approach, they consider a situation in which the loss is precisely equal to its VaR. The difference between the $CoVaR$ and the unconditional VaR of the financial system gives delta CoVaR:

$$\Delta CoVaR_q^{j|i} = CoVaR_q^{j|i} - VaR_q^j$$
$$\Delta CoVaR_q^{j|i} = CoVaR_q^{j|X^i=VaR_q^i} - CoVaR_q^{j|X^i=VaR_{0.5}^i}.$$

Delta CoVaR might be calculated and interpreted in following way (direction matters):

1. Contribution—Which institutions contribute (in a non-causal sense)?
   $VaR^{system}|$ institution i in distress;
2. Exposure—Which institutions are most exposed if there is a systemic crisis?
   VaR^i | system in distress;
3. Network—VaR of institution j conditional on institution i.

When one is interested in what is the VaR of the financial system if a particular institution is under financial stress, one should calculate CoVaR. When one is interested in how the VaR of the system would change when a particular institution becomes financially stressed, the ΔCoVaR is proper measure.

Conditional Value at Risk Estimation

There are a few methods of CoVaR estimation used: quantile regression, multivariate GARCH, copula function, bootstrap approach or based on, the Extreme Value Theory. In the paper two of them are applied—quantile regression and GARCH. Both of these methods define delta CoVaR in the same way: it is the particular coefficient multiplied by the difference in two values of VaR (calculated as extreme quantile and median).

Quantile Regression

Quantile regression approach is based on Koenker and Basset (1978) quantile regression proposition. According to Adrian, Brunnermeier (2009, 2011) it is an efficient way to estimate CoVaR. It models the relation between a predictor variable (or a set of predictor variables) and specific quantiles of the response variable. When estimating CoVaR, the focus is on a specific low quantile of a distribution and hence it is convenient to use quantile regression here. Quantile regression minimizes weighted absolute values:

$$\beta^q = \arg\min_{\beta} \sum_t \begin{cases} q|y_t - \alpha - \beta x_t| & if \quad y_t - \alpha - \beta x_t \geq 0 \\ (1-q)|y_t - \alpha - \beta x_t| & if \quad y_t - \alpha - \beta x_t < 0 \end{cases},$$

and

$$VaR_q|x = F_y^{-1}(q|x) = \alpha_q + \beta_q x.$$

Predicted value is an estimate of the quantile at q tolerace level of y as a linear function of x, where $F^{-1}(q|x)$ is the inverse CDF conditional on x.

In quantile regression—system j versus institution i:

$$X_t^j = \alpha_q^i + \beta_q^i X_t^i + \varepsilon_t^i;$$

after estimation:

$$\widehat{X}_t^j = \widehat{\alpha}_q^i + \widehat{\beta}_q^i X_t^i.$$

CoVaR can be obtained in following way:

$$CoVaR_{q,t}^{j|X_i=VaR_q^i} = \widehat{\alpha}_q^{j|i} + \widehat{\beta}_q^{j|i} VaR_{q,t}^i$$

$$CoVaR_{0.5,t}^{j|X_i=VaR_{0.5}^i} = \widehat{\alpha}_q^{j|i} + \widehat{\beta}_q^{j|i} VaR_{0.5,t}^i,$$

then delta CoVaR is equal:

$$\Delta CoVaR_{q,t}^{j|i} = \widehat{\beta}_q^{j|i}\left(VaR_{q,t}^i - VaR_{0.5,t}^i\right).$$

GARCH Approach

The GARCH approach follows a two-step procedure:

- In the first step, the volatility of the joint normal distribution is estimated. For this purpose the respective underlying GJR-GARCH(1,1) model is fitted to each bank's return series.
- In the second step, the correlation is estimated, with the estimates from step one serving as inputs. Thus, given the estimates from the Dynamic Conditional Correlation (DCC) approach, the conditional covariance matrix Σ_t can be specified entirely.

VaR of each institution i is obtained by estimating a univariate GJR-GARCH(1,1) as follows:

$$r_t = \mu + \varepsilon_t = \mu + \sqrt{h_t} z_t, \quad z_t \sim N(0,1),$$

where conditional variance:

$$h_t = \omega + \left(\alpha + \alpha^{-} \mathrm{I}_{(\varepsilon_{t-1<0})}\right)\varepsilon_{t-1}^2 + \beta h_{t-1},$$

then VaR:

$$VaR_{q,t}^i = \sqrt{h_t} \cdot quantile\left(\widehat{z}_t^i, q\right).$$

DCC specification for the institution *i* and financial system are the following:

$$\begin{aligned} &X_t = \mu + \varepsilon_t, \quad \varepsilon_t \mid \mathrm{F}_{t-1} \tilde{} N(0, D_t R_t D_t) \\ &D_t^2 = diag\{H_t\} \\ &H_{i,t} = \omega_i + \alpha_i \varepsilon_{i,t-1}^2 + \beta_i H_{i,t-1} \\ &z_t = D_t^{-1} \varepsilon_t \end{aligned}$$

Following Engle (2002) specification of the conditional correlation matrix is:

$$R_t = diag\{Q_t\}^{-1/2} Q_t diag\{Q_t\}^{-1/2}$$

where diag{Q_t} is the (2 × 2) matrix with the diagonal of Q_t on the diagonal and zeros off-diagonal.

$$Q_t = \Omega + \alpha z_{t-1} z_{t-1}' + \beta Q_{t-1}, \Omega = \bar{R}(1 - \alpha - \beta)$$

$$\widehat{\gamma}_{ji,t} = \widehat{\rho}_{ij,t} \frac{\sqrt{\widehat{h}_{j,t}}}{\sqrt{\widehat{h}_{i,t}}},$$

where gamma coefficient is the linear projection coefficient of the system return *j* on the bank return *i*, $_{ij,t}$ is the correlation between the system and the bank at time *t*. Finally delta CoVaR is defined as:

$$\Delta CoVaR_{q,t}^{j|i} = \gamma_{ji,t}\left(VaR_{q,t}^i - VaR_{0.5,t}^i\right).$$

These two approaches lead to formulas for delta CoVaR of similar form.

Composite Indicator of Financial Ratios

Important issue in systemic risk analysis are Systemically Important Financial Institutions (SIFI). SIFI are financial institutions whose failure might trigger a financial crisis. The Basel Committee has identified five factors for assessing whether a financial institution is systemically important: its size, its complexity, its interconnectedness, the lack of readily available substitutes for the financial infrastructure it provides, and its global activity. Not all banks in a given financial system are considered systemically important according to these criteria. The Financial

Stability Board publishes a list of Global Systemically Important Financial Institutions (G-SIFI) in November each year.

It seems that evaluating the financial condition of such institutions at an appropriate frequency, using financial ratios, could provide a warning signal indicating financial difficulties and be the part of the assessment of systemic risk. Therefore, the authors propose to use financial ratios in assessment of systemic risk. In this assessment, the analyzed banks have not been identified as SIFI, but have been ordered according to their financial condition.

The IMF's Executive Board prepared a list of Financial Soundness Indicators (IMF 2006, 2013). The ratios presented in Table 1 are the compromise between the availability of data and the diversity within groups of ratios used in the empirical study.

Authors use linear ordering by a measure of development (called also a composite indicator). The concept of the pattern of development and the measure of development in English was presented by Professor Zdzisław Hellwig at the UNESCO conference in Warsaw in 1967 (for details see, e.g.: Hellwig 1968; Walesiak 2016).

Linear ordering requires: the identification of stimulants, destimulants and nominants (indicated in Table 1), the pattern of development, and finally the calculation of the measure of development (distance from the pattern of development). In the first step, standardization was performed. In the next step, the linear ordering of a set of objects was carried out based on the Manhattan distance from the pattern (ideal) object.

The higher the value of the measure of development (composite indicator), the better the financial condition of the bank.

Table 1 Chosen financial indicators

	Ratio	Type	Variable
X1	"Impaired Loans/Gross Loans %"	Quality of Loans	Destimulant
X2	"Impaired Loans/Equity %"	Quality of Loans	Destimulant
X3	"Equity/Total Assets %"	Leverage	Stimulant
X4	"Net Interest Margin %"	Profitability	Stimulant
X5	"Net Interest Revenue/Avg Assets %"	Profitability	Stimulant
X6	"Return on Avg Assets (ROAA) %"	Profitability	Stimulant
X7	"Return on Avg Equity (ROAE) %"	Profitability	Stimulant
X8	"Cost to Income Ratio % "	Efficiency	Destimulant
X9	"Recurring Earning Power %"	Efficiency	Stimulant
X10	"Net Loans/Total Assets %"	Liquidity	Destimulant
X11	"Net Loans/Total Deposits & Short-Term funding %"	Liquidity	Destimulant
X12	"Liquid Assets/Total Deposits & Borrowing %"	Liquidity	Destimulant

Empirical Results

Authors considered the largest ten banks in Poland listed on Warsaw Stock Exchange. The sample was restricted to banks for which all data was available. Important simplifying assumption was that the financial system was composed of a banking industry index—WIGBanking (a proxy of the financial system). Sample period was from 2.01.2006 to 25.12.2006, from 4.01.2010 to 27.12.2010 and from 5.01.2015 to 28.12.2015 (Reuters database). Weekly logarithmic rates of return are calculated. VaR was estimated by historical simulation filtered with GARCH.

For the same ten banks for years: 2006, 2010 and 2015, twelve financial ratios indicted in Table 1 (for each bank separately) were calculated (Scopus database). Total assets values in EUR for indicated points in time are also collected from the Scopus database.

In Tables 2, 3 and 4 the authors present results of calculations of:

1. delta CoVaR (using GARCH—DCC and quantile regression approach) for VaR tolerance level of 0.01 and 0.05—the so-called DCC 0.05; DCC 0.01; QR 0.05 and QR 0.01;
2. measure of development (the so-called measure).

Size of bank measured by the value of total assets in EUR was also included—the so-called size.

Table 2 Results for 2015

Bank	Δ CoVaR DCC 0.05	Δ CoVaR QR 0.05	Measure	Size	Δ CoVaR DCC 0.01	Δ CoVaR QR 0.01
Bank BPH SA	0.039508	0.033960	0.241107	7,378,867	0.032432	0.033196
Bank Ochrony Srodowiska SA–Capital Group	0.008041	0.011937	0.265230	4,925,963	0.028955	0.022846
Bank Zachodni WBK S.A.	**0.046251**	**0.063560**	**0.760604**	**32,893,914**	**0.076921**	**0.103091**
Getin Holding SA	0.032598	0.042660	0.606395	5,458,331	0.046236	0.081283
Bank Handlowy w Warszawie S.A.	0.027653	0.031005	**0.745951**	11,656,199	0.056521	**0.084523**
ING Bank Slaski S. A.–Capital Group	0.032582	0.032487	0.689037	25,638,491	0.053262	0.067974
mBank SA	0.037930	0.045880	0.618566	29,083,048	0.064990	0.073233
Bank Millennium	0.033958	0.048185	0.601697	15,594,864	0.057263	0.085714
Bank Polska Kasa Opieki SA-Bank Pekao SA	**0.054058**	**0.063920**	0.654716	**39,739,966**	**0.065986**	0.074278
PKO BP	**0.051675**	**0.053946**	**0.696244**	**62,661,953**	**0.077226**	**0.092657**

Table 3 Results for 2010

Bank	Δ CoVaR DCC 0.05	Δ CoVaR QR 0.05	Measure	Size	Δ CoVaR DCC 0.01	Δ CoVaR QR 0.01
Bank BPH SA	0.021670	0.034014	0.262168	9,415,509	0.038134	0.037869
Bank Ochrony Srodowiska SA–Capital Group	0.007049	0.011635	0.327191	3,832,820	0.013468	0.021034
Bank Zachodni WBK S.A.	**0.042118**	0.049258	**0.738226**	13,420,753	**0.070088**	**0.104057**
Getin Holding SA	0.032308	0.036293	0.527065	11,830,179	0.050681	0.060767
Bank Handlowy w Warszawie S.A.	0.030428	0.033810	**0.750997**	9,472,723	0.054986	0.067639
ING Bank Slaski S.A.–Capital Group	0.029817	0.033701	0.646487	16,289,901	0.053690	0.066153
mBank SA	0.037159	**0.052318**	0.486955	**22,734,635**	0.058457	0.075335
Bank Millennium	0.035433	0.042045	0.397278	11,863,002	0.055236	0.077629
Bank Polska Kasa Opieki SA-Bank Pekao SA	**0.048709**	**0.058401**	**0.698878**	**33,856,105**	**0.072943**	**0.095143**
PKO BP	**0.048492**	**0.053886**	0.693866	**42,840,315**	**0.080942**	**0.095391**

Table 4 Results for 2006

Bank	Δ CoVaR DCC 0.05	Δ CoVaR QR 0.05	Measure	Size	Δ CoVaR DCC 0.01	Δ CoVaR QR 0.01
Bank BPH SA	0.039508	0.033960	0.341742	**16,894,027**	0.069529	0.037809
Bank Ochrony Srodowiska SA–Capital Group	0.008041	0.011937	0.255678	2,129,797	0.015364	0.021576
Bank Zachodni WBK S.A.	**0.046251**	**0.063560**	**0.748611**	8,607,104	**0.076918**	**0.134192**
Getin Holding SA	0.032598	0.042660	0.516210	3,142,362	0.051134	0.071425
Bank Handlowy w Warszawie S.A.	0.027653	0.031005	0.518599	9,389,362	0.049972	0.062028
ING Bank Slaski S.A.–Capital Group	0.032582	0.032487	0.490807	12,646,565	0.058692	0.063794
mBank SA	0.037930	0.045880	0.396278	11,043,334	0.059654	0.066044
Bank Millennium	0.033958	0.048185	0.401698	6,441,749	0.052950	0.088987
Bank Polska Kasa Opieki SA-Bank Pekao SA	**0.054058**	**0.063920**	**0.676469**	**17,662,745**	**0.080944**	**0.104125**
PKO BP	**0.051675**	**0.053946**	**0.642782**	**26,435,031**	**0.086250**	**0.095498**

All the results are collected for three years: 2006 (before the global financial crises), 2010 (after the global financial crises) and finally 2015 (‘current’).

The results in Tables 2, 3 and 4 present results for a set of banks based on the pattern of development (Hellwig 1968) and on delta CoVaR, and on the size. The largest values are indicated in bold.

Results of delta CoVaR at level 0.05 obtained with quantile regression method were higher comparing to results obtained with DCC approach. Only in case of two banks (BPH and ING) the authors got an opposite result (delta CoVaR using DCC approach was higher comparing to QR method). The same can be noted for the delta CoVaR results at tolerance level of 0.01. In case of two banks (BPH and BOS) delta CoVaR using the DCC approach was higher comparing to QR. It is hard to conclude which results are more reliable, but from prudential reasons one should stress on results obtained with quantile regression method.

The highest values of the measure of development (meaning better financial standing) were obtained for:

- BZ WBK, BH w Warszawie and PKO BP (in 2015);
- BH w Warszawie, BZ WBK and Bank Pekao (in 2010);
- BZ WBK, Bank Pekao and PKO BP (in 2006).

The lowest values of measure of development (meaning worse financial standing) were obtained for:

- BPH, BOS (in 2015);
- BPH, BOS (in 2010);
- BOS, BPH (in 2006).

In 2015 the contribution of individual bank into systemic risk (risk of banking system) measured by delta CoVaR at 0.05 level is higher for Bank Pekao, PKO BP and BZ WBK (different ordering for DCC and QR approach). From the side of financial soundness, there is no threat in case of BZ WBK, Bank Handlowy, PKO BP, but value of composite indicator (measure) for Bank Pekao is in the middle place of the ranking.

In 2010, the contribution of individual bank to systemic risk (risk of banking system), measured by delta CoVaR at 0.05 level for DCC approach, is higher for Bank Pekao, PKO BP and BZ WBK (different banks ordering for QR approach: Bank Pekao, PKO BP and mBank). From the side of financial soundness, there is no threat in case of Bank Handlowy, BZ WBK, Bank Pekao, but the value of the composite indicator (measure) for PKO BP is in the 4th place of the ranking.

In 2006, the contribution of the individual bank into systemic risk (risk of banking system), measured by delta CoVaR at 0.05 level for DCC approach, is higher for Bank Pekao, PKO BP and BZ WBK (different ordering for DCC and QR approach). On the side of financial soundness, there is no threat in case of BZ WBK, Bank Pekao and PKO BP.

In the three selected years, two banks were characterized by low composite indicator, namely BOS and Bank BPH (in March of 2017 Bank BPH was acquired by Alior Bank), but their contribution into systemic risk measured by delta CoVaR is low (the size is also small).

Authors also checked for the dependence between delta CoVaR, the measure of development (M) and the size (Size) by calculating the coefficients of Spearman's rank correlation. Results are presented in Table 5. Thereof, entries in bold indicate the statistically significant values.

As expected, there exists a high significant correlation between delta CoVaR calculated by GARCH and the quantile regression approach (at level 0.05 coefficients 0.9 and 0.95; at level 0.01 coefficients 0.77, 0.95, 0.67). High significant correlation exists also between delta CoVaR calculated by GARCH approach and the size (at level 0.05 coefficients 0.78, 0.84 and 0.68; at level 0.01 coefficients 0.94, 0.88, 0.81). Correlation between delta CoVaR calculated by the quantile regression approach and the size is lower (comparing to GARCH approach) and not always significant.

Authors obtained interesting results of correlation between CoVaR and the measure of development—in most cases the correlations are not significant, and if they are, they are at 0.67 and 0.7, 0.82. This confirms the possibility of using the combined delta CoVaR and the measure in systemic risk assessment.

Conclusions

CoVaR and ΔCoVaR extend the VaR framework to measuring systemic risk rather than to individual institution risk.

ΔCoVaR is higher for quantile regression comparing to DCC approach. The results are similar to Girardi and Ergün (2013) and Benoit et al. (2013).

Delta CoVaR is more influenced by the size of the bank than its financial condition, it is confirmed by the positive, large and statistically significant correlation coefficients between delta CoVaR and the size, and by the smaller (comparing to previous case) and mostly insignificant correlation coefficients between delta CoVaR and the measure (composite indicator).

Lower values of the measure of financial condition (composite indicator) were not reflected in the higher values of the delta CoVaR.

Measuring delta CoVaR, the authors have approximated the system with the WIGBanking index looking for a better solution than the use of accounting data, since the information coming from the accounting data is lagged and the data frequency is low. In the case of financial markets, the data frequency (for prices) is high, therefore the use stock prices of banks and the banking index seems reasonable. Construction of delta CoVaR allows to use market prices, however, a problem appears when using the banking index. The banking index is not independent of the individual stock price. This interferes with the interpretation of results. It is hard to distinguish whether the result is determined by the bad financial condition of the bank or by the size of the bank. The obtained results indicate that often used index approximation might be not appropriate.

Table 5 Spearman's rank correlation coefficients

	0.05					0.01				
2015	DCC/QR	DCC/M	QR/M	DCC/Size	QR/Size	DCC/QR	DCC/M	QR/M	DCC/Size	QR/Size
corr	**0.90303**	0.22424	0.33333	**0.78182**	**0.79394**	**0.76970**	**0.69697**	**0.67273**	**0.93939**	0.55152
p-value	**0.00088**	0.53669	0.34885	**0.01165**	**0.00984**	**0.01367**	**0.03114**	**0.03938**	**0.00000**	0.10430
2010	DCC/QR	DCC/M	QR/M	DCC/S	QR/S	DCC/QR	DCC/M	QR/M	DCC/S	QR/S
corr	**0.95152**	0.55152	0.32121	**0.84242**	**0.79394**	**0.95152**	0.61212	0.63636	**0.87879**	**0.75758**
p-value	**0.00000**	0.10430	0.36768	**0.00446**	**0.00984**	**0.00000**	0.06647	0.05445	**0.00198**	**0.01592**
2006	DCC/QR	DCC/M	QR/M	DCC/S	QR/S	DCC/QR	DCC/M	QR/M	DCC/S	QR/S
corr	**0.90303**	0.55152	**0.67273**	**0.68485**	0.41818	**0.67273**	0.53939	**0.81818**	**0.80606**	0.26061
p-value	**0.00088**	0.10430	**0.03938**	**0.03509**	0.23242	**0.03938**	0.11330	**0.00681**	**0.00824**	0.46968

This problem could be solved by constructing a broad index (using broader definition of the system than the banking sector) or removing the bank from the index (when calculating CoVaR for a given bank). Similar approach is used in the work of Karaś and Szczepaniak (2016). There is still lack of research in this area for Polish market. Comparing and evaluation of both approaches will be the subject of further work.

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Contemporary Challenges in the Asset Liability Management

Beata Lubinska

Abstract The role of the active management of the banking book in the banking industry is constantly growing. This is dictated by heavily regulated landscape and increased competition for resources such as liquidity and capital. Given the market pressure, the relentless pursuit for the most efficient and productive use of a bank's resources subject to consolidated risk and return appetite remains of upmost importance for banks of all size. The need for the use of the optimization technique to manage the banking book of a financial institution is becoming an imperative to remain profitable. This article states that the application of optimization techniques can provide useful information to understand the target structure for the banking book in terms of its composition of liabilities and is valid tool which helps to decrease the overall cost of funding. Moreover, the application of optimization techniques, in this article, is seen as the integrated management of the exposure to financial risks under one approach.

Introduction

This article proposes the application of numerical optimization techniques to decrease the cost of funding of a financial institution. It states that there is an economic benefit for the financial institution deriving from the optimization exercise and, in addition, it ensures the overall awareness of the senior management (Treasurer and Asset Liability Management Committee members) as to the direction which has to be taken in order to achieve the target profile of the banking book. The optimization output will support a bank with strategic decision making like the *Funding Plan* or the *New Product Policy*. Consequently, it aims to answer the question: how should a bank structure its funding base in order to be cost efficient and remain within the regulatory and internal limits?

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The optimization problem, in this article, has been set up in form of nonlinear objective function which minimize the cost of funds. Therefore, it represents nonlinear constrained optimization since minimization of objective function is subject to the banks appetite for the exposure to the interest rate risk (*NII sensitivity*), liquidity risk (short term and structural liquidity metrics) and concentration limit. The constraints functions are both equality and inequality functions. The article provides the reader with the description of the numerical optimization technique applied in the exercise and it walks through the main Interest Rate Risk in the Banking Book (*IRRBB*) and liquidity risk metrics, which have been set up as constraints functions.

Asset—liability management is one of the most important issues in bank strategic planning (Kosmidou and Zopounidis 2002). The application of the optimization tool for determination of the optimal balance among profitability, risk, liquidity and other uncertainties has been already studied prior to the financial crisis in 2007–2009. After the financial crisis, significant regulatory pressures have additionally forced banks to improve their risk management and capital allocation practices. The Basel Committee on Banking Supervision 2016, the European Commission 2014 and the Prudential Regulation Authority 2015 require banks to revamp their approach towards the financial risk management and practice. The recent Basel III regulation highlights the necessity of the maintenance of the balance funding structure and minimum liquidity cushions and therefore forces banks towards new business model in order to create the right incentives and to maintain regulatory limits (Lubinska 2017).

ALM of the Banking Book

The role of the Asset Liability management in the active management of the banking book is constantly growing. This is due to its contribution related to the tactical position banks should take on to maintain healthy balance between profitability and exposure to the financial risks in the banking book. From one side, it is up to the bank's Treasurer to assess the direction the bank should be positioned on the interest rate curve ensuring profits in terms of the Net Interest Income (NII) and the cheapest achievable funding structure. From the other side though, it is the role of the second line of defence (risk management department) to make sure that Treasurer's decisions will not lead to the excessive exposure to financial risks. This monitoring role is performed through setting up the internal policies and limits. Thus, Treasurer keeps the NII volatility within the limits and, at the same time, tries to gain, in the most efficient way, from the movement of the interest rate curve. From the liquidity perspective, the main task of the Treasury department is to keep the optimal amount of the liquidity portfolio known as Liquid Asset Buffer (LAB), maintaining its Counterbalancing Capacity at the desirable level (Basel Committee on Banking Supervision October 2013). The Counterbalancing Capacity indicates the level of immunization a bank has for the potential liquidity needs arising in the stress situation. Consequently, one of the main tasks of Treasurer is to find the target position for a bank ensuring the balance between healthy exposure to the Interest

Rate Risk (IRRBB), its robust liquidity position and, in the same time, the ALM profitability.

The realized profitability of the bank in terms of P&L impact is determined both by the past hedging strategies as to the interest rate component and maturity transformation performed by Treasury with reference to its liquidity component. There is clear *trade-off* between expected P&L and its volatility (sensitivity). Thus, the riskiness embedded in the banking book structure is determined by the funding and hedging strategy of the bank and its risk tolerance. It is the Treasurer's decision regarding the minimization of the NII sensitivity deriving from the interest rate risk and liquidity component of the banking book and what profitability needs to be provided by the ALM unit to the bank. The real challenge consists in understanding the trade-off between profitability and risk. This drives the funding strategies based on the choice of the appropriate composition of liabilities which represent the optimal trade off (target position) between its economical aspect (funding cost in this case) and the exposure to the financial risk this structure will impose on the bank.

Among factors, such as the level of uncertainty and the capability of the bank to predict the direction of the market, there are also other factors which should be considered in the achievement of the target position such as unpredictable behavior of customers of the bank both from the asset and liability side which defines the final composition of the banking book. The behavioral assumption related to the asset side is mostly defined by the *prepayment rate* of mortgages or personal loans prepaid before its contractual maturity date. From the liability side the uncertainty is driven by the behavior of the depositors who can decide to withdraw their funds overnight. These behavioral aspects can change the liquidity profile of the bank within the short-term period. Also, the hedging strategies undertaken in the past might turn out to be inefficient and might need to be adjusted.

As a result of this risk return trade off, the main challenge of the Asset Liability Management is to find the banking book target position in terms of the exposure to the financial risks to minimize the cost of funding being subject, at the same time, to the limits dictated by the internal policies and the regulator. This article proposes the application of the numerical optimization technique to find out the target composition of the funding structure, in terms of the proportions in the total liability base of a bank. However, the same method can be applied to optimize the structure of the liquidity buffer and the minimization of the cost of carry the bank runs through holding those liquid assets.

Numerical Optimization Methods: General Concepts

Numerical methods are often required in finance to optimise the value of something when it depends on multiple inputs. As opposed to analytical optimisation which involves finding the maximum and minimum of a function by finding point at which the function derivatives are zero, numerical optimisation is used when the explicitly defined function to be optimised does not lend itself to the analytical techniques, or when the function is not explicitly defined (Parramore and Watsham 2010).

This section addresses the nonlinear optimization method known as the interior-point method which gets their name from the fact that the optimal solution is approached from the strict interior of the feasible region. This method is used by the Matlab optimization toolbox known as *fmincon* to find a minimum of a constrained nonlinear multivariable function.

Interior-point (or barrier) methods have proved to be successful for nonlinear optimization and, they are currently considered the most powerful algorithm for large—scale nonlinear programming. Barrier methods for nonlinear optimization were developed in the 1960s but fell out of favour for almost two decades. The success of interior—point methods for linear programming stimulated renewed interest in them for nonlinear case and by the late 1990s, a new generation of methods and software for nonlinear programming had emerged. The terms "interior-point methods" and "barrier methods "are now used interchangeably (Nocedal and Wright 2006).

The problem under consideration here can be described as follows:

$$\min_{x \in R^n} f(x) \tag{1a}$$

subject to:

$$c_i(x) = 0, i \in \varepsilon, \tag{1b}$$
$$c_i(x) \geq 0, i \in I. \tag{1c}$$

where $c(x)$ is a m-vector of nonlinear constraint functions with i-th component $c_i(x)$, $i = 1, \ldots, m$ and ε and I are nonintersecting index sets. It is assumed that f and c are twice—continuously differentiable.

Any point x satisfying the constraints above is called a feasible point, and the set of all such points is the feasible region.

In order to solve the optimization problem, the gradient of objective function f (x) denoted by $\nabla f(x)$ or $g(x)$, has to be determined along with the Hessian matrix of second partial derivatives of $f \nabla^2 f(x)$. The gradient and Hessian of *constrained functions* $c_i(x)$ are denoted by $\nabla c_i(x)$ and $\nabla^2 c_i(x)$ (Forsgren et al. 2002).

The logarithmic barrier function associated with (1) is defined as follows:

$$B(x, \mu) = f(x) - \mu \sum_{i=1}^{m} \log c_i(x). \tag{2}$$

Here μ is a small positive scalar, often called the barrier parameter. As μ converges to zero the minimum of $B(x, \mu)$ should coverage to a solution of (1).

The barrier function gradient is:

$$g_b = g - \mu \sum_{i=1}^{m} \frac{1}{c_i(x)} \nabla c_i(x). \tag{3}$$

where g is the gradient of the objective function $f(x)$ and ∇c_i is the gradient of c_i.

In addition to the original, known as “primal” variable x, the Lagrange multiplier inspired dual variable λ is introduced:

$$\lambda \in R^m$$

and

$$c_i(x)\lambda_i = \mu, \forall i = 1, \ldots, m. \tag{4}$$

In order to find the solution to the optimization problem it is necessary to satisfy the Karush–Kuhn–Tucker (KKT) optimality condition. KKT are first-order necessary conditions for a solution in nonlinear programming to be optimal, provided that some regularity conditions are satisfied. Allowing inequality constraints, the KKT approach to nonlinear programming generalizes the method of Lagrange multipliers, which allows only equality constraints. The system of equations and inequalities corresponding to the KKT conditions is usually not solved directly, except in the few special cases where a closed-form solution can be derived analytically. In general, many optimization algorithms can be interpreted as methods for numerically solving the KKT system of equations and inequalities.

This article is not meant to overview the KKT optimality conditions nor to provide the numerical solution to the inequality optimization problem. Instead, it aims to provide the reader with the high level overview of the technique used to solve the concrete optimization problem of minimization of cost of funds.

Optimization Process

The first step in the optimization process is to identify the initial structure of the banking book which will act as a “starting point” of building the optimization problem. It defines the position, in terms of the asset and liability structure, existing at the analysis date. In addition, certain assumptions related to the liquidity profile in terms of the roll-over of term deposits, current and savings accounts (CASA) balance volatility and rate sensitivity, amortization profile and prepayment rate of assets have been defined as the initial conditions of the model. Interestingly, the analysis of the initial structure of banks based in different geographical locations shows clear differences in the asset base and funding structure adopted by banks. For example, it appeared that the commercial banks based in Italy have preferences towards floating rate items. Personal loans and commercial loans products are usually indexed to interbank market benchmark such as Euribor. The reset frequency differs between 1M, 3M and 6M. From the funding base perspective, there is significant reliance on current accounts provided by commercial clients and it is mostly focused on transactional current accounts. The commercial banks fund also important part of their assets through senior debt issuance and short-term wholesale funding. Meanwhile the banks based in UK tend towards administered rate products which show high correlation to the Bank of England base rate (more than 80%). The floating rate products are predominantly linked to GBP Libor 3M. The retail banks are funded by retail current accounts and retail time deposits. The residual part of their funding structure consists of senior debt issuance. The short-term funding is mostly used for funding LAB and collateral funding.

The second step, in the optimization process, is to define the objective, constraints functions and the assumptions related to the banking book structure and behaviour such as profiling of items without deterministic maturity, roll—over of time deposits and prepayment rate. In addition, there are assumptions related to the amortization profile of assets and liabilities and their pricing (external rate to clients). The external rate to client is composed of the Funds Transfer Pricing (FTP) components (interest rate risk and liquidity risk component) and commercial spread to clients. The below section focus on the detailed description of the objective and constraints function applied in the optimization process.

The objective of the optimization model for the liability side is to minimize the funding costs of the bank. Therefore, the analysis needs to be performed over certain time horizon and predetermined banking book growth assumptions, for example, constant balance sheet scenario where there is a *like for like* renewal of assets and liabilities falling under maturity.

The objective function is multivariable equality function which describes the total cost of funding and where variables represents the proportions of different source of funding in the total liability structure. The model searches for the minimum value of this function subject to the predefined constraints.

Let us assume that w_A, $w_B \ldots w_j$ represent j—funding opportunities and w is the proportion this funding opportunity has in the total funding base. Moreover, c_A, $c_B, \ldots c_j$ represents the annual cost of funds for the corresponding funding opportunity. Then, over the time horizon of 6 months the minimization function can be written as follows:

$$\begin{aligned} total\_cost\ (w_A, w_B, w_{C,\ldots}\ w_j) = {} & w_A * total\_L * \sum_{i=1}^{6} c_{A_i}/12 \\ & + w_B * total\_L * \sum_{i=1}^{6} c_{B_i}/12 \\ & + w_C * total\_L * \sum_{i=1}^{6} c_{C_i}/12 + \ldots \\ & + w_j * total\_L * \sum_{i=1}^{6} c_{j_i}/12. \end{aligned} \tag{5}$$

In this particular example, the analysis is performed under the time horizon of 6 months ($i = 6$), applied to the funding base composed of j different funding opportunities (A, B, C, $\ldots j$) and the corresponding annual cost of funds for funding opportunity is denoted as $c_{A,}\ c_B\ c_{C,\ldots,}\ c_j$ for every observation period.

The constraint functions are constructed in such a way to reflect the risk appetite of banks in different jurisdictions for liquidity and interest rate risk. In addition, on the funding side, there is also constraint imposed on the funding concentration to avoid over-reliance on one source of funding.

It is proposed the bank's appetite for liquidity and funding risk is determined through:

- cumulative short-term liquidity ratio (known as *Survival Horizon*) which is set up over time horizon of 30 or 60 days and determines the adequacy of the liquidity buffer of the bank
- structural liquidity ratio which measures the extent of the maturity transformation run by the bank

The short-term liquidity risk is quantified through *Survival Horizon (SH)* metric that defines for how long, during an extreme but plausible liquidity stress the bank can survive before management actions are deployed. The goal of this metric is to ensure that the bank would have sufficient time to react and make decisions in stress which mobilise further liquidity creating actions to offset a significant stress. The Survival Horizon metric assesses the liquidity position under lasting 30 or 60 days stress conditions, constructed through definition of different assumptions of inflow and outflow for items on the balance sheet.

The structural limit shows the extent of the maturity transformation of the bank. It requires bank to maintain a stable funding profile in relation to the composition of their balance sheet and, consequently, to reduce funding risk over a longer time. The main objective of this metric is to ensure the bank is funding its activities with sufficiently stable sources of funding to mitigate the risk of future funding stress. The items without deterministic maturity are allocated to their respective time buckets according to the outcome of the behavioural analysis.

The bank's exposure to the interest rate risk can be measured through the *Net Interest Income (NII) sensitivity* (impact on Earnings or ΔNII) under predefined interest rates shift scenario, in this example, +/− 200bps parallel shift. There is an underlying assumption, embedded in the model, related to the constant balance sheet (there is no new business assumption) and spot risk free interest rate risk curve. The ΔNII +/− 200bps is calculated using the *Maturity Gap* approach where the impact on the interest margin resulting from the movements of the interest rates is calculated as a product between the changes in the interest rates and the difference between an interest rate risk sensitive asset and liabilities:

$$\Delta NII = \Delta i \times GAP = \Delta i \times (sensitive\ assets - sensitive\ liabilities). \tag{6}$$

Thus, the delta of interest margin is the function of two elements:

- interest rates movements Δi,
- difference between assets and liabilities *GAP*

The total gap under the gapping period of 6 months is obtained by the summation of the subsequent gaps weighted for the time factor. This time factor represents the time between the central value of the bucket and the end of the gapping period:

$$\Delta IM = \sum GAP\ x(T - t) \times \Delta i. \tag{7}$$

where:

T represents the length of the gapping period, t maturity related to the i-th time bucket, Δi—shock in the interest rates curve (Lubinska 2014).

Additionally, in the optimization process, there is also the concentration limit which encourages the diversification of funding portfolio and prevents an excessive concentration of funding sources.

Conclusion

The article provides an overview of the application of the optimization method to obtain the target structure of the funding base for commercial banks. It is proposed to calculate such a target structure using non-linear optimization solver in Matlab known as *fmincon*. The examined problem has been set up in form of nonlinear objective function which minimize the cost of funds. The problem represents nonlinear constrained optimization problem since minimization of objective function is subject to the banks appetite for the exposure to the interest rate risk (*NII sensitivity*), liquidity risk (short term and structural liquidity metrics) and concentration limit. The constraints functions are both equality and inequality functions. The article launches the hypothesis that it is possible to find the target structure of the banking book which provide the bank with the positive economic result[1] and, in the same time, ensure the respect of the internal limits for risks incurred by the bank. Moreover, it improves the management of the interest rate risk and liquidity risk as it has appeared, in the analysis, performed by the author in her research, that the model optimizes also the short-term liquidity metrics preventing the excess liquidity to be kept under the form of liquidity buffer, inefficient management of stable funding and NII volatility. For this reason, in author's view, it can be seen as an integrated management of those risks.

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Part V
Corporate Finance

Does It Pay off to Change the CEO? Changes in Operating Performance: Preliminary Results

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Abstract This study analysed operating performance associated with the CEO succession in companies listed on the Warsaw Stock Exchange. An event study based on accounting data was applied. Operating performance was calculated as median and mean ROA and EBITDA/TA ratios within 3 years after CEO appointments and compared to ratios' results in the same period before the event. Abnormal operating performance for the entire sample was negative and statistically significant. After the event the operating performance did not improve following new CEO appointments or re-appointments. Obtained results indicate that CEO appointments decrease the value of the company. Companies performed better for re-appointments compared to new CEO appointments. However in case of new CEOs we observed small improvement within the first 2 years after the succession.

Introduction

Despite general belief that the success of a specific undertaking is usually the result of the work of a number of people rather than one person, research proves that the quality of leadership has a significant impact on company results (Kaiser et al. 2008). Favaro et al. (2010) emphasize that in the twenty-first century newly appointed CEOs must make decisions more quickly than their previous generation counterparts, formulate aims and directions and make them credible with results. According to the data published by PwC in 2014, the CEO was changed in as many as 14.3% of 2500 largest companies in the world. Moreover an average CEO term was reduced from 8.1 to 6.3 years in the first decade of the twenty-first century (Favaro et al. 2010). This fact had far reaching consequences for the development prospects of the companies in question and, consequently, for their financial results and valuations.

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Regarding the finance theory (Fama and Miller 1972), a change in the CEO of a company can significantly affect the value of cash flows in the future and the combined going concern risk and consequently, the company value. When the CEO is appointed, he or she may improve the operating performance, increase the value of the company and generate benefits for shareholders but reverse effects will be more likely.

Most empirical studies have considered the market performance of CEO turnover and developed markets. In most of them, the turnover of employees in key positions had a positive impact on the shareholder reaction (Davidson et al. 1990; Elsaid et al. 2011; Fahlenbrach et al. 2010; Huang et al. 2008; Ishak and Latif 2013; Ismail and Manaf 2016; Jalal and Prezas 2012; Worrell et al. 1993). However, succession does not always have a positive effect (Dedman and Lin 2002; Warner et al. 1988; Nguyen and Nielsen 2010; Vafeas and Vlittis 2009; Erkens et al. 2014). We found only two studies conducted on the Warsaw Stock Exchange (WSE). Gurgul and Majdosz (2007) proved that shareholders reacted negatively to the resignation of a management board member. The second study was a preliminary event study of all CEO appointments (Byrka-Kita et al. 2017a). Authors observed a negative market reaction. Generally, the market performance evidence suggests that shareholders perceive management succession decisions as creating benefits in the future. Is the reality consistent with investors' expectations? Does management turnover improve future company performance?

The set of studies was based on accounting data, and investigated whether the impact of CEO appointments on operating performance, is poorer in comparison to the literature portfolio on market performance. Huson et al. (2004) proved that the managerial quality and expected firm operating performance increase after CEO turnover and firm financial performance tends to deteriorate prior to top management turnover. Denis and Denis (1995) reported that forced resignations of top managers are preceded by large and significant declines in operating performance and followed by large improvements in performance. Fahlenbrach et al. (2010) found evidence that CEOs do not affect the appointing firm's operating performance, decision-making, and CEO compensation, except for a decrease in operating performance following the appointment of an interlocked director. There have been no studies on CEO turnover and operating performance in the Polish capital market, or in other Central European markets.

We decided to explore the impact of CEO appointments on firm's performance in the Polish capital market. In our study we examined if the CEO succession in Polish companies quoted on the Warsaw Stock Exchange (WSE) in the period between 2001 and 2013 did lead to improvement in their operating performance. We also analysed the difference in operating performance between new CEO appointments and re-appointments. The research will fill the research gap regarding developing markets such as the Polish one. The results should significantly contribute to the literature on the empirical analysis of company value creation.

The paper is organized as follows. It starts with the introduction. Section "Literature Review and Hypotheses Development" reviews the literature and formulates research hypotheses. Section "Sample Selection and Data" describes the data and sample selection process. Section "Measures of Abnormal Operating Performance" discusses measures of abnormal operating performance. In Sect. "Results" empirical results are presented. Section "Conclusions" includes conclusions of obtained results and suggests further study directions.

Literature Review and Hypotheses Development

The succession of a key person was explained on the basis of several management theories including the scapegoat theory. In management scapegoating is a known practice where a lower staff employee is blamed for the mistakes of senior executives. In case of CEO turnover, the scapegoat hypothesis assumes that quality does not vary across managers. Poor performance arises from the chance alone rather than low managerial quality. In other words, poor performance results from bad luck, not bad management (Huson et al. 2004). Corporate supervisory board may replace managers of poorly performing firms even if the managers are not responsible for the poor performance (Khanna and Poulsen 1995). A fired manager can be viewed as a scapegoat and CEO turnover does not increase managerial quality and expected firm performance.

The improved management hypothesis is opposite to the scapegoat hypothesis. The assumption is that quality varies across managers. If performance is sufficiently poor, another manager is appointed whose expected quality exceeds that of his predecessor. Consequently, future performance is expected to increase following the change in management (Huson et al. 2004). The improved management hypothesis is consistent with the effectiveness of internal control mechanisms. If they are effective, there should be a higher frequency of top management changes in poorly performing firms and improvement in firm performance following management changes should be observed (Denis and Denis 1995).

Denis and Denis (1995) studied 721 management changes between 1985 and 1988. They examined changes in operating performance for the 7 years centred on the year of the management change for following subgroups: forced resignations (83), normal retirements (99), as well as a sub-sample of top executive changes (296) and non-top management changes (295). The mean and median, the unadjusted and industry-adjusted ratio of operating income before depreciation to total assets (OIBD/TA) were employed in the several observation windows. Authors found evidence that forced top management changes were preceded by large and significant operating performance declines. The change of a top-executive was followed by significant improvement in operating performance. Moreover they documented that these firms significantly downsized their operations following the management change; declines in employment, capital expenditures, and total assets were observed. In case of normal retirements significant changes in operating performance were not observed, but they were followed by small increases in operating income. Denis and Denis found the proof of effective internal control mechanisms.

Huson et al. (2004) studied mean and median changes in the operating return on assets (OROA) from 3 years before to 3 years after CEO succession for a sample of 1344 CEO successions at large public firms during the 1971–1994 period. Results for three performance measures were reported: unadjusted, industry-adjusted and control group-adjusted OROA for all turnovers and two subgroups of voluntary and forced turnovers. Authors proved that firm financial performance tends to deteriorate prior to top management turnover and the managerial quality and expected firm operating performance increase after CEO turnover. Their evidence favours the improved management hypothesis over the scapegoat hypothesis. Moreover, they examined determinants of firm performance. They observed that board composition, institutional shareholdings, takeover pressure, and outside successors of CEOs positively affect expected performance changes.

Fahlenbrach et al. (2010) explored operating performance surrounding 26,231 appointments from 5400 firms, where 1731 (6.6%) were CEO appointments between 1989 and 2002. The ROA measure was applied as the ratio of operating income before depreciation to lagged book value of assets. Performance before the appointment was calculated as the average over event years −2 and −3. Performance after the appointment was calculated as the average over event years +1 through +3. To control for industry and time effects the industry-adjusted ROA as well as size, performance, industry-adjusted ROA were analysed. Fahlenbrach et al. found evidence that CEOs do not affect the appointing firm's operating performance, decision-making, and CEO compensation, except for a decrease in operating performance following the appointment of an interlocked director. Observed results are contradictory to presented findings of Huson et al. (2004) and Denis and Denis (1995).

Summing up, the majority of empirical studies conducted on developed markets documented improvement in operating performance following top management changes. There have been no studies on CEO turnover consequences in operating performance in the Polish capital market or in other Central European markets. Two studies were based on market data and explored the market reaction to CEO resignation (Gurgul and Majdosz 2007) and to CEO appointments (Byrka-Kita et al. 2017a). In the present study we were searching for answers to the following questions:

- Is there an increase in operating performance following CEO appointments in the Polish capital market?
- Is operating performance the same for re-appointments and new appointments?

In contrast to the observed negative shareholder reaction on WSE but consistent with the evidence of previous studies the following research hypotheses were formulated:

H1 *Operating performance improves following CEO appointment in Polish public companies.*

H2 *Improvement in operating performance is higher following new appointments rather than re-appointments.*

H3 *Operating performance before CEO appointments is better for re-appointments than new appointments.*

Sample Selection and Data

The sample selection and verification procedure was divided into four stages. Within the first three CEO appointments were identified in companies whose shares were traded on the regulated public capital market in the period 2000–2015 on the Warsaw Stock Exchange.

First, we searched through newswires in GPWinfoStrefa and identified over 10,000 press releases in the period from January 2005 to December 2015. We rejected appointments in public companies operating in an unregulated market and those other than CEO appointments.

At the next stage of the selection process we identified appointments before 2005 based on resources of the Polish Financial Supervision Authority and commercial business services. We compared and added missing events generated from the Notoria On-Line Service.

At the third stage a detailed selection of CEO appointments was performed. We had to reject events which could not be verified because of lack of current reports (observations from the period 2000–2004). Moreover, we did not include to the sample temporary CEO appointments (e.g. acting CEO) or involved foreign companies because of a different standard of financial reporting. The number of observations in our base was reduced to 2033 events in the period from January 2000 to December 2015. The detailed selection procedure was described in the working paper published in conference proceedings (Byrka-Kita et al. 2017b).

At the last stage we had to take into account the methodological criteria of the event study based on accounting data. Regarding a general rule of companies' statutes we assumed that the general CEO term of office is 3 years. We include into the final sample those observations, where we were able to collect accounting data in all 3 years before and 3 years after the CEO appointment. Finally, sample consisted of 1057 appointments for ROA measures and 1021 appointments for EBITDA to Total Assets ratios and covered the period from January 2001 to December 2013. For the purpose of hypothesis verification new and re-appointments of CEO were identified. Accounting data for companies were obtained from the database of Notoria Service.

Measures of Abnormal Operating Performance

In the research the event studies that employ accounting-based measures of operating performance were conducted. These studies generally assess operating performance following major corporate events or decisions, such as dividend initiation, stock splits, mergers and acquisitions, management buyouts, or security offerings. Barber and Lyon (1996) summarized methodological issues of detecting an abnormal performance.

Based on literature review the two most frequently used measures of operating performance were applied. Return on Assets for company *i* in the year *t* was defined as ratio of net profit (loss) to book value of total assets (yearly average value). The second ratio was calculated as a relation of EBITDA[1] (Earnings Before Interests, Taxes, Depreciation and Amortization) to book value of total assets (yearly average value) for company *i* in the year *t*.

The essence of abnormal operating performance is similar to abnormal returns and event studies which employed market-based measures, it is a difference between the actual and expected operating performance. To assess whether a firm is performing unusually well or poorly, we must specify the performance we expect in the absence of an event, thus providing a benchmark against which sample firms can be compared. Barber and Lyon (1996) listed models of expected performance applied in earlier studies on operating performance following major corporate events or decisions:

1. Past performance-adjusted model;
2. Industry-adjusted model;
3. Past and industry-adjusted model.

In the present research past performance-adjusted model was selected, where the expected performance is simply a firm's own past performance (Barber and Lyon 1996).

$$AP_{it} = P_{it} - P_{i,t-1} \tag{1}$$

where:

AP_{it}—abnormal performance of company *i* in period *t* [+1,+3];

P_{it}—post event operating performance of company *i* in period *t* [+1,+3];

$P_{i,\ t-1}$—expected performance is pre-event operating performance of company *i* in period *t* [−3,−1].

The event year $t = 0$ was assumed to be the publication year of the report in which the company informed its shareholders about its decision on CEO appointment. The event year was excluded from the calculation. Regarding an assumption that the general CEO term of office is 3 years, the abnormal operating performance for company *i* (AP_{it}) was detected as a difference between mean/median of the *ROA* ratio or *EBITDA/TA* in the 3 year period [+1,+3] after CEO appointment and mean/median of *ROA* ratio or *EBITDA/TA* in the 3 year period [−3,−1] before the appointment. Mean and median values were used as an aggregate measure of abnormal operating performance of total sample and subsamples.

[1]There is no EBITDA category in Polish profit and loss statement standard. EBITDA was calculated as a sum of operating profit/loss and depreciation.

$$\Delta\widetilde{ROA}_i = \widetilde{ROA}_{i,[+1,+3]} - \widetilde{ROA}_{i,[-3,-1]} \parallel \Delta\overline{ROA}_i = \overline{ROA}_{i,[+1,+3]} - \overline{ROA}_{i,[-3,-1]} \quad (2)$$

$$\Delta EBIT\widetilde{DA}/TA_i = EBIT\widetilde{DA}/TA_{i,[+1,+3]} - EBIT\widetilde{DA}/TA_{i,[-3,-1]} \parallel \Delta\overline{EBITDA/TA}_i = \overline{EBITDA/TA}_{i,[+1,+3]} - \overline{EBITDA/TA}_{i,[-3,-1]} \quad (3)$$

To verify the statistical significance of results, in case of mean values a t-test was first performed. A normal distribution was checked using the Kolmogorov-Smirnov test, the Lilliefors test and the Shapiro-Wilk test. Due to the absence of compatibility of the abnormal performance for individual observations with normal distribution, the Wilcoxon signed-rank test was used in case of mean and median values. Finally, the Mann-Whitney U test was applied to check for significant differences between two subgroups: new-appointments and re-appointments.

Results

At the beginning we analysed the mean and median of the ROA ratio and the EBITDA/TA ratio in each of the 7 years centred on the year of the CEO appointment. Figure 1 illustrates mean and median ROA values for all CEO appointments, new appointments and re-appointments. Generally, the operating performance was lower for new CEO appointments as compared to re-appointments. Management re-appointments and changes are preceded by the decrease in performance. If the new CEO assumed the position small improvement within 1 or 2 years was noticeable. CEO re-appointments are followed by a small decrease in performance.

Similar results were obtained for a total sample and sub-groups within the EBITDA/TA ratio. Mean and median values of the EBITDA/TA ratio in each of the 7 years are presented in Fig. 2.

In the next step detailed operating performance changes were calculated. At this stage we included into the sample only those CEO appointments where we were able to compute the ROA and EBITDA/TA ratios in all 6 years, in each year of the windows [−3,−1] and [+1,+3].

Table 1 reports median and mean ROA over 6 years and includes abnormal operating performance (ΔROA) measured as the difference between mean/median value in the period after CEO appointments (+1,+3) and before CEO appointments. Additionally, differences in ROA results between two sub-samples were computed. We can observe a negative and statistical significant change of the ratio for the total sample as well as for subgroups of new and re-appointments. Results are statistically significant. There is no operating improvement after the event. We found no evidence supporting the H1 research hypothesis. Moreover, we did not find any

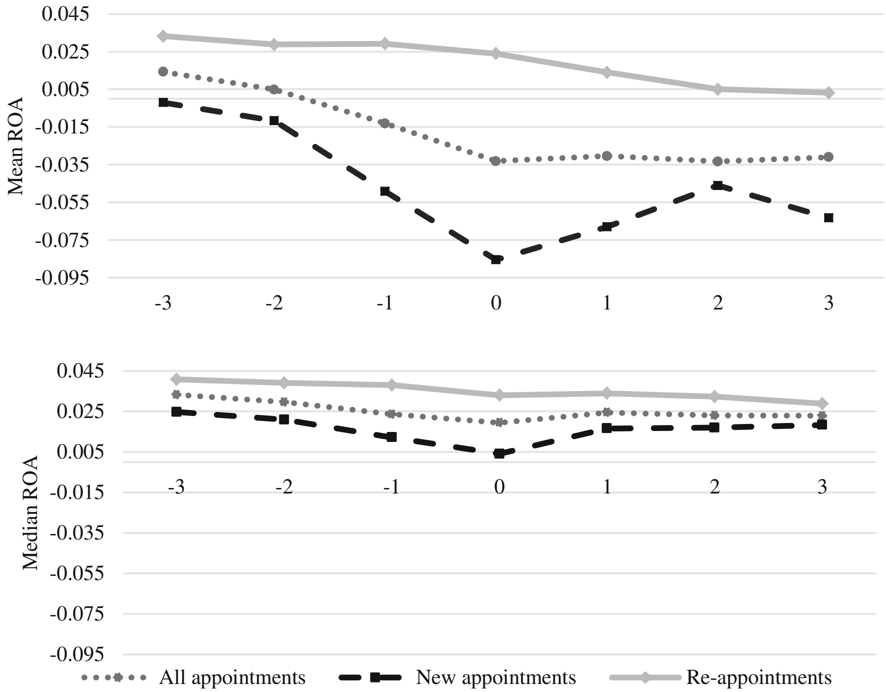

Fig 1 Mean and median Return on Assets (ROA) yearly in the period (−3,+3)

evidence supporting the H2 hypothesis that "Improvement in operating performance is higher following new appointments rather than re-appointments." The difference in change of median ROA between two sub-samples is positive, however these results are statistically insignificant. The H2 hypothesis has to be rejected. To verify the last hypothesis the difference in operating performance associated with re-appointments and new appointments was computed and tested. We can observe a statistically significant difference between operating performance for new and re-appointments before as well as after the event. Our findings support the H3 research hypothesis. Table 2 reports operating performance changes computed within the EBITDA/TA ratio. Results are similar to those obtained for ROA changes. There is one exception. A positive difference in operating performance changes between re-appointments and new appointments was observed. However, the result is statistically insignificant.

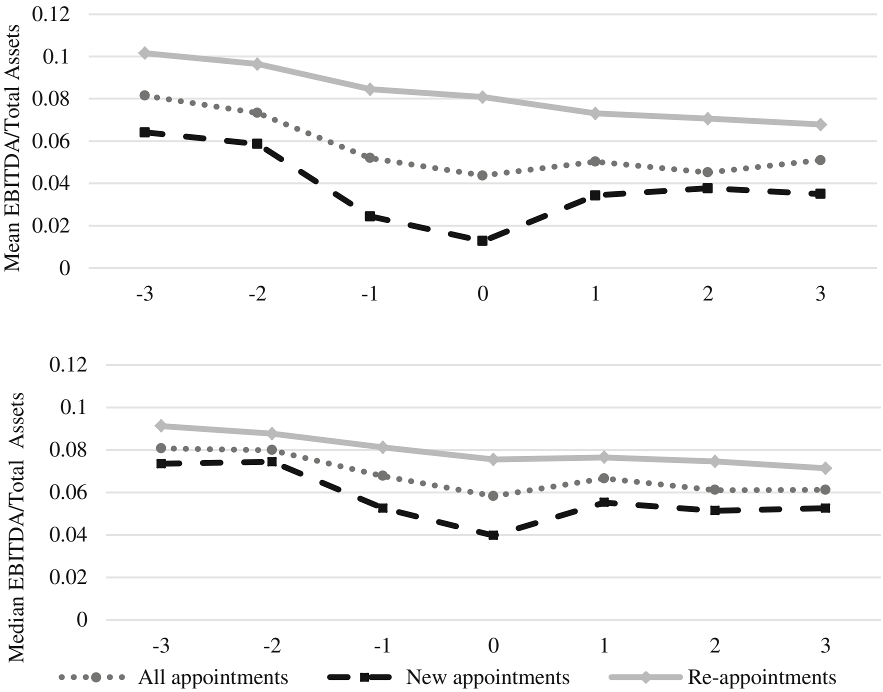

Fig 2 Mean and median EBITDA/TA ratio yearly in the period (−3,+3)

Conclusions

The paper presents preliminary results of research on operating performance following CEO appointments in the Polish capital market. The evidence of negative abnormal operating performance was obtained for the entire sample as well as for sub-groups of new CEO appointments and re-appointments. The results support the idea that decisions of the Supervisory Board to replace or reappoint a CEO are associated with the decreasing value of the company. Those findings are consistent with shareholders' negative reaction to CEO appointments observed by Byrka-Kita et al. (2017a) as an expression of the shareholders' doubts and concerns—will the company improve its financial results when the existing CEO is re-appointed or when a new CEO is appointed? The present study found evidence that shareholders' disapproval of the decision had a reasonable ground. Within 3 years after the event the operating performance did not improve following new CEO appointments and re-appointments. It was also taken into account that in certain situations firms can be motivated to overestimate or underestimate their reported earnings. For that reason accrual-based (ROA) and cash-based (EBITA/TA) performance measures were used. Results of both measures were similar.

The present observations are different than those presented by Huson et al. (2004) and Denis and Denis (1995) who all studied the U.S. market. Our evidence favours

Table 1 Change in Return on Assets ratio (ROA)

	All appointments		New appointments		Re-appointments		New (-) re-appointments[a]	
t/ROA	Median	Mean	Median	Mean	Median	Mean		
Sample	1057	1057	533	533	524	524	Median	Mean
t = −3	0.0387	0.0256	0.0292	0.0071	0.0465	0.0445	−0.0173	−0.0374
t = −2	0.0354	0.0166	0.0241	−0.0010	0.0472	0.0345	−0.0232	−0.0354
t = −1	0.0302	0.0034	0.0156	−0.0271	0.0428	0.0345	−0.0272	−0.0616
t = +1	0.0289	0.0041	0.0214	−0.0198	0.0368	0.0284	−0.0154	−0.0482
t = +2	0.0257	−0.0027	0.0192	−0.0143	0.0342	0.0090	−0.0150	−0.0233
t = +3	0.0245	−0.0307	0.0199	−0.0638	0.0288	0.0030	−0.0089	−0.0669
ROA [−3,−1][b]	0.0341***	0.0152***	0.0223***	−0.0070***	0.0440***	0.0378***	−0.0217***	−0.0448***
ROA [+1,+3][b]	0.0259***	−0.0098***	0.0202***	−0.0326	0.0328***	0.0135***	−0.0126***	−0.0461***
Δ ROA[b]	**−0.0082*****	**−0.0250*****	**−0.0021****	**−0.0256****	**−0.0112*****	**−0.0243*****	**0.0091**	**−0.0013**
Min Δ ROA	−1.9812	−1.7245	−0.9771	−1.4252	−1.9812	−1.7245		
Max Δ ROA	1.0423	1.0395	1.0423	1.0395	0.8746	0.8457		
Positive Δ ROA	441	462	234	245	207	217		
Percentage of positives	*41.72*	*43.71*	*43.90*	*45.97*	*39.50*	*41.41*		
Negative Δ ROA	616	595	299	288	317	307		
Percentage of negatives	*58.28*	*56.29*	*56.10*	*54.03*	*60.50*	*58.59*		

[a]The presented statistical significance of the difference between the means and medians was tested with the U Mann-Whitney two-sample test
[b]The presented statistical significance of results was tested using the Wilcoxon signed-rank test
Statistical significance at levels: *** $\alpha = 0.01$; ** $\alpha = 0.05$; * $\alpha = 0.1$

Table 2 Change in EBITDA/TA ratio

	All appointments		New appointments		Re-appointments		New (-) re-appointments[a]	
EBITDA/TA	Median	Mean	Median	Mean	Median	Mean		
Sample	1021	1021	511	511	510	510	Median	Mean
t = −3	0.0933	0.0951	0.0857	0.0789	0.1009	0.1113	−0.0152	−0.0324
t = −2	0.0884	0.0860	0.0806	0.0678	0.0990	0.1042	−0.0184	−0.0364
t = −1	0.0761	0.0642	0.0646	0.0368	0.0873	0.0916	−0.0227	−0.0547
t = +1	0.0715	0.0665	0.0620	0.0527	0.0809	0.0804	−0.0189	−0.0277
t = +2	0.0663	0.0613	0.0546	0.0456	0.0791	0.0771	−0.0245	−0.0315
t = +3	0.0652	0.0556	0.0557	0.0420	0.0727	0.0692	−0.0170	−0.0272
EBITDA/TA [−3,−1][b]	0.0843***	0.0818***	0.0764***	0.0612***	0.0941***	0.1024***	−0.0176***	−0.0412***
EBITDA/TA [+1,+3][b]	0.0664***	0.0611***	0.0571***	0.0467***	0.0761***	0.0756***	−0.0190***	−0.0288***
Δ EBITDA/TA[b]	**−0.0179*** **	**−0.0206*** **	**−0.0194*** **	**−0.0145*** **	**−0.0180*** **	**−0.0268**	**−0.0014**	**0.0124**
Min Δ EBITDA/TA	−0.7424	−0.7728	−0.5474	−0.5272	−0.7424	−0.7728		
Max Δ EBITDA/TA	0.7619	0.9759	0.7619	0.9759	0.7562	0.6371		
Positive Δ EBITDA/TA	396	409	209	222	187	187		
Percentage of positives	*38.79*	*40.06*	*40.90*	*43.44*	*36.67*	*36.67*		
Negative Δ EBITDA/TA	625	612	302	289	323	323		
Percentage of negatives	*61.21*	*59.94*	*59.10*	*56.56*	*63.33*	*63.33*		

[a]The presented statistical significance of the difference between the means and medians was tested with the U Mann-Whitney two-sample test
[b]The presented statistical significance of results was tested using the Wilcoxon signed-rank test
Statistical significance at levels: *** α = 0.01; ** α = 0.05; * α = 0.1

the scapegoat hypothesis over the improved management hypothesis. The differences can be attributed to the CEO's tenure and applied industry-adjusted performance measures. The CEO's term of office is frequently shorter than 3 years therefore a more precise sample selection procedure should be performed. Cases where the new CEO's tenure ended before the end of year +3 should be excluded. Moreover, operating performance measures should be adjusted by industry performance. There is a possibility that results will turn out to be different. Particularly, small improvement within 2 years following the replacement of a CEO was illustrated with in a graphic presentation of both performance measures.

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The Capitalistic Firm as a System that Produces Economic and Social Values

Patrizia Gazzola and Piero Mella

Abstract The aim of the paper is to analyse the capitalistic firm, not only as systems for the creation of economic and financial value for their shareholders, but also that is evaluated for the social values. The financial performance and the value of capital, is measured by a coherent system of monetary values. Nevertheless, if we do not limit our view to simply the shareholders but consider instead the stakeholders, we must then also broaden our notion of the production of sustainable value to include both the social and the environmental values. This implies an intense social action based on transparency, reputation and the dialogue with the stakeholders that need to be communicates. The sustainability report is the instrument to inform the stakeholders how the firm, by pursuing its own prevailing interests, contributes to improving the quality of life of the members of the society in which it operates and that can, in all respects, represent a means for the creation of sustainable value.

Introduction

Today's best companies are considered *Business Value-Creating Organizations* (BVCO) and they are achieving financial values but also the social ones. Few years ago, it was difficult to obtain information about the social involvement of an organization in the community because firms only communicate the financial values. Now there is a much greater opportunity for stakeholders to hear alternative views from independent published media and social media (De Bakker and Den Hond 2008). The informations are very fast thanks to the social network like: Facebook, Twiter, etc. In 24 h a news can go all the word. People react more strongly to negative than to positive information. There is also asymmetry in trust, unfavourable

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events decrease trust far more than favourable events increase. Even judgements about objects with good and bad characteristics are more heavily influenced by negative data. Corporate scandal can be considered as a set of questionable, unethical, and/or illegal actions that a person or persons within a corporation engage in (Colombo and Gazzola 2014). This often becomes a wide public incident event which may lead to a damage, disaster, or loss. A corporate scandal can make a business to lose millions of dollars, even to mitigate its impacts and correct what was wrong, or moreover, to advocate and dismiss actions against. The impacts that a scandal produce goes beyond a sales reduction; corporate campaigns can affect the stock market value exchange, social responsible investor will cut its investment in companies which are involved in practices considered as "unethical". The consequences could be different: firm's reputation is declining and all stakeholders will take action over irresponsible companies (Dentoni and Peterson 2011). We consider reputation like: the company's image or the image that they project in the society where it operates, the client perceptions, the way how employees lives their commitment and how they belong to them and how the company approach to cultural values. Current managers should realize the power that stakeholders have, especially the power of social networks, campaigns and boycotts (Gazzola and Colombo 2013). The paper is theoretical and adopts a system theory view. It establishes a review of the current literature by highlighting the centrality of values for the organizations.

The Business Value-creating Organizations

The capitalistic firm, as an autopoietic production, is a business and profit-oriented organization (Mella 2004), whose fitness resides in its capability, or efficiency (Beer 1981), to produce adequate levels of economic and financial values (Mella 2012). The capitalistic firm is:

1. A *productive* organization that transforms utility, since it carries out a *productive* transformation of factors (QF) into productions (QP);
2. A *business* organization, it is preordained to develop an economic transformation of values, by selling its production, QP, in markets at prices, pP, at least equal to the unit average cost of production, cP;
3. A *profit* organization: if the operating logic of the business organization is to achieve the maximum *economic efficiency* by seeking $\{[\max]\ (pP - cP) > 0\}$, distinguishing between unit variable (vc) and total fixed costs (FC), we can more accurately write: $\{[\max]\ [(pP - vc) - FC] > 0\}$, then it becomes a profit organization;
4. A *capitalistic enterprise,* if it carries out a *financial* transformation, in the sense that the firm finances its economic processes with external capital in the form of *Equity* [E] and *Debt* [D], forming the *Invested Capital* (IC = D + E);
5. An *economic social actor,* it interfaces and interacts with stakeholders, in an ethical and social environment, which influence the organization's structure and processes through a system of *corporate governance* (Freeman and Evan 1990).

The productive organization's autopoiesis (Bednarz 1988) is based on the *technical fitness,* that is the capability to: satisfy needs and aspirations and search for new needs and aspirations (Mella 2014); continually enlarge the variety of products in order to reach new consumers; improve the quality of production; increase the *productivity* of the processes in order to reduce the unitary factor requirements and the purchased volumes. The *profit* organization's autopoiesis depends on the ability to:

1. Create a dynamic portfolio of through an effective *entrepreneurial function;*
2. Achieve the maximum exploitation of the present market and expand toward new markets in order to increase its production volume, QP, and increase as much as possible the selling price, pP, through an efficient *marketing function;*
3. Contract the unit factor requirements while expanding the quality of products by means of an efficient *production function*, thereby increasing productivity;
4. Reduce the average factor costs through an efficient *supply function*.

The autopoiesis of the firm, considered as an *economic social actor*, depends on its capacity to earn the appreciation of the stakeholders (Ayuso et al. 2006) and to produce social shared value (Kramer and Porter 2011). The attainment of perceived levels of social performance produces reputation, brand and confidence, so that the environment itself sets the conditions for the firm's legitimation and consent (Cetindamar 2007), which favours autopoiesis. This implies the organizational ability to recognize the set of relevant stakeholders as well as to identify their expectations and the capability to communicate the global value produced in terms of social benefits and prevented damage to the environment (Kaptein and van Tulder 2003).

The System of Financial Performance

There are quite a number of financial performance indicators, but a limited number are sufficient to express the fitness of the capitalistic firm as a system for producing values. It can be summed up by the following balance sheet relation:

$$\begin{cases} L + IC = D + E & \text{[financial position]} \\ (CM + CL + CS) + (I + T + R) = RP & \text{[economic position]} \\ (CM + CL + CI) = cP \cdot QP & \text{[production cost]} \\ OR = RP - (CM + CL + CI) & \text{[economic production]} \\ OR - I - T = R = div + af & \text{[economic distribution]} \end{cases}$$

where L indicates liquidity, IC is the Invested Capital, D and E represent the financial capital in terms of Debts and Equity, (CM + CL + CI) indicates the Cost of factors (Materials, Manpower and Structure costs), I = (D·i%) represents the Interests payed on D, T denotes Taxes, R the net income, and div and af indicate the dividends and the self-financing provisions. The most concise performance indicator is the return on equity, ROE (the ratio between the net income R and the equity E in a period T). It expresses, in extremely concise form, the capacity of the firm to satisfactorily remunerate those who have invested equity in it, guaranteeing a return that is sufficient to maintain the capital's integrity, both in monetary terms (preserving its purchasing power), financial terms (financial return, interest, dividend and capital gains at least equal to that obtainable from investments with similar risk conditions), and real terms (capacity to renew investments at the end of their cycle) (Ruefli et al. 1999). ROE is a relevant measure of performance for shareholders and the most important performance indicator for the financial transformation is the return on investment, ROI (the ratio between the operating result OR and the invested capital IC in a period of time T). ROE depends directly on ROI by means of the well-known general law of returns (Modigliani and Miller 1958):

$$\text{ROE} = [\text{ROI} + (\text{spread DER})], \text{where spread} = \text{ROI} - \text{ROD}$$

ROI non only reveals the overall financial efficiency, but also represents the most concise measure of economic performance. This previous M-M relation clarifies how the firm's general financial performance, indicated by ROE, is a function both of economic efficiency, expressed by ROI, and the capacity of the firm to acquire a financial structure, expressed by DER, that permits it to take advantage of the financial leverage effect in the presence of a differential in returns indicated by the spread. From ROE derives other concise indicators of fitness that refer to the firm's ability to meet the expectations of investors: the Economic Value Added (EVA), the dividend on equity (DOE) and the economic value of the firm (EVF); we shall consider them in the next section.

Concise Financial Performance Measures: EVA, DOE and EVF

The capitalist firm bases its autopoiesis on its capacity to regenerate its financial and economic circuits. This implies that the suppliers of Debt and Equity financial capital receive a fair return, at least equal to their opportunity cost. If we let ROE^* stand for the *fair return* on equity capital expected by the investor which is needed to get him to invest his risk capital in the enterprise—that is, his financial opportunity cost, understood as the return that satisfies his expectations, considering the risk and return from alternative investments—then we can derive the minimum net operating results necessary to provide a satisfactory return on the equity capital E: $R^* = E \cdot ROE^*$.

If at the same time we let $ROD^* = i^*$ be the interest rate deemed fair by the investor which is necessary to induce him to invest his finance capital *D*, then we can calculate $IP^* = D \cdot i^*$, which represents the minimum net financial return necessary to satisfactorily compensate the finance capital D. The firm that requires a stable productive investment $CI = D + E$ must then be able to achieve an operating income

(OI) sufficient to provide a fair return on *D*, with an interest rate equal to I*, and on *E*, taking into account the income tax T*. Thus: OI $\geq$ I* + T* + R*.

In the case of an inequality the investment produces a value greater than the sum of the fair financial returns. This additional amount is the EVA, a performance indicator that includes *ROE* and expresses a concise overall fitness indicator of the agent-firm.

$$\mathrm{EVA} = \mathrm{OI} - \mathrm{I}^{*} - \mathrm{T}^{*} - \mathrm{R}^{*}$$

Economic fitness is an important component of *financial fitness* and the economic and financial performances are strictly related, we redefine EVA = IC·(*ROI* – *COI)*, in which *cost of invested capital* or *capital cost rate*: *CCR* = *COI*—or also the *weighted average capital cost* (*WACC*)—represents the *cost of investment*:

$$COI = \frac{ROD \cdot \mathrm{D} + ROE^{*} \cdot \mathrm{E}}{\mathrm{IC}} = ROD\frac{\mathrm{D}}{\mathrm{IC}} + ROE^{*}\frac{\mathrm{E}}{\mathrm{IC}} = WACC = CCR.$$

While *ROI* is the *return on investment*, *WACC* represents the part of this return that is needed to pay the interest on the Debt, at an average cost equal to *ROD*, as well as to guarantee the shareholders a proper return equal to their opportunity cost, *ROE**.

The spread (*ROI* – *COI*) thus takes on the meaning of *overall financial performance*, whose absolute value is instead represented by the EVA, taking into account the amount of IC. We define *COI* = *WACC* as the *ROI**, that is, the minimum return for IC that guarantees a *fair* interest and dividend return that would allow the firm to pay back its debts at a cost equal to the *ROD*, as well as guarantee a satisfactory return for the *equity holders* in the amount of *ROE**. Thus EVA is a performance indicator of both efficiency and outcome for the *capitalistic enterprise,* and it expresses the efficiency of the firm in achieving a $ROI > ROI^{*} = COI = WACC$.

Another *condition* for the existence of the *capitalistic firm* is that it succeed in producing a *ROI* such that $ROI > COI$, which, as we can also see from the equation of *COI*, also implies that $ROE > ROE^{*}$. Since the profit organization is preordained so that {[max] (pP – cP) > 0}, it also follows that EVA = [max].

In general shareholders, being holders of pure investment equity, compare their satisfaction not so much on the basis of the indications from *ROE* as on

$$DOE = \frac{R}{E}d = \frac{\mathrm{DIV}}{\mathrm{E}}$$

where *d* is the average dividend rate that would guarantee a self-financing adequate for the firm’s growth. A satisfactory return for the shareholders would require that $DOE > ROE^{*}$. However, since the self-financing obtained from retained profits reduces the periodic returns for the shareholders while also increasing equity, there is progress in the firm’s fitness, since it strengthens the financial structure of the firm and reduces the financial leverage with a potential increase in future earnings.

To consider the inverse relationship between *DOE* and *corporate growth* from net self-financing it is useful to determine the *EVF*, a concise indicator that reveals the firm's ability to maintain its equity financially integral and produce a value in terms of goodwill that, in the case of listed public companies, can translate into an increase in stock value. EVF is defined as the level of capital capable of producing a net result equal to that effectively achieved by the firm as a financial transformer, R, under the assumption that this capital was invested with a satisfactory return equal to ROE°, acceptable to shareholders. Since by definition EVF * $ROE^{\circ} = \text{R}$, and $\text{R} = ROE \cdot \text{E}$, with *ROE* equal to the effective financial return, through substitution we obtain:

$$EVF = \frac{ROE}{ROE^{\circ}} \text{E}$$

From the preceding relation we see that if $ROE > ROE^{\circ}$, then EVF > E, and vice-versa. If EVF = E, then the agent-firm maintains its risk capital financially integral at the end of the investment. If EVF > E, the agent-firm revalues E and the difference represents *goodwill*. If EVF < E, then E is devalued and badwill is produced (financial loss or negative goodwill). EVF quantifies the value of the firm, which is considered as an asset for the shareholders, and in its simplest form corresponds to the financial value of the capital that derives from the capitalization of the average standard profit, R, at a rate equal to the opportunity cost to the shareholders (ROE°). In general, though not necessarily, we set $ROE^{\circ} = ROE^{*}$, in the sense that the satisfactory return should correspond to that considered appropriate by the investor.

If EVA > 0, then EVF > E, with the difference representing the value of knowledge (human capital) as well as the value of goodwill (Mella and Demartini 2011). It is clear that the firm must manage its own business portfolio so as to provide a fair return to all the capital while also producing an EVA that maintains equity financially integral, thereby producing a goodwill that is proportionate to EVA:

$$\text{EVF} = \frac{\text{R}^{*} + \text{EVA}}{ROE^{*}} = \text{E} + \frac{\text{EVA}}{ROE^{*}} = \text{E} + \text{Goodwill}$$

From the preceding performance indicators it follows that the fitness of the firm is linked to its capacity to produce:

(a) A *ROE* which is not below the minimum or fair *ROE** necessary to satisfy shareholders, thereby creating value;
(b) A $ROI > ROI^{*} = COI$. If this *second condition* is met, then EVF > E, thereby achieving the financial integrity of the equity capital invested by the shareholders.

From the Financial Report to the Sustainability Report

The system of values achieved by the firm as a system of economic transformation is reflected in the financial report. The corporate balance allows for the calculation of a suitable system of economic and financial ratios as well as concise values (EVA and EVF) that translate the values produced into performance indicators in order to assess whether or not the economic-financial objectives of the business and profit organization have been achieved. These indicators allow the stakeholders to compare the numerical data with the initial objectives and with the organization's mission, highlighting the corporation's efficiency in developing its businesses with respect to its competitors within its particular market and environmental context. Thus firms should not be considered merely as systems for the production of value but also as economic social actors which operate in a social environment to which they belong and with which they interact, not only through a system of monetary and financial exchanges but also through physical, human and communication flows that produce knowledge, trust and reputation. Precisely due to the fact that the system of economic and financial values in the report derive only from monetary exchanges and reflect only the conditions of productive, economic and financial efficiency, the report that contains such values has three limits with regard to the information it conveys:

1. It is not able to express the conditions for long-term success that derive from the non-monetary ties to the social environment (Kim et al. 2012). All informations are fundamentals in evaluating the relationship between the firm and the macrosystem; however, it cannot be included in the corporate balance as understood in an accounting sense: as the representation of the system of values produced by the firm.
2. The traditional corporate balance cannot account for the ethical values and other intangibles which are fundamental to the success of the enterprise in creating economic values (Gazzola and Mella 2015).
3. The statement of produced values does not provide sufficient indications of the ability of the firm to expand in a way compatible with the environmental resources and the social values.

To evaluate the overall impact of the firm's activity, it is necessary to come up with another document that supplements the traditional corporate balance: the sustainability report (Kolk 2004), since its objective is to indicate the value created by investments in the social field and, more generally, the results of the firm's social and environmental policy.

Conclusion

The creation of social value for the firm is necessary to maintain an effective process for the creation of economic and financial values. A firm that focusses not only on the quality of the product but also on the safety of its employees, the social impact of its activities and the use of ethically-correct procedures is creating value (Schwartz and Carroll 2003) by gaining the trust of its workers, the market and its collectivity of reference. The social responsibility of the firm cannot be merely a fact of philanthropism or good intentions. We cannot separate the responsibility to earn profits from that of protecting the health of employees, their safety, and from protecting the surrounding social and environmental context (Carroll 1999). The sustainability report represents the instrument for monitoring, financial accounts preparation and communication regarding the responsible management approach to achieve a sustainable growth that respects the shared values of the context in which the firm operates. The sustainability report is thus a means for giving value to the firm, since it permits the firm to monitor and prepare the financial accounts for the process of responsible management between the firm and its interlocutors in order to increase its economic advantage and at the same time its social legitimization. The major limitation of the study is the lack of empirical research that we plan to develop in a future research.

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Corporate Cash Holdings and Tax Changes: Evidence from Some CEE Countries

Józefa Monika Gryko

Abstract The paper investigates determinants of corporate cash holdings in Central Eastern Europe (CEE) countries. In particular, it looks into the effect of tax changes and tax uncertainty on cash holdings in industrial listed companies from Bulgaria, Latvia, Lithuania, Poland, Romania, Slovak Republic and Slovenia. The sample contains 484 firms from those countries with data for the period 2008–2014. The main goal of the research was to find out how changes in tax rates and tax system influence corporate cash holdings. Beside determinants related to tax changes, the research included control variables indicated in literature as cash holdings determinants, such as: financial constraints, company's profitability, leverage, working capital strategy and economic environment uncertainty. The results show that cash holdings increases with growth in profit tax rate and decreases with growth in number of tax payments. Simplification of the tax system is accompanied by an increase in the level of cash holdings, however various effects of changes in particular factors were observed, such as cash holding decreases with growth in corporate income tax rate, but it increases with uncertainty measured by growth in numbers of hours required to prepare, file and pay taxes.

Introduction

The problem of shaping cash holdings in an enterprise is important due to the need to implement cash maintaining motives: transactions, precautionary and speculations—motive. However, maintaining cash is associated with costs. Reconciliation of the need to maintain liquidity with the need to minimize cash maintenance costs makes research on determinants of cash holdings important.

The literature is dominated by two views on the effect of excess cash to the value of the company. According to Myers and Majluf (1984), at least for some

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companies, maintaining financial slack is beneficial to the shareholders. Having cash holding allows the realization of investment opportunities. In turn, Jensen (1986) points to the lack of benefits associated with maintaining financial flexibility. With the ability to finance operations, managers are deprived of continuous capital market supervision, which can lead to increased business costs and the emergence of agent benefits at the expense of long-term business value.

Kim et al. (1998) examined the problem of optimizing liquid assets in the context of investment. As a starting point they adopted the explanation of the costs and benefits taken into account in managing the level of liquid assets. Investing in liquid assets is costly because companies abandon investment in other, less liquid but more profitable assets, bear the transaction costs associated with purchasing short-term securities and incur higher tax burdens compared to the situation when owners invest their capital in the same securities. In addition, some authors (Ang 1991; Ang et al. 2000) complement these possible costs with agency costs that arise in companies with very high levels of liquid assets. Despite these costs, companies must maintain liquid assets because of the demand for short-term business needs.

Empirical studies on the determinants of cash in the company were also conducted by Opler et al. (1999). Based on previous research (Vogel and Maddala 1967; Baskin 1987; Harford 1999) they presented the significance of transaction costs as a cash management indicator, taking into account the impact of information asymmetry and agency costs.

The issue of holding cash was also investigated by Baum et al. (2006). They focused on the issue of changes in the level of liquid assets in relation to the uncertainty surrounding the business environment. They have come to the conclusion that uncertainty and the associated volatility of macroeconomic conditions affect managers' decisions regarding liquid assets and distorts the efficiency of resource allocation. Increased uncertainty about the environment prevents managers from adapting to the specifics of the firm's prediction regarding important information such as expected cash flows, which forces more universal decisions on liquidity management.

The less frequently undertaken in the literature is the impact of tax factors on cash holdings. There are risks involved in the need to pay tax payments in the future when tax authorities contest tax settlements (Hanlon et al. 2017). There are some factors of increasing importance in tax risk management: gray areas in tax law, aggressive tax avoidance, and in multinational firms tax costs associated with repatriating foreign income (Foley et al. 2007). Jacob et al. (2014) argued that there is a trade-off between tax uncertainty and large capital investment in the context of cash holding motives.

Changes in Taxation and Cash Holdings: Hypothesis

The main aim of this article is to seek determinants connected with tax-based precautionary motive to hold cash. The level of complication of tax law and the attempts of tax optimization give rise to the risk of the size of tax payments. Maintaining surplus cash is an element of risk management dealing with uncertainty about future tax liability.

When analyzing the impact of the tax factor, two issues related to taxation should be identified. First, taxation serves the fiscal function, so the tax rate is important for the amount of money remaining in the enterprise. Assuming that taxation serves the fiscal function only, it should be expected that cash will increase with the fall in tax rates.

On the other hand, with regard to risk management, in countries with higher tax rates, the amount of tax paid is higher, hence the possible challenge of declarations by tax authorities leads to higher expected tax payments, adding penalties and interest. Since the value of the payments at risk is therefore higher, so it is reasonable to maintain a higher cash reserves for precautionary reasons. In such a situation in economies with a higher tax rate, the company will maintain a higher level of cash. Therefore, profit tax rate is an important determinant of cash holdings but the sign of the association between tax rate and cash holdings should not be predicted. Hence the following hypothesis has been adopted:

H1 *There is a negative/positive association between cash holdings and profit tax rate.*

The second issue is the uncertainty associated with the development of the tax system. The more complex the tax system, the greater the tax uncertainty. There is a greater risk of errors in tax settlements and issues of interpretation of tax rules. The risk of changes in the tax system should in turn lead to a higher level of cash holdings. Hence the following hypothesis has been adopted:

H2 *There is a positive association between cash holdings and tax uncertainty.*

Other control variables that, based on previous research, should influence the level of cash holdings, were also included in the study. This allowed for the realization of the secondary goal concerning the examination of the influence of other determinants on the level of corporate cash holdings. Those factors are: financial constraints, company's profitability, leverage, working capital strategy and economic environment uncertainty.

The smaller a company is, the more vulnerable it is to the negative effects of market inefficiencies, so it should maintain a higher level of liquid assets. Therefore, the negative relationship between cash holdings and financial constraints is expected.

In the light of the pecking order theory, the negative relationship between cash holdings and leverage should be expected, as if the level of investment exceeds the retained earnings then the level of debt increases. In the same situation, the level of cash decreases. At the same time, disciplining the role of debt should limit the ability of managers to accumulate free cash.

The negative relation of the net working capital ratio to the cash level is expected due to the company liquidity strategy and the ability to maintain liquidity reserves in other current assets than cash. The expected return on sales ratio relationship with cash holdings can be both positive and negative. On the one hand, profitable companies have more opportunities to accumulate liquid assets and, on the other, surplus cash holdings may allow managers to choose investment projects that are not necessarily in line with the criterion of maximizing the value of an enterprise.

Data and Methodology

The study was conducted on industrial listed companies from Central Eastern Europe (CEE) countries: Bulgaria, Latvia, Lithuania, Poland, Romania, Slovak Republic and Slovenia for the period 2008–2014.

The choice of publicly listed companies was due to the expectation that these companies perform tax optimization aimed to reduce the tax burden, employ tax directors, while their activities are often transnational in nature, which may allow a larger scale activities of aggressive tax reporting (Armstrong et al. 2012).

The study was based on data from financial statements of companies. The data came from the Amadeus database. Companies whose data did not allow for at least one observation separately in each of the sub-periods were excluded from the study. In addition, outliers (i.e. observations over three times the standard deviation) were also eliminated. Finally, an unassembled panel of 555 subjects was obtained, which provided about 2500 annual observations. In the course of research the missing observations were eliminated in pairs.

The dependent variable was the level of liquid cash and cash equivalents (cash), measured as the ratio of cash and cash equivalents to total assets.

Measurement of variables related to the tax system was based on the World Bank Group and Price Waterhouse Coopers reports. These reports allowed for the introduction of three tax system variables.

Total tax rate for profit tax (TTRCIT) is the amount of profit taxes borne by the business in the year of operation expressed as a share of commercial profit. Next is total tax time (TTT) measured as number of hours in the year needed to make payments comply to tax regulations. And last measure is total tax payments (TTP)—the number of tax payments made in a tax year.

Uncertainty associated with the formation of the tax system should be aligned with changes in tax systems. In the CEE countries, changes in both tax rates and the number of payments, methods and frequency of tax settlements occurred in the analyzed period. It is generally observed that it is becoming easier for business to pay taxes.

In Poland total tax rates was relatively stable, but there were changes in application of tax regulations. These changes were aimed at reducing uncertainty through the ability to request individual tax rulings and the popularization of electronic filing and payment systems. In Bulgaria and Romania, considerable reductions in total tax rates and also the introduction of electronic filing and payment of taxes can be observed.

Reports also allowed to observe the changes in the formation of a separate sub-indicators. Changes make it possible to determine the level of uncertainty associated with the tax system, thus annual changes in the level of indicators employed were used to measure tax uncertainty.

By comparing the highlighted sub-indicators, the Paying Taxes report assigns each country a place in the ranking. Changing the place in the ease of paying taxes ranking shows not only the change itself, but also its importance compared to changes in other countries.

Therefore, a variable that reflects changes in a place in the ranking (ΔRank) is adopted. Each year, the value of rank change in the ease of paying taxes ranking is determined for each country. The variable value was 0 if compared to the previous year, the position did not change; 1 if the country ranked higher than the previous year, which means a positive change (becoming easier for business to pay taxes) and −1 if the country was ranked lower than the previous year.

Similarly, for sub-indicators variables representing the annual change have been created as follows: change in total profit tax rate compared to previous year (ΔTTRCIT), change in number of payments compared to the previous year (ΔTTP), and for changes in the number of hours in the year needed to make tax obligations the variable (ΔTTT) has been standardized by calculating percentage change in the number of hours needed.

Additionally, control variables were adopted:

1. *Size*—enterprise size measured as natural logarithm of company assets. Size is identified with the level of financial constraints. The larger the company, the less its financial limitations. Assuming semi-strong market efficiency, investors watch the effects of managers' decisions over time and improve the valuation of the potential consequences of the company's decisions (DeAngelo and DeAngelo 2007). In this situation, it is easier to raise capital from the market and there is no need to keep cash to ensure financial freedom.
2. *ROS*—return on sales measured as operating profit (EBIT) to sales revenue.
3. *Lev*—enterprise debt level measured as the share of total liabilities in the assets of the enterprise.
4. *NWC_TA*—the level of other liquid assets financed with fixed capital measured as a share of working capital (excluding cash and cash equivalents) in fixed assets.
5. Δ*GDP*—Change in Gross Domestic Product at constant prices (data source: OECD). The variable used as the economic environment condition estimator. Real GDP growth is a signal of economic well-being and smaller uncertainty related to the environment, while a decrease in GDP means greater uncertainty as to future performance and economic conditions. Adopting GDP as a measure of volatility in the economic environment induce expectation of negative relationship between the level of cash and the change in GDP. The precaution motive would prompt companies to accumulate more cash during periods of economic downturn.

Results

First, Model 1 was built, which took into account the importance of the differentiation of rates, labor input and the number of payments per year in the countries studied. The least squares method was used for panel data, with the number of observations for a single company ranging from three to seven. The importance of tax factors for shaping cash holdings is shown in Table 1.

Analyzing the results it was observed that the level of cash increases with the increase in tax rates. It justifies the statement that tax uncertainty influences the

Table 1 Cross section time series regressions

	Model 1
Constant	0.1332[b]
Size	−0.0083[b]
ROS	0.0001[b]
Lev	−0.0889[b]
NWC_TA	−0.0167
PKB	−0.0004
TTCIT	0.3673[b]
TTT	0.0000
TTP	−0.0002[a]
Observations	2.582
R^2	0.127

Models were estimated using the least squares method for panel data with heteroscedasticity (HC1) correction with the Gretl software. Four hundred and eighty four cross-sectional units were included. Standard errors are corrected for heteroscedasticity
[a]Significant at 5% level
[b]Significant at 1% level

formation of cash holdings in an enterprise. Firms operating in countries with higher tax rates maintain more cash than in countries with lower rates. There was no effect of time spent on tax activities on the level of cash holdings, while the level of cash decreased with increasing amounts of tax payments per year. It should be assumed that an increase in the number of tax payments per year results in a smaller amount of individual payments, which in turn has the effect of lowering the value of the expected tax return, with penalties and interest, in the event of contestation of the tax authorities interpretation.

The next step was to assess how changes in the tax system affect the level of cash holdings. The results are shown in Table 2. In order to assess the impact of changes in taxation on cash holdings, two more models were built. In Model 2, only the change in the ease of payment of taxes was adopted as an explanatory variable. Model 3 includes variations in sub-indicators that made up for a collective change in rank.

Contrary to expectations, increasing the ease of paying taxes does not translate into a reduction in the amount of cash in an enterprise. On the contrary, as the ranking improves, the amount of cash increases. Explanations are suggested by analysis of variables in Model 3.

There are three sub-indicators influencing a place in the ranking. The fall in tax rates influences the improvement of the country’s position in the Paying taxes ranking. The fall in tax rates reduces the amount of tax payments in relation to the previous year, hence more cash remains at the disposal of the company. As a result, the decrease in tax rates led to an increase in cash holdings. In Model 3, the impact of total tax rate change on cash holdings is negative.

Another sub-indicator was associated with time required to prepare, fil and pay taxes. Total tax time reduction implies a decrease in tax uncertainty. This is a factor

Table 2 Cross section time series regressions

	Model 2	Model 3
Constant	0.1493[b]	0.1531[b]
Size	−0.0068[b]	−0.0069[b]
ROS	0.0001[b]	0.0001[b]
Lev	−0.0820[b]	−0.0826[b]
NWC_TA	−0.0171	−0.0170
ΔGDP	0.0018[b]	0.0021[b]
ΔRank	0.0039[b]	
ΔTTCIT		−0.1490[a]
ΔTTT		0.0428[a]
ΔTTP		0.0000
Observations	2.585	2.585
R^2	0.098	0.098

Models were estimated using the least squares method for panel data with heteroscedasticity (HC1) correction with the Gretl software. Four hundred and eighty four cross-sectional units were included

[a]Significant at 5% level

[b]Significant at 1% level

allowing to reduce the cash held for the precautionary motive. Hence in Model 3 relation of total tax time with cash holdings is positive.

Models also allowed to indicate other determinants of holding cash in the enterprise. As expected, larger, less financially constrained companies holds less cash. A negative relationship between size and cash holdings was found.

Positive relationship between profitability of sales and cash holdings was also found. Firms whose sales generated higher profits retained their portion in the form of cash.

The results of all models show that leverage is negatively related to cash holdings. So less indebted companies have larger spare debt capacity and have the ability to obtain debt, so they have less need to holding cash.

The relation of cash holding with net working capital level was negative, but not statistically significant. The impact of changes in the economic environment has not been clearly established.

Conclusion

The results of the study confirm that tax uncertainty affects cash holdings. The higher the tax rate, the more cash the company needs to provide both the transaction handling (transactional motive) and the tax risk hedge (cautionary motive). Reaction to the change in tax rate is due to the fiscal role of taxes—the increase in rates results in a decrease in cash and the decrease in the rates causes increase in cash available to the company.

Differences between countries in total tax time do not affect the level of cash. This is due to the function of adjusting to a specific tax environment. It is only the reduction of the time required to fulfill tax obligations results in decrease in cash held for precautionary reasons.

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Determinants of Capital Structure Across European Countries

Julia Koralun-Bereźnicka

Abstract The research aim is to verify whether and how the impact of primary determinants of capital structure varies across European countries. Several firm-specific factors, as well as industry features are taken into account in the international comparative analysis, which also captures the problem of debt maturity. The study is based on the BACH-ESD database provided by the European Commission and includes 11 EU countries during the period 2000–2014. The results of the panel data models estimated for different countries and for three debt measures indicate that the impact of direct determinants of debt varies considerably across countries and depending on debt maturity. The differences occur in terms of both significance and direction. The research findings confirm the prevalence of the industry effect over the size effect in the capital structure, although the difference between the relative importance of the two effects varies across countries. The results also indicate the greater appropriateness of the pecking order theory for long-term debt, whilst the trade-off predictions appear more suitable for explaining short-term financing decisions.

Introduction

The existing literature examining the corporate debt among European companies suggests that the key determinants of capital structure are not uniform. They vary across countries and maturities of debt instruments. The apparent contradictions between different studies aimed at verifying the significance of leverage determinants—revealed in the next section—make it purposeful to search for the reasons underlying the diverseness of the empirical findings. The contribution of this study to the existing literature is threefold. First, it provides new insights into the capital structure determinants by taking into account the country specifics not only as a

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factor directly affecting corporate financial policies, but also as an indirect factor. This indirect country impact means that the influence of the direct determinants of financing choices, such as profitability or asset structure, may differ across countries in terms of significance and direction. Secondly, the study verifies whether the impact of direct determinants of debt depends on debt maturity by considering three different debt measures. Finally, while the majority of previous research is based on the easily accessible public company data, this study covers private companies of three sizes: small, medium and large-sized firms.

Literature Review

The static trade-off theory of debt (TOT) by Modigliani and Miller (1958) and the pecking-order theory (POT) by Myers and Majluf (1984) are considered as the leading theories explaining corporate capital structure. Although both of them have been empirically verified on numerous occasions, the results do not provide a unanimous view neither on the direction nor the significance of even the most commonly explored determinants, such as interest tax shield and non-debt tax shield, assets structure, financial liquidity, firm growth, profitability, working capital, risk or firm size.

The POT predicts a positive relation between tax burden and debt, as higher tax rates indicate greater benefits from the interest tax shield. A number of studies, e.g. by Bancel and Mittoo (2004) confirm this relation, although an inverse regularity, reported by Abor and Biekpe (2005), is explained on the grounds of tax incentives for listed companies which may motivate IPOs. Therefore, an increase in the corporate income tax may lead to an equity increase.

Also non-debt tax shields are considered as a significant determinant of leverage. The negative relation predicted by TOT is based on the substitutability hypothesis, according to which companies using other (non-debt) tax shields have less need for the tax benefits of debt (Graham et al. 2004). However, a positive relation found e.g. by Leary and Roberts (2005) is explained by the fact that companies with non-debt tax shields usually have considerable assets that can be used as collateral for debt.

Both theories remain consistent in terms of the predicted sign between collateral and debt. Firms with more collateral have more possibilities of increasing debt, which indicates a positive relation reported e.g. by Frank and Goyal (2003) or Hernadi and Ormos (2012).

According to the TOT, higher liquidity increases debt availability due to lower bankruptcy costs. This, in turn indicates a positive relation with leverage, found e.g. by Anderson and Carverhill (2012). However, the POT assumes a negative relation explained on the grounds of the conflict of interests between debtholders and shareholders concerning the degree of liquidity: excessively liquid firms can raise less debt than less liquid firms (Udomsirikul et al. 2011).

Firm growth is also one of the factors whose impact on debt alters between the leading theories. According to the POT, firms with growth opportunities are more likely to use short-term debt in order to avoid the agency costs. Therefore, a positive relation is expected and reported e.g. by Abor and Biekpe (2005). However, from the TOT point of view, the agency cost problem is more troublesome for growing companies, due to the greater flexibility in the choice of future investments, which implies an inverse relationship between long-term debt and growth opportunities, found e.g. by Hall et al. (2004).

Profitability, which seems to have received particular attention from researchers interested in determinants of debt, also constitutes a source of discrepancies between the POT and TOT. According to the first one, firms generating high returns may have less debt, since internal financing is preferred. This indicates a negative relation reported by Hall et al. (2004). The TOT, however, provides arguments in favour of the positive relation. First, profitable companies should have higher leverage in order to compensate taxes. Second, market is reluctant to offer funds to unprofitable companies. The empirical support for the negative relation is provided e.g. by Frank and Goyal (2003).

Risk, measured e.g. by earnings volatility, constitutes another commonly verified determinant of debt. Surprisingly perhaps, both leading theories agree on the sign of the relation between risk and financial leverage. The negative relation stems from the fact that it is more difficult for investors to predict profits for companies with highly variable earnings. Therefore lenders expect a higher premium for the offered funds, which increases the cost of debt (Bancel and Mittoo 2004). Nevertheless, there are some empirical findings opposing this view, although with regard to short-term debt. The positive relationship between risk and short-term debt, found by Oppong-Boakye et al. (2013) is due to the rationing of credit: firms with limited opportunities in terms of long-term debt, turn to financing with short-term debt.

The factor which seems to raise slightly lower interest, though still noticeable in corporate finance literature, is the working capital. Its negative relation with debt predicted by POT results from the fact that companies with higher leverage tend to choose more aggressive working capital strategies in order to ensure the internal financing and avoid the issuance of debt and equity. Nazir and Afza (2009) provide an empirical confirmation of the relation.

The last firm-level determinant of capital structure considered in this study is the firm size, whose positive relation with debt expected by TOT is explained by the fact that large companies tend to have more diversified business, better reputation in the credit market and bear lower costs of obtaining information. Many empirical findings report such a relation, e.g. Frank and Goyal (2003), Kurshev and Strebulaev (2008).

Apart from the internal factors of leverage, firm financial decisions might be significantly affected by external conditions, such as the country-specific features or industrial specifics. The importance of country factors in terms of capital structure is a widely accepted view, which has been empirically recognised on multiple occasions, e.g. by (La Porta et al. 1997; Rajan and Zingales 1995; Booth et al. 2001; Claessens et al. 2001). The country specifics covers such factors as the level of economic development or industrialisation (Demirgüç-Kunt and Maksimovic 1999; Ariss 2016), institutional environment and international transactions (Graham and Harvey 2001; Bancel and Mittoo 2004; Brounen et al. 2006), the banking sector or stock and bond markets development (Fan et al. 2012), protection of creditors and law enforcement (Hall et al. 2004), the banking system orientation or the gross domestic product growth rate (De Jong et al. 2008). Moreover, it appears that the impact of country features on capital structure may be twofold. Apart from the direct influence of the country-related variables on debt, they may also affect corporate financing choices indirectly—by influencing firm-specific variables responsible for debt level (De Jong et al. 2008).

Another external factor considered in this study is the industrial specifics. Numerous previous researches provide evidence for the significance of the industrial classification in terms of debt (Harris and Raviv 1991; Stancic et al. 2017). The main industrial features responsible for leverage diversity in this cross-section include such variables as the assets flexibility (Shleifer and Vishny 1992), technological differences (Maksimovic and Zechner 1991) or industrial competition (Leibenstein 1966).

Taking into account the leading theories of capital structure as well as the previous findings reported in the literature, four main research hypotheses are put: (1) the aforementioned firm-specific variables, its country and industry impact capital structure significantly; (2) the significance and (or) the direction of the impact of firm characteristics and its industry on debt vary across countries; (3) the significance and (or) the direction of the impact of firm characteristics, its industry and country vary depending on the debt maturity; (4) the relative importance of the size effect and industry effect in capital structure depends on the country and on the debt maturity.

The verification of these hypotheses, based on a wide-ranged European data, would contribute to the existing knowledge in the field by exploring the potential indirect effects of the country specifics.

Data and Methodology

The source of the data is the BACH-ESD[1] database provided by the European Commission (Banque de France 2017). It gathers comparable information from corporate financial statements aggregated by country, industry and size for the following EU countries: Austria, Belgium, Czech Republic, France, Germany, Italy, Netherlands, Poland, Portugal, Slovakia and Spain. The empirical part of the study covers companies of three size groups: small (S), medium (M) and large (L) in the eleven countries and in fifteen industries according to the NACE classification[2] at the section level: A, B, C, D, E, F, G, H, J, L, N, P, Q, R, S. The analytical period ranges from 2000 to 2014. Data from more recent periods still contains major gaps which is why they were excluded from the analysis. The variables are ratios based on book values from yearly financial reports aggregated for all companies in each

[1]Bank for the Accounts of Companies Harmonised—European Sectoral references Database.

[2]Nomenclature Statistique des Activités économiques dans la Communauté Européenne.

Table 1 Construction of variables

Variables	Definition
Dependent variables	
Debt to assets ratio (D/A)	Total debt/total assets
Long-term debt to assets (LTD/A)	Non-current debt/total assets
Short-term debt to assets (STD/A)	Current debt/total assets
Explanatory variables	
Tax burden (TAX)	Tax on profit/EBT
Assets tangibility (TNG)	Tangible fixed assets/total assets
Liquidity (LIQ)	Cash and liquid assets at bank/total assets
Assets growth (GRT)	(Total assets$_t$ − total assets$_{t-1}$)/total assets$_{t-1}$
Return on equity (ROE)	Net profit or loss for the period/equity
Earnings variability (RSK)	(EAT$_t$ − EAT$_{t-1}$)/EAT$_{t-1}$
Depreciation (DPR)	Depreciation on fixed assets/net turnover
Working capital ratio (WCR)	Operating working capital/net turnover
Industry	A, B, C, D, E, F, G, H, J, L, N, P, Q, R, S
Country	AT, BE, CZ, DE, ES, FR, IT, NL, PL, PT, SK
Size	S, M, L

Notes: EBT—earnings before tax, EAT—earnings after taxes, industry symbols as in NACE

category of country, industry, size and year. The ratios employed as dependent and explanatory variables are defined in Table 1.

The four-dimensional structure of the data (countries, industries, size groups and years) indicates the use of panel data modelling to detect the hypothesized effects. The general formula of the panel data model employed in this study is defined by Formula (1),

$$\begin{aligned} D_{icst} = {} & \delta_0 + \delta_1 TAX_{icst} + \delta_2 TNG_{icst} + \delta_3 LIQ_{icst} \\ & + \delta_4 ROE_{icst} + \delta_5 DPR_{icst} + \delta_6 WCR_{icst} + \delta_7 GRW_{icst} \\ & + \delta_8 RSK_{icst} + \sum_{c=1}^{11} \alpha_c D\_ct_c + \sum_{i=1}^{16} \beta_i D\_ind_i + \sum_{t=1}^{15} \gamma_t D\_yr_t \\ & + \sum_{s=1}^{3} \lambda_s D\_size_s + \varepsilon_{icst}, \quad c = 1, \ldots 11,\ i = 1, \ldots, 16,\ s = 1,2,3,\ t = 1, \ldots, 15 \end{aligned} \tag{1}$$

where: D_{icst} is one of the three debt measures listed in Table 1, δ, α, β and γ are structural parameters reflecting the impact of each variable or effect on the dependent variable and ε_{icst} is the random error. The variables defined as *D_ct* represent 11 dummy variables for countries, *D_ind* correspond to 16 dummy variables for industries, *D_size*—to 3 size groups, whereas *D_yr* is a set of 15 year dummies. The model resembles the fixed effects model defined by Baltagi (2008). For the majority of the estimated models the use of the Hausman specification test indicates the suitability of the fixed effects model. In order to compare the relevant importance of the effects of country, size and industry, the Akaike's information criteria (AIC) is applied. The model is estimated separately for each of the three debt measures and for each country, as well as for all countries in total, although the country dummies are only included where applicable, i.e. in the latter model.

Results

The estimation results for the panel regression models explaining the variability of the three debt measures for all countries are shown in Table 2. The model is also estimated separately for each of the eleven countries—in each case for the same three debt measures. For the reasons of conciseness, the detailed results are not reported here, although the conclusions section captures these findings. When comparing the impact of the firm-specific variables on debt, it should be noticed that it varies significantly depending on the debt measure. Surprisingly perhaps, the parameters reflecting the explanatory power appear quite weak especially in the model for D/A. The differences in significance and sign of explanatory variables related to the debt maturity indicate that the factors affecting financing decisions vary between long-term debt and short-term debt.

In the models estimated for individual countries separately the R^2 values vary from 0.40 for the model explaining D/A in Austria to as much as 0.89 for STD/A in Germany. The average R^2 for all countries equals 0.64. The joint significance test for size indicates relatively weak impact of the size dummy variables on capital structure, as opposed to the country effect as well as the industry effect, both of which prove significant in all three models. The values of the AIC for the models explaining D/A are displayed in Table 3.

Every time the omission of an effect increases the AIC value. Omitting the size dummy variables has the weakest effect on the AIC, suggesting that the size effect is of the lowest relevance within the analysed sample. Similar regularities are observed for the other two debt measures, i.e. LTD/A and STD/A. It appears however, that when either of the two other effects is omitted, the decrease of the explanatory power is much more considerable. In the model for all countries, the order of effects according to their importance is as follows: the country effect, the industry effect and finally the size effect. When the total debt measure is analysed separately across countries, in every case these are the industry features which matter more than the size-related specifics. The only exception from this rule found within the examined population is the case of the long-term debt ratio in Austria. The omission of the industry effect in this case is less important for the model than omitting the size effect. It is also worth noticing that the differences between the importance of the industry and size effect are more significant for bigger countries, such as France, Germany, Italy or Spain, than in the remaining, smaller countries. It suggests that although the priority of factors is very similar across countries, the country features still affect the relative importance of the effects in question. It might indicate that the industrial specifics is more pronounced in the aforementioned large and developed countries than the size-related differences in corporate financing in comparison to the relative significance of these effects in smaller and (or) less-developed countries.

Table 2 Estimation results of panel regressions for all countries

	Total debt (D/A)		Long-term debt (LTD/A)		Short-term debt (STD/A)	
Variable	Estimate	Std. error	Estimate	Std. error	Estimate	Std. error
Const.	0.653***	0.011	0.116***	0.009	0.251***	0.009
TAX	0.000**	0.000	−0.001***	0.000	0.000	0.000
TNG	−0.062***	0.013	0.133***	0.011	−0.171***	0.011
LIQ	−0.023	0.045	−0.344***	0.038	0.035	0.036
GRT	−0.009***	0.002	−0.001	0.002	−0.007***	0.002
RSK	0.000***	0.000	0.000	0.000	0.000**	0.000
ROE	0.012**	0.006	0.009*	0.005	0.005	0.005
DPR	0.356***	0.047	0.578***	0.039	−0.324***	0.037
WCR	0.004	0.008	0.003	0.006	−0.006	0.006
S[a]	0.005	0.004	0.025***	0.003	0.015***	0.003
L	0.003	0.004	−0.012***	0.003	−0.021***	0.003
BE	−0.110***	0.007	0.085***	0.005	0.092***	0.005
CZ	−0.164***	0.008				
DE	−0.015**	0.006	0.049***	0.005	0.117***	0.005
ES	−0.104***	0.006	0.082***	0.005	0.113***	0.005
FR	−0.017***	0.006	0.143***	0.005	0.109***	0.005
IT	0.018***	0.007	0.035***	0.005	0.242***	0.005
NL	−0.082***	0.009	0.132***	0.007	0.059***	0.007
PL	−0.184***	0.007	0.001	0.006	0.059***	0.006
PT	0.008	0.007	0.109***	0.005	0.174***	0.005
SK	−0.058***	0.008	−0.017***	0.007	0.207***	0.006
B	−0.068***	0.008	−0.102***	0.007	−0.033***	0.006
C	−0.022***	0.007	−0.056***	0.006	0.026***	0.006
D	−0.016**	0.007	−0.002	0.006	−0.065***	0.006
E	−0.006	0.007	−0.040***	0.006	−0.038***	0.006
F	0.103***	0.008	−0.029***	0.006	0.112***	0.006
G	0.045***	0.008	−0.058***	0.006	0.112***	0.006
H	0.029***	0.007	−0.010*	0.006	0.002	0.005
J	−0.017**	0.008	−0.051***	0.007	−0.008	0.006
L	−0.022***	0.009	0.027***	0.007	−0.058***	0.007
N	0.107***	0.007	−0.002	0.006	0.084***	0.006
P	−0.006	0.010	−0.048***	0.008	−0.019**	0.008
Q	−0.019**	0.008	0.003	0.006	−0.037***	0.006
R	0.026***	0.008	−0.025***	0.006	0.015**	0.006
S[b]	0.029***	0.008	−0.052***	0.007	0.028***	0.006
2001	0.059***	0.009	−0.039***	0.007	0.081***	0.007
2002	0.054***	0.008	−0.040***	0.007	0.083***	0.006
2003	0.040***	0.008	−0.044***	0.007	0.070***	0.006
2004	0.034***	0.008	−0.035***	0.007	0.059***	0.006
2005	0.030***	0.008	−0.034***	0.007	0.053***	0.006
2006	0.027***	0.008	−0.028***	0.007	0.044***	0.006

(continued)

Table 2 (continued)

Variable	Total debt (D/A)		Long-term debt (LTD/A)		Short-term debt (STD/A)	
	Estimate	Std. error	Estimate	Std. error	Estimate	Std. error
2007	0.028***	0.008	−0.023***	0.006	0.045***	0.006
2008	0.026***	0.008	−0.023***	0.006	0.040***	0.006
2009	0.021***	0.007	−0.015**	0.006	0.029***	0.006
2010	0.023***	0.007	−0.006	0.006	0.026***	0.006
2011	0.023***	0.007	−0.003	0.006	0.021***	0.006
2012	0.021***	0.007	−0.002	0.006	0.021***	0.006
2013	0.015**	0.007	−0.002	0.006	0.015***	0.006
No. obs.	5033		4804		4804	
R^2	0.394		0.509		0.680	
Adj. R^2	0.388		0.504		0.677	
Hausman test	48.47 [0.001]		58.92 [0.000]		54.42 [0.000]	
Joint significance						
Size	1.350 [0.177]		2.514 [0.012]		−1.351 [0.177]	
Country	−15.061 [0.000]		17.999 [0.000]		35.846 [0.000]	
Industry	2.409 [0.016]		−8.062 [0.000]		2.275 [0.023]	

[a]Size dummy variable (small firms)
[b]Industry dummy variable (section S according to NACE: Other services activities)
*—significant at the 10% level, **—5%, ***—1%

Table 3 Values of Akaike's Information Criterion for models explaining D/A

Country	Omitted effect			
	None[a]	Country[b]	Industry[c]	Size[d]
All countries	−8455.0	−6962.6	−7668.5	−8456.7
AT	−1438.2		−1279.2	−1342.6
BE	−989.0		−814.7	−954.4
CZ	−388.8		−330.6	−380.9
DE	−1743.2		−1249.4	−1710.3
ES	−1289.1		−1053.0	−1232.6
FR	−1908.0		−1365.5	−1910.1
IT	−1796.5		−1411.2	−1770.2
NL	−263.0		−215.5	−258.2
PL	−755.5		−572.3	−732.5
PT	−816.0		−643.0	−807.7
SK	−501.2		−391.1	−428.0

[a]All effects included (size, country, industry)
[b]Size and industry effect included, country effect omitted where relevant, that is only in the model for all countries
[c]Size and country effect included
[d]Country and industry effect included

Conclusions

The research findings provide support for the significance of several firm-level determinants of debt, as well as for the relevance of the effects of country and industry in capital structure, as stated in the research hypothesis (1). However, both the significance and the direction of their influence on debt vary across countries as well as depending on the debt maturity. This variability indicates the likely truthfulness of the hypotheses (2) and (3).

When it comes to the cross-sectional comparisons of the determinants of debt, it appears that they vary slightly more depending on which debt measure is taken into account than across countries. These conclusions are in agreement with those obtained by Bevan and Danbolt (2002) or more recently by Degryse et al. (2012), who also report differences between the significance of variables related to debt maturity.

As for the total debt ratio, companies in more countries seem to follow the POT predictions on debt. This is the case for Austria, Spain, France, Italy, Poland, Portugal and Slovakia. However more support for TOT is found in Belgium, Germany and the Netherlands. This seems to prove that despite the fact that the analysis covers EU member states, the country related differences in capital structure remain considerable.

The country effect, however, is less evident when taking into account other debt measures. On the one hand, it appears that the factors affecting long term debt bear more resemblance across countries, in general providing support for the POT predictions on debt. On the other hand, the TOT expectations appear more suitable for short-term debt across the majority of the analysed countries.

Referring to the prioritisation of the size and industry effects across countries and across debt measures, mentioned in hypothesis (4), it can be concluded that the prevalence of the industry effect over the size effect in capital structure can be recognised as a general rule with only few exceptions.

Overall, this study strengthens the importance of the country effect in capital structure. It also contributes additional evidence that suggests the country specificity is not only a direct determinant of corporate financing choices, but also that it affects the way other primary determinants influence leverage. Therefore, the research provides a framework for the exploration of the indirect impact of country on corporate finance. The main limitation of the study is the data aggregation. On the one hand, this aggregation ensures the cross-sectional comparability, but on the other hand, the resulting loss of firm-level information may also be considered as an important weakness of the database. It would also be reasonable if the results were updated, which, however, is conditioned by the delays in data release calendar.

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Profitability of Serial Acquirers on the Polish Capital Market

Andrzej Rutkowski

Abstract The research presented in the article aims to identify the effect of serial acquisitions on the financial management of purchasing companies. The research covered a total of 405 Warsaw Stock Exchange (WSE)-listed companies which were not financial institutions. The study group, i.e. the group of serial acquirers, comprised 93 companies which in the study period undertook four or more acquisitions. They accounted for 76% of the total number of transactions. The control group was made up of the remaining companies. The financial results of these two groups of companies were observed for the years 2002–2015. Rates of return on equity, return on assets, and capital market ratios, such as MV/BV and PE, were analysed for both groups, as were their asset growth rates and sales growth rates. The proposed hypotheses were tested by a two-sample *t*-test with unequal variances. The research conducted on the WSE shows that serial acquirers have a lower return on equity (ROE) and a lower return on total assets (ROA). The serial acquirers more quickly increase their assets and achieve a higher sales growth rate than the remaining companies. The capital market values their prospective achievable yield higher, thanks in part to their newly-acquired assets (MV/BV).

The Essence of Serial Acquisitions

Mergers and acquisitions in developed markets have been the subject of much research. Serial acquisitions have met with relatively less research interest. By analysing the results of empirical research, several theories can be identified explaining the behaviour of serial acquirers and the shape of their rates of return from successive transactions:

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- The principle of diminishing returns—each of a purchaser's successive undertakings provides a lower rate of return. This results from the fact that the purchaser will choose to engage first in the undertaking that has the highest rate of return (Schipper and Thompson 1983; Ismail 2008).
- The hubris hypothesis, or overconfidence hypothesis—success in past transactions convinces the purchaser that subsequent transactions will ensure higher rates of return (Roll 1986; Billett and Qian 2008; Doukas and Petmezas 2007; Malmendier and Tate 2008; Rahahleh and Wei 2012; Ferris et al. 2013; de Bodt et al. 2016).
- The theory of discounting past information (the capitalisation hypothesis). According to this concept, the market analyses specific operations of the serial acquirer in relation to its subsequent acquisitions. In evaluating the first undertaking, it considers the consequences of subsequent transactions. Acquisition is part of a general plan (Macias et al. 2016).
- The learning hypothesis—the rate of return from subsequent acquisitions should be ever higher, as the business entity is able to carry out transactions with ever-increasing knowledgeability. Experienced managers are able to reduce the risks associated with this complex transaction (Laamanen and Keil 2008; Aktas et al. 2013; Ismail and Abdallah 2013; Zollo et al. 2013).
- The indigestion hypothesis—this explains the occurrence of ever-lower rates of return from successive transactions, despite initial successes. This results from further acquisitions reducing the manageability of the new, larger organisation, which now contains new entities (Conn et al. 2004; Kengelbach et al. 2012).
- The empire-building hypothesis—this derives from management's determination to achieve growth and take control of assets, which increases the company's assets to a non-optimal level (Mueller 1969; Rhoades 1983; Karolyi et al. 2015).

These theories attempt to clarify the following issues:

- the mechanism for making decisions on acquisitions and for shaping the behaviours of the purchaser's management,
- the place of mergers and acquisitions in business strategies,
- the shaping of rates of return from successive acquisitions,
- the relationship between the rates of return from successive acquisitions,
- the essence of potential conflicts between different stakeholder groups.

Selected Studies on Serial Acquisitions Around the World

Some of the first research into serial acquisitions was conducted by Schipper and Thompson (1983). They pointed out that the first transaction in the series usually led to a positive rate of return, while subsequent ones yielded lower and lower rates of return. This is supported by the theory of diminishing returns and the discounting effect. The authors emphasise that it is difficult to identify the reaction of the market to the announcement of one transaction when it is part of a programme which includes many acquisitions.

Fuller et al. (2002) noted that the acquirers generally achieved rates of return which were positive in acquisitions of non-public companies and negative in acquisitions of public companies. The rate of return falls after the fifth and subsequent takeovers.

Malmendier and Tate (2008) investigated the phenomenon of over-confidence based on an analysis of press articles. They argued that manager over-confidence is not a decisive factor in the undertaking of subsequent ventures. However, management makes acquisitions that are likely to provide a lower rate of return and less synergy. These actions lead to a decrease in the value of companies.

In their research, Aktas et al. (2009) observed decreases in cumulative abnormal return (CAR) in the implementation of acquisition programmes. They argue that rates of return are influenced by factors such as a fall in investment opportunities, budgetary constraints or increased competition.

Research by Kengelbach et al. (2012) shows that acquirer profits do not depend on the number of acquisitions but the specifics of the transaction. This is consistent with the specialised learning hypothesis. They state that the longer the interval between successive transactions and the smaller the transaction relative to the size of the purchaser, the greater the benefits. The results of the study also support the "indigestion hypothesis".

In practice, it is difficult to unambiguously compare the results of the empirical research presented above. This is due in part to the authors' different approaches to identifying a purchaser as a serial acquirer, to how the control group is treated, to identifying the moment from which a purchaser is recognised as a serial acquirer, and to the importance of the enterprise in its environment, as well as their use of differing metrics for assessing acquisition results.

Research on Serial Acquirers Listed on WSE

The research presented in the article aims to identify the effect of serial acquisitions on the financial management of purchasing companies. According to the assumptions, the research attempted to answer the following questions:

- Do serial acquirers achieve higher rates of return on equity for their owners (ROE) than other companies?
- Do serial acquirers achieve a higher return on total assets (ROA), and provide higher rates of rates of return for all their stakeholders than other companies?
- How are serial acquirers perceived by the capital market (MV/BV, PE)? Are their shares valued higher than the shares of other companies?
- Do serial acquirers have higher growth rates in their assets (resources) and sales revenues (market position)?

Study Sample The research presented in this paper was conducted on companies listed on the WSE which were neither financial institutions nor investment funds or financial services. This was to ensure the comparability of data from financial statements. Companies assessed by capital market analysts as having a highly non-transparent ownership structure were removed from the wider initial study group. In addition, developers and media companies were excluded from the study group. This was due to a large number of outliers among their ratio values. In the end, the entire study sample consisted of 405 relatively homogeneous companies.

For the purposes of analysis, the study group was divided into two sub-groups: serial acquirers and non-serial acquirers (others). Serial acquirers were defined as companies which had made four or more acquisitions in the study period 2002–2015. The other companies, which made from zero to three acquisitions, were included in the control group (non-serial, others). The study group, i.e. the group of serial acquirers, comprised 93 companies. They accounted for 76% of the total number of transactions. The control group comprised 308 companies.

Methodology The study used eleven ratios calculated from the consolidated financial statements prepared at the end of successive years and the share valuations of the companies at the end of the same periods:

1. The *accounting* return on equity (ROE_BV), being the ratio of net profit to book value of equity at the end of the year. This ratio is a measure of the owner's value creation. Its size reflects the company's financial results. Due to the occurrence of significantly large outliers in terms of the ratio of derivatives to net profit, the lower yield limit was set to −200%. This limitation on variability relates to ratios 1, 2, 3, 4 and 5.
2. The *investment accounting* return on equity (ROE_BV_lag), being the ratio of net profit to book value of equity at the beginning of the year.
3. The *market* return on equity (ROE_MV), being the ratio of net profit to the market value of equity at the end of the year.
4. The *market investment* return on equity (ROE_MV_lag), being the ratio of net profit to the market value of equity at the beginning of the year.
5. The *accounting* return on assets (ROA), being the ratio of net profit to book value of total assets at the end of the year.
6. The *operating* return on assets (ROA_EBIT), being the ratio of operating profit (EBIT) to book value of total assets at the end of the year.
7. The *investment operating* return on assets (ROA_EBIT_lag), being the ratio of operating profit (EBIT) to book value of total assets at the beginning of the year.
8. The MV/BV ratio, being the ratio of the market value of equity (the company's capitalisation) to the book value of equity.
9. The Price/Earnings (PE) ratio, being the ratio of stock price to earnings per share.
10. The sales growth rate (gS) index, which determines the average annual growth rate of sales. Due to the occurrence of significantly large outliers in terms of this ratio as a result of the bankruptcy of some companies, the lower sales growth rate limit was set to −80%.

11. The assets growth rate (gA) index, which determines the average annual growth rate of book value of total assets.

Using these eleven ratios, eleven null hypotheses were proposed which relate to the values of these ratios over the whole study period of 2002–2015. Testing them will provide answers to the research questions.

Hypothesis 1 The serial acquirer companies have the same *accounting* rates of return on equity (ROE_BV) as the other companies.

Hypothesis 2 The serial acquirer companies have the same *investment accounting* rates of return on equity (ROE_BV_lag) as the other companies.

Hypothesis 3 The serial acquirer companies have the same *market* rates of return on equity (ROE_MV) as the other companies.

Hypothesis 4 The serial acquirer companies have the same *investment market* rates of return on equity (ROE_MV_lag) as the other companies.

Hypothesis 5 The serial acquirer companies have the same rates of return on assets (ROA) as the other companies.

Hypothesis 6 The serial acquirer companies have the same *operating* rates of return on assets (ROA_EBIT) as the other companies.

Hypothesis 7 The serial acquirer companies have the same *investment operating* rates of return on assets (ROA_EBIT_lag) as the other companies.

Hypothesis 8 The serial acquirer companies have the same market to book value ratio (MV/BV) as the other companies.

Hypothesis 9 The serial acquisition companies have the same price to earnings ratio (PE) as the other companies.

Hypothesis 10 The serial acquirer companies have the same sales growth rate (gS) as the other companies.

Hypothesis 11 The serial acquirer companies have the same assets growth rate (gA) as the other companies.

The hypotheses were tested using a two-sample *t*-test with unequal variances. Each null hypothesis was considered in the context of three alternative hypotheses (Hamilton 2013; Kanji 2001. Stata 15 software was used to test the hypotheses):

H_{a1} The ratio value in the group of serial acquirer companies is different from the ratio value of the group of other companies.

H_{a2} The ratio value in the group of serial acquirer companies is higher than the ratio value of the group of other companies.

H_{a3} The ratio value in the group of serial acquirer companies is lower than the ratio value of the group of other companies.

The test results are presented in Tables 1 and 2.

Table 1 Two-sample *t*-test with unequal variances results

Ratio	Serial acquirers		Other companies		*p*-Value
	Mean	*N*	Mean	*N*	
ROE_BV	0.117	1002	0.468	2096	0.0336
ROE_BV_lag	0.678	894	0.114	1770	0.1568
ROE_MV	0.093	837	0.400	1588	0.1722
ROE_MV_lag	0.060	813	0.223	1807	0.1120
ROA	0.037	1008	0.042	2114	0.2022
ROA_EBIT	0.057	1008	0.063	2112	0.1111
ROA_EBIT_lag	0.076	910	0.444	1848	0.1556
MV_BV	8.645	865	4.832	1700	0.0375
PE	35.52	708	37.97	1328	0.2710
gS	0.104	890	0.083	1783	0.0128
gA	0.090	907	0.014	1836	0.0002

Table 2 Conclusions from two-sample *t*-test with unequal variances

Serial acquirers	Relation	Other companies	*p*-Value
ROE_BV	$<$	ROE_BV	0.0336**
ROE_BV_Lag	$>$	ROE_BV_Lag	0.1568
ROE_MV	$<$	ROE_MV	0.1722
ROE_MV_Lag	$<$	ROE_MV_Lag	0.1120
ROA	$<$	ROA	0.2022
ROA_EBIT	$<$	ROA_EBIT	0.1111
ROA_EBIT_Lag	$<$	ROA_EBIT_Lag	0.1556
MV_BV	$>$	MV_BV	0.0375**
PE	$<$	PE	0.2710
gS	$>$	gS	0.0153**
gA	$>$	gA	0.0002***

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Based on the tests results (Tables 1 and 2), the following conclusions can be drawn:

- The companies that made serial acquisitions have lower rates of return on their equity. This applies to yield calculated based both on book value and on market value. This means that serial acquisitions do not ensure a higher rate of return.
- The companies that made serial acquisitions achieve lower rates of return on their assets (but the difference is not statistically significant). This means that serial acquisitions do not ensure a higher rate of return to all of their stakeholders.
- On analysis of the value of the MV/BV ratio, it must be stated that the market positively values companies that make serial acquisitions, and looks favourably on the assets, and on the possibility to generate additional benefits through their exploitation.

- The companies making serial acquisitions have statistically significant, higher asset growth rates and statistically significant, higher sales growth rates than other companies not operating the same way. These results seem to be consistent with the empire-building hypothesis. Furthermore, it seems that these growth rates are strictly connected with the opportunity to create greater profits in the future.

Conclusions

Issues relating to mergers and acquisitions, including serial acquisitions in emerging markets, require further in-depth research. The study presented above requires further examination of the different issues connected to serial acquisitions, such as sector specifics, company operating results, company strategy, company internalization, company capital structure and ownership structure. The undertaking of serial acquisitions is influenced by many factors that have been initially identified in developed capital markets. Much controversy remains in the literature as to the essence of the processes which lead to serial acquisitions and as to the mechanism shaping the serial purchaser group's financial performance, which is used to assess the effectiveness of these acquisitions.

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Failure Models for Insolvency and Bankruptcy

Piotr Staszkiewicz and Bartosz Witkowski

Abstract This working paper discusses the problem of mutual use the insolvency and bankruptcy variable for business failure modeling. The research shows how the terms bankruptcy and insolvency modeling on the unformal dataset might result in different fits of the models. Models were estimated based on 17,024 firm's yearly observations from the 2004 to 2014 for the Polish financial market. Following priory research, the models were developed with application of the logit regression. The evidence gathered during the study supports the conclusion that the use of the legal definition of insolvency is a weak instrument for bankruptcy modeling.

Introduction

Since Altman (1968) pioneering research the failure prediction attract considerable attention both in academy and business.

The authors of the predictions model tend to apply different methodology and strategies to develop the working models. The strategies can be roughly aggregated into three areas: the search for the optimal search of variables, the search for optimal methods, and the search of cross boarder determinants.

This research contributes to the first area predominately by attempting to quantify the discussion on the differences between "insolvency" and "bankruptcy".

The goal of the research is to illustrate the quantitative effect of interchanging the insolvency and bankruptcy as the dependent variables for the failure models.

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Hypothesis Development

Prior Polish studies indicate the difference between the terms: "bankruptcy" and "insolvency". The first has economic roots. The second has the formal and legal background. The bankruptcy, loosely speaking, denotes the process of ceasing the entity from the business landscape, while insolvency is related to the launch of the formal legal procedure.

Balina (2012, p. 159) defines a bankrupt company as the company that is not able to meet its financial obligation on time and the ongoing value of its assets are insufficient to cover the liabilities. Prusak (2002, p. 43) denotes a bankrupt company as one that is unable to sustain in the market without external help.

Hołda (2007, p. 51) defines the insolvency in three perspectives. First, economic: the impairment of the liquidity and assets value. Second, legal: court resolution which constitutes the insolvency. Third, psychological: a debtor or creditor's awareness of a company meeting the legal conditions for an insolvency filling.

This discussion stimulates the qualitative research of actual differences for both approaches in terms of the risk quantification. Thus, the following set of hypotheses were developed for the study:

H0$_1$ *The same variables are significant both for insolvency and bankruptcy modeling.*

H0$_2$ *Prediction ability of both models is equal.*

Dataset and Reference Model

For the model variable selection, we follow Camacho-Miñano et al. (2013) as the Spanish market. It is the one that is the most similar to the Polish market in terms of the *ex-ante* efficiency. With this approach, the insolvency is attributed to the filing of the protection request at the court, while the bankruptcy is estimated as mutual lack of the sufficient short and long-term financing for the company. If at the balance sheet date the current assets to total assets were less than two and total assets to total liabilities were less than one and a half, the entity was considered bankrupt. Both models share the same analytical form exempt from the dependent variable and is as follows:

$$Log\frac{p(Y=1)}{p(Y=0)} = \beta_o + \beta_1 Size + \beta_2 \frac{KP}{TA} + \beta_3 \frac{NA}{KAP} + \beta_4 \frac{AK}{ZB} + \varepsilon \qquad (1)$$

Table 1 presents the variable definition uses for the research.

We apply, following priory research (i.e. Gruszczyński and Pajdo 2003), the logit regression we use the maximum likelihood estimator with Quasi-Maximum

Table 1 Definition of variables

Name	Description
Size	Natural logarithm of total asset PLN
KP/TA	Relation of working capital to total assets
NA/KAP	Debts receivables to net equity
AK/ZB	Total assets to total labilities
Dependent variable (Y)	
Insolvent	Variable value of 1 for entities which at the balance sheet date were at the insolvency proceeding, else 0.
Bankrupt	Variable value of 1 if meeting the Camacho-Miñano et al. Bankruptcy condition, else 0.

Likelihood[1] standard error correction. Two separate models were estimated for dependent variable Insolvent and Bankrupt.

The data were compiled from the insolvency courts in three major Polish cities: Wrocław, Warszawa and Gdańsk as they represent significant part of Polish proceedings. The insolvency data was manually reconciled to the financial data bases: Amadeus, Oribs and Emis. The time span of observation is 2004–2012. The sample used consists of 17,024 firms-yearly observation for 2175 entities. The data set was developed from priory research of Morawska and Staszkiewicz (2016a, 2016b).

Results and Discussion

Table 2 presents the results of estimation.

Both models include the same regressors; however, not all variables are significant both for insolvency and bankruptcy. The pseudo R-squared of the insolvency is close to zero; however, the models cannot be compared with the use of this measure due to different distribution of the dependent variable[2]. The models suffer however from close linearity for KP/TA and NA/KAP due to the outrage values in 1% of cases. Therefore a straight application of the Spanish model into Polish market accouters specification issue. In addition for large data sets the heterogeneity might constitute a biasness issue.

We addressed the above concerns by additional robust and different specification testing. We applied 32 different models on reduced model's specification with application of different estimation method: logit, probit, probit with heteroscedasticity clustered on size of entities and on the pre, during, post crisis

[1]Reassessment of standard errors based on negative hessian does not change the conclusions.

[2]The bankruptcy model outperforms the insolvency model as regards the information criteria.

Table 2 Logit estimation model for insolvency and bankruptcy

	Insolvency	Bankruptcy
	Y = 1 for failure	Y = 1 for bankrupt
Const	−0.33 (0.22)	−5.7** (0.25)
Size	−0.28** (0.028)	0.30** (0.027)
KP/TA	0.44** (0.095)	−1.6** (0.087)
NA/KAP	0.44** (0.095)	6.4** (0.17)
AK/ZB	7.2e – 05 (8.6e − 05)	−0.056** (0.015)
n	17,024	17,024
R^2 McFaddena	0.01	0.58
lnL	−6.4e + 003	−4.5e + 003

Standard errors of estimation in brackets
*significant at 10%
**significant at 5%

Table 3 Alternative model's specification and AUC values.

Variable excluded	Sample N	Logit		Probit		Probit_HF		Probit_HR	
		Ban	Ins	Ban	Ins	Ban	Ins	Ban	Ins
NA/KAP	17,024	0.989[a]	0.582	0.988[a]	0.582	NA[b]	0.580	0.988	0.580
	16,485	0.990	0.620	0.989	0.620	0.989	0.623	0.989	0.621
KP/TA	17,024	0.991[a]	0.582	0.991[a]	0.582	NA[b]	0.580	0.991[a]	0.580
	16,485	0.992	0.650	0.991	0.650	0.992	0.652	0.991	0.651

Ban—denotes models with independent variable bankruptcy, Ins—denotes models with independent variable insolvency. Probit HF denotes specification for probit heteroscedasticity with two sets of potential control variables: size of entities and the timing of crisis. Probit HR denotes only control variables
[a]Convergence not achieved [b]NA—Not calculated due to the collinearity

periods[3] on total and censored sample.[4] Table 3 presents summary of the AUC for the estimated models. Irrespectively of the estimation strategy the difference between bankruptcy and insolvency in fits is substantial.

The evidences gathered indicates that the change of the perspective from bankruptcy to insolvency yield with different quality of the model. In priory researches, as shown in Table 4, there were substantial effort put on identification of the most

[3]In most probit models with potential heteroscedasticity of the error term in the equation for the latent variable in the typical two-equation utility notation of the binary choice model, the homoscedasticity hypothesis was rejected on any significance level >0.0001, while the size of entities played a statistically significant role, and the pre/during/post-crisis dummies did not, thus they specification "probit_HR" is estimated without them.

[4]Sample censoring was used due to extremely high dispersion of the KP/TA, NA/KAP and AK/ZB variables, which caused the problems with algorithm convergence while the model was estimated on full sample (visible in lines 1 and 3 in the table). The problem is typical while ratios are considered and consisted in eliminating form the sample the cases with bottom 1% and top 1% of cases with extreme values of the aforementioned variables. This reduces spurious effects caused by overinfluential extreme cases in the sample as well as eliminates strong collinearity of the independent variables caused by the co-behavior of the extreme cases.

Table 4 Comparison of independent variables used in the bankruptcy/insolvency/failue prediction models[a]

Bellovary, Giacomino, and Akers Appendix B Factors included in five or more studies	Dimitras, Zanakis, and Zopounidis Table A.2
Factor/Consideration	Code names for financial quantum and ratio
Net income/Total amount	AE Administrator expenses
Current ratio	AP Accounts payable
Working capital/Total assets	APP Average payment period (for account payable)
Retained earnings/Total assets	AV Added value
learnings before interest and taxes/Total assets	CA Current audit
Sales/Total assets	Ca Cash
Quick ratio	CF Cash flow
Total debt/Total assets	CL Current liabilities
Current assets/Total assets	D Depreciation
Net income/Net worth	EBIT Earnings before interests and taxes
Total liabilities/Total assets	FA Fixed assets
Cash/Total assets	FAP Free assets percentage
Market value of equity/Book value of total debt	OFA Gross fixed assets
Cash flow from operations/Total assets	GNP Gross national product
Cash flow from operations/Total liabilities	GP Gross profit
Current liabilities · Total assets	IE Interest expenses
Cash flow from operations/Total debt	In Inventory
Quick assets/Total assets	LA Liquid assets
Current assets/Sales	LTD Long term debt
learnings before interest and taxes/Interest	MVE Market value of equity
Inventory/Sales	CE Capital employed
Operating income/Total assets	NO No credit interval
Cash flow from operations/Sales	NI Net income
Net income/Sales	NP Notes payable
Long-term debt/Total assets	NW Net worth
Net worth/Total assets	OE Operating expenses
Total debt/Net worth	PBD Profit before depreciation
Total liabilities/Net worth	PBT Profit before taxes
Cash/Current liabilities	Prod Production/Sales/Inventory
Cash flow from operations/Current liabilities	QA Quick assets
Working capital/Sales	H Receivables
Capital/Assets	RE Retained earnings
Net worth/Total assets	ROI Return on investment
Net worth/Total liabilities	S Sales
No-credit interval	SC Shareholders-capital
Total assets (log)	SE Shareholders' equity
Cash flow (using net income)/Debt	SOP Stock option percentage
Cash flow from operations	SP Stock price
Operating expenses/Operating income	STD Short term debt
Quick assets/Sales	T Taxes
Sales/Inventory	TO Total creditors
Working capital/Net worth	TP Trading profit
	TA Total assets
	TC Total capital
	TD Total debt

(continued)

Table 4 (continued)

Bellovary, Giacomino, and Akers Appendix B Factors included in five or more studies	Dimitras, Zanakis, and Zopounidis Table A.2
	TE Total expenses TL Total liabilities WC Working capital

Source: own presenation based on Bellovary et al. (2007) and Dimitras et al. (1996)
[a]Kept original definition of variables allow reconciliation to sources

suitable set of independent variables for the prediction models. The Table 4 shows the comparison of two synthesis presented by Bellovary et al. and Dimitras et al.

Prior researches, as stated in the above table, indicate that substantial emphasis was put on the search for the relevant independent variables, while the semantic differences between the dependent variables stay more aside the core discussion. This research is somehow limited by the linguistic issue, as it is based on the semantic differences for the Polish market. Further study is needed to trace the international differences.

Conclusion

The goal of the research was to illustrate the quantitative effect of interchanging the dependent variables of insolvency and bankruptcy for the failure models.

We found that the same variables are insignificant both for insolvency and bankruptcy modeling and that the prediction capability of both insolvency and bankruptcy models is unequal.

The results achieved allow to formulate the warning about interchanging of the insolvency with bankruptcy since modeling results in significantly different findings. The research provides evidences for the need to validate business prediction and credit rating models and check for their robustness.

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Part VI
Personal Finance

Parental Influence on Financial Knowledge of University Students

Kutlu Ergün

Abstract This study aimed to find out the relationship between financial knowledge and parental influence among university students. Online survey instrument was used to collect data. Totally 169 students from Poland, Croatia, Greece, Turkey, Portugal, Slovakia, Slovenia, Latvia, Lithuania and Hungary participated in this study. Logistic regression was used to analyse the data. Students from Poland had the highest financial knowledge score (5.7 out of 7). Result found that male students, students 26 years old or above, PhD students, those whose fathers' had high school degree, those who discussed with their mothers when making financial decision were more knowledgeable on personal financial knowledge. Result showed that origin of country was significant for financial knowledge since students from Poland was found to be more knowledgeable than students from Greece, Hungary, Latvia, Lithuania, Turkey, Slovakia and Slovenia. It was concluded that mothers had significant impact on financial knowledge of university students, but higher level of parental education had no influence on financial knowledge of university students.

Introduction

Financial knowledge refers to the understanding that an individual has important personal finance concepts, like saving and budgeting. Financial attitudes refer to one's beliefs and values about various financial concepts (Chowa et al. 2012). Financial behavior includes effective money management, searching for financial information that supports informed decision making, setting financial planning and financial goals [The Consumer Financial Protection Bureau (CFPB) 2015]. Individual financial knowledge refers to Money management and its use. This knowledge includes the ability to manage income and expenses and the ability of using and changing money. It also includes knowledge of insurance, credit, savings and

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borrowing (Wagland and Taylor 2009). Financial knowledge, skills and behavior should be addressed in a comprehensive conceptualization of financial literacy, as well as their mutual relations with each other. In particular, financial information represents a fundamental form of financial literacy (Hung et al. 2009).

Financial literacy has been defined in many ways. The OECD/INFE (2011) defines financial literacy as "combination of awareness, knowledge, skill, attitude and behaviour necessary to make sound financial decisions and ultimately achieve individual financial wellbeing". Lusardi and Mitchell (2014) define financial literacy as "ability to process economic information and make informed decisions about financial planning, wealth accumulation, debt, and pensions".

Many studies have shown that the vast majority of adult people are unaware of basic economic concepts such as risk diversification, inflation, and compound interest. It is also noteworthy that financial literacy affects savings and portfolio choices (Jappelli and Padula 2013). Within the framework of theoretic perspective, Delavande et al. (2008) suggested that people invest more effectively to get higher returns if they have financial knowledge. Jappelli and Padula (2013) stated that financial literacy and saving are in a positive relationship with each other. Lusardi et al. (2013) suggested that individuals do not only invest in capital markets but also make investments to acquire financial knowledge. Nijssen (2010) suggests that the individual makes a choice that has high return. He also stated that high return expectations increase the risk.

Financial literacy has become increasingly important for consumers to survive in the modern world and to cope with the growing number of diverse and sophisticated financial products and services (Bird 2008). Those with a high level of financial literacy are more inclined to plan their financial matters and they achieve more successful financial plans (Lusardi and Mitchell 2008). A low level of literacy prevents people from making informed financial decision (Oehler and Werner 2008). Financial literacy allows individuals use the financial products without unnecessary costs and provide them with ability needed for more effective life (Angelo and Ramsay 2011). An individual who has financial capability can benefit from the financial innovations and new financial products and come up financial complexity that may arise in the financial environment (Hall 2008). Household members without financial literacy can make negative decisions that affect not only themselves but the family and all society. In this respect, increasing financial literacy is the primary goal for society policies (Gale and Levine 2010). This means that the young people are not able to obtain sufficient financial information from their parents, other adults, or their friends (Lusardi 2013).

Financial literacy levels of students are affected positively by parents (Jorgensen 2007). Children want their parents help them with financial issues because parents are the key influence in children's lives. The positive and negative financial attitudes, behaviours and knowledge of young adults are primarily influenced by their parents. Parents may have an influence on their children's financial socialization (Jorgensen and Savla 2010). Strong parenting skills such as modelling and teaching to children about financial subjects can influence financial literacy during teen years (Clarke et al. 2005).

Many studies have been carried out to determine and evaluate financial literacy among general population. Most of the studies found that financial literacy level of male are higher than female (Chen and Volpe 1998; Beal and Delpachitra 2003; Lusardi and Mitchell 2011; Klapper et al. 2011; Atkinson and Messy 2012). Many studies indicated that students from business end economic department had high level of financial literacy (Chen and Volpe 1998; Mandell 2008; Xiao et al. 2007. On the other hand it was carried out some studies indicating he positive impact of parents on financial literacy of students (Jorgensen 2007; Clarke et al. 2005). Age is the man determinant of financial literacy, and there are some studies supporting this impact. Generally it was found that youth had low level of financial literacy (Danes and Hira 1987; Rodrigues et al. 2012). Some studies concluded that students who have master or higher educational level had higher financial literacy level than students who have lower educational level (Chen and Volpe 1998; Jorgensen 2007; Shaari et al. 2013).

This study adds to financial literacy research by focusing on the parental influence on financial knowledge of university students. Result of this study may be useful for family financial advisors in helping family to increase discussion with their children about financial concepts. The first section of this study is introduction which summarise some of financial concepts such as financial knowledge, financial behaviour and attitudes. The second section has methodology which describes method of this research. Third section describes the results and analysis of logistic regression. Conclusion is the last section which has some suggestions regarding financial knowledge of university students.

Methods

This study used an online survey shared on social media to obtain data from participant students. The survey was open for any students. It was also up to the individual to choose to take part in. It was not possible to determine the sample because of the nature of online survey. The amount of sample was small and it is certainly not generalisable. The survey questions were created by literature review and modified for this research needs. (Chen and Volpe 1998; Hogarth et al. 2003; Jump$tart Survey 2008; OECD/INFE 2012; Jappelli and Padula 2013). One hundred and sixty nine students from Poland, Portugal, Slovakia, Latvia, Slovenia, Hungary, Turkey, Croatia, Greece, and Lithuania took part in this study. The first section of the questionnaire had seven questions about "*gender", "age", "cycle of study", "father's educational level", "mother's educational level", "discussing when making financial decision", and "nationality"*. The second section had seven questions financial knowledge about *"relationship between interest rate and inflation", "time value of money", "investing", "risk diversification", "personal credit ratings", "purchasing power", and "saving"*. The relationship between first and second sections was examined by logistic regression. After determining the median score of correct answers of the sample (five out of seven), students with scores higher than the sample median of five were classified as more knowledgeable students on financial knowledge; students with scores equal to or below the sample median five were classified as less knowledgeable students on financially knowledge. This dichotomous variable (being knowledgeable or not) was used in the logistic regression as the dependent variable. The independent variables for this study were age, cycle of study, father's educational level, mother's educational level, discussing when making financial decision, and nationality. The reference categories were chosen, and coded as 1, and other categories were coded as 0 for the logistic regression.

It is used a logistic or logit transformation to link the dependent variable to the set of independent variables. The logit link has the form:

$$Logit\ (P) = log\left(\frac{P}{1-P}\right) \tag{1}$$

The model for the logistic regression:

$$Logit\ (P) = log\left(\frac{P}{1-P}\right) = \beta_0 + \beta_1 X_1 \ldots + \beta_k X_k \tag{2}$$

P is the probability of being more financially knowledgeable, and

1−P is the probability of being less financially knowledgeable.

It was used *k−1* dummy variables for each independent variable which have *k* categories to contrast the different categories since independent variables are categorical It was also chosen a reference category for each variable to contrast all remaining categories with the reference category.

Results and Analysis

Table 1 shows that 54.4% of students were male, 45.6%; 50.9% of students were 22–25 years old age; 50.9%, 63.3% of students were in the cycle of bachelor's degree; 43.2% of students' fathers' educational level were the level of high school. 33.7% of students' mothers' educational level were the level of master or Ph.D. 49.7 of students indicated that they didn't discuss anyone when making financial decision. The highest percentage of the participant students were from Greece and Turkey as 12.4%. Latvian students had the lowest participant percentage as 7.7% in all participant countries. Table 2 shows also the scores of participating countries. The average score for countries was 4.7 out of 7. Students from Poland had the highest score, 5.7 out of 7; Croatia, 4.7; Greece, 4.3; Hungary, 4.1; Latvia, 5.2; Lithuania, 4.0; Turkey, 3.8; Portugal, 5.6; Slovakia, 5.3; and Slovenia, 4.7. The number of more knowledgeable students from the countries of Croatia, Portugal, Slovakia and Poland were higher than Greece, Hungary, Latvia, Lithuania, Turkey and Slovenia. 70% of students correctly answered the question about *"interest rate*

Table 1 Descriptive analysis

Variables	Frequency	Percentage	Scores (out of 7)
Gender			
Male	92	54.4	5.3
Female	77	45.6	4.0
Age			
17–21	48	28.4	4.5
22–25	86	50.9	4.7
26 or above	35	20.7	5.0
Cycle of study			
Bachelor	107	63.3	4.6
Master	48	28.4	4.7
PhD	14	8.3	5.3
Father's educational level			
Lower than high school	20	11.8	4.5
High school	73	43.2	4.9
Bachelor	45	26.6	4.3
Master or PhD	31	18.3	4.9
Mother's educational level			
Lower than high school	20	11.8	4.5
High school	41	24.3	4.4
Bachelor	51	30.2	4.4
Master or PhD	57	33.7	5.3
Discussing when making financial decision			
Mother	50	29.6	4.9
Father	35	20.7	4.0
No one	84	49.7	4.9
Average score across all participating countries:			4.7

and inflation"; 49% , *"time value of money"*; 67%, *"investing"*; 55% *"risk diversification"*;; 71%, *"personal credit ratings"*; 78%, *"purchasing power"*; 74%; *"saving"*. Number of incorrect responses for the question about "time value of money" was higher than correct responses. Number of correct responses for the question about "purchasing power" was the highest in all correct responses.

Table 2 indicates the coefficients and the odds ratios predicted by the logistic regression model used to test whether there is significant relationship of "gender", "cycle of study", "age" "father's educational level", "mother's educational level", "discussing when making financial decision", and "nationality" on financial knowledge of participant students.

The logistic regression showed that coefficient of male ($\beta = 3.002$) had a positive sign, and statistically significant (*P-value* < 0.01). The exp(B) shows the odds ratio and indicted that males are 20.199 times as likely to be financially knowledgeable than females. The confidence interval for exp(B) is 6.445 to 62.800 times as likely to be financially knowledgeable than females. The age 17–21 coefficient ($\beta = -1.137$)

Table 2 Logistic regression analysis

	β	S.E.	*p*-Value	exp(B)	Lower 95%	Upper 95%
Gender						
Male	3.002***	0.581	0.000	20.199	6.445	62.800
Age						
17–21	−1.137*	0.650	0.080	0.321	0.090	1.148
22–25	−0.803	0.581	0.167	0.448	0.143	1.399
Cycle of study						
Bachelor	−1.589*	0.838	0.058	0.204	0.040	1.055
Master	−1.494*	0.885	0.091	0.224	0.040	1.272
Father's education level						
Lower-high school	0.476	1.051	0.651	1.609	0.205	12.621
High school	1.792**	0.711	0.012	6.000	1.490	24.162
Bachelor	1.164	0.772	0.132	3.203	0.705	14.546
Mother's education level						
Lower-high school	−0.564	1.429	0.693	0.569	0.035	9.364
High school	−0.393	0.664	0.554	0.675	0.184	2.481
Bachelor	0.263	0.681	0.669	1.301	0.342	4.946
Discussing when making financial decision						
Mother	1.246**	0.577	0.031	3.476	1.123	10.759
Father	0.097	0.659	0.883	1.101	0.303	4.010
Nationality						
Croatia	−0.110	0.935	0.906	0.896	0.143	5.600
Greece	−2.156**	1.004	0.032	0.116	0.016	0.829
Hungary	3.268***	1.002	0.001	0.038	0.005	0.272
Latvia	−2.140*	1.100	0.052	0.118	0.14	1.016
Lithuania	−4.608***	1.081	0.000	0.10	0.001	0.083
Turkey	−3.368**	1.536	0.028	0.034	0.002	0.687
Portugal	−1.171	0.872	0.180	0.310	0.056	1.715
Slovakia	−1.824*	0.992	0.066	0.161	0.023	1.127
Slovenia	−2.093**	1.251	0.013	0.045	0.004	0.527
Constant	0.391	0.944	0.678	1.479		

*$p < 0.10$ **$p < 0.05$; ***$p < 0.01$

is negative and statistically significant (*P-value* < 0.1). Exp(B) for age 17–21 is 0.090, which means that 17–21 years old students are 0.090 times less likely to be financially knowledgeable than students in 26 years old or above. The coefficient of 22–25 years old students is non-significant. Coefficient of bachelor's degree ($\beta = -1.589$) was statistically significant (*P-value* < 0.1). The exp(B) indicted that bachelor's degree students were 0.040 times less likely to be financially knowledgeable than PhD students. Coefficient of master's degree students ($\beta = -1.494$) was statistically significant (*P-value* < 0.1). The exp(B) indicted that master's degree students were 0.040 times less likely to be financially knowledgeable than PhD students. All coefficients of father's educational level are positive, but only for the coefficient of high school variable (*P-value* < 0.05) was statistically significant. The exp(B) indicted that students whose fathers' educational level was high school were 1.490 times more likely to be financially knowledgeable than students whose fathers' educational level were master's degree or PhD. All coefficients for mother's educational level were statistically non-significant. Coefficient of mother (discussing when making financial decision) is 1.256 and statistically significant (*P-value* < 0.05). The exp(B) indicted that students who discussed with his/her mother when making financial decision were 1.123 times more likely to be financially knowledgeable than students who didn't discuss anyone when making a financial decision. Poland was the reference country for all variables for nationality. The signs and values of the coefficients for the other dummy variables suggested the influence of Poland was stronger among Greece *(−2.156, P-value < 0.005)*, Hungary *(−3.268, P-value < 0.001)*, Latvia *(−2.140, P-value < 0.1)*, Lithuania *(−4.608, P-value < 0.001)*, Turkey *(−3.368, P-value < 0.005)*, Slovakia *(−1.824, P-value < 0.1)*, Slovenia *(−2.093, P-value < 0.005)*, but not among Croatian and Portuguese.

Logistic regression found that students from Poland were more knowledgeable than students from Greece, Hungary, Latvia, Lithuania, Turkey, Slovakia and Slovenia. There were no significant relationship between Poland and both Croatia and Portugal. Result showed that male students are more knowledgeable than female students on financial knowledge. This result is consistent with the previous studies (Clercq and Venter 2009; Lusardi and Mitchell 2011; Beckmann 2013). This study found age was the significant determinant for financial knowledge. Taylor (2011) concluded that financial capability varies significantly for both men and women in a nonlinear way. Rodrigues et al. (2012) found and concluded that age and financial involvement were directly proportional. As age increases, the financial involvement also increases. PhD students in this study were found to be more knowledgeable than bachelor's and master degree students. The result is consistent with the studies conducted by Danes and Hira (1987), Jorgensen (2007) and Shaari et al. (2013). This study found that students whose fathers' educational level was high school were more knowledgeable than those whose fathers' educational level was master or PhD. Higher level of father's education had no influence on financial knowledge of university students. It was not found any significance relationship between mother education level and students' financial knowledge. Potrich et al. (2015) found that the parental educational level has no significant impact on the individuals' financial literacy. On the other hand, Grohmann and Menkhoff (2015) showed that parents had an indirect effect on the financial literacy of their adult children. Students who discussed with his/her mother when making a financial decision found to be more financially knowledgeable than students who didn't discuss anyone when making financial decision. A scientific poll commissioned by CreditCards.com (2011) found that adults most often identified their mothers as the family member with the most influence on their financial knowledge. Same survey conducted in 2015 found that adults relied more on themselves on their financial knowledge. But mother's influence had the second place in that survey.

Conclusions

This study may provide additional evidence on parental influence about levels of financial literacy of university students, and further research can be conducted to attain more generalisable results. It can be useful for policy makers on financial education to enhance parental influence on financial literacy of university students. This study showed that financial knowledge score of students from Poland were higher than the students from Greece, Hungary, Latvia, Lithuania, Turkey, Slovakia and Slovenia. Gender, age and cycle of study were found to be determinant of financial knowledge level of university students. Contrary to expectations, this study found that higher level of father's and mother's educations were not significant impact on university students' financial knowledge. This result didn't find confirm most of previous studies. It was found an interesting result that fathers who had high school graduation had more influence on financial knowledge of university students than those who had PhD degrees. Result showed that students who discuss with their mothers when making financial decision were more knowledgeable than those who didn't discuss anyone when making financial decision. Mothers have significant impact on their children financial knowledge. It can be concluded that mothers play significant role influencing financial knowledge of university students although higher level of parental education has no influence on financial knowledge of university students. Parents should be included in making financial decision of university students to make informed choices and improve the financial knowledge of university students.

Limitations

I can confirm that there were some limitations of this study. The main limitation of this study concerns that the questionnaire was administered to a small amount of students. So the sample was very small proportion of students in these countries. Thus, the result is certainly not generalisable in all European countries, and larger sample size is required for appropriate generalization of the findings. This kind of online survey didn't allow me to determine the definite sample size. All student participation was voluntary, and self-selected. The language of the questionnaire was in English. Therefore, only the students who knew English took part in this survey. Only close-ended questions were used in this study; future studies should consider adding open-ended questions. Although there were some limitations it provides data for future researchers for further studies.

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Does Households' Financial Well-being Determine the Levels of Their Sight Deposits Under Turmoil?

Katarzyna Kochaniak

Abstract The paper presents the results of the study aimed at verifying the significance of households' financial well-being for the values of their sight deposits, under economic and financial destabilisation. The reason for conducting this analysis is the European Banking Authority's stance about retail sight deposits being stable funding for credit institutions under stress, due to their transactional nature. Thus, this opinion assumes the existence of linkages between the levels of deposits and financial situation (especially incomes) of their owners. The study is based on data from the Eurosystem HFCS, which relate to households' financial well-being in 15 euro area countries in the time of economic and financial turmoil. The regression models are used to estimate the impact of respondents' incomes and assets (real and financial assets). The main findings are that the significance of households' financial well-being for the allocation of deposits is heterogeneous in the countries analysed. In part of them the primary influence is assigned to the level of recent annual gross income, while in the other to net wealth accumulated by a household in the long run. From all the sight deposits declared, the most sensitive to financial situation are those placed by respondents on retirement. However, assuming the constancy of the financial situation of households in the euro area, their willingness to allocate more sight deposits appears geographically differentiated. The most willing in this regard is the Finnish population.

Introduction

During the global banking crisis funding instability appeared as one of the key factors jeopardising the safety of credit institutions. Afterwards, this problem was discussed in the revised EU regulations. The entities' funding sources were ranked according their availability under idiosyncratic and systemic stress periods. Retail

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deposits became distinguished as a preferred category of credit institutions' liabilities (Regulation of the European Parliament and of the Council 2013) and described in documents relating to liquidity standards (EBA 2013b; Commission Delegated Regulation 2015). However, not all of retail deposits can be perceived as stable. According to the EBA, sight deposits belong to those preferred due to their transactional nature (EBA 2013a, p. 7). Their stability results from the fact that their accounts are regularly credited by salaries in order to cover customers' spending. Thus, the Authority assumes the dependence of the levels of sight deposits on the financial well-being of their owners, encouraging to verify it empirically.

This paper aims to recognise the significance of households' financial well-being for the levels of their sight deposits placed in credit institutions under destabilization in 15 euro area countries. It answers the following research questions:

– Which approach to household well-being—inflows (incomes) or balance-sheet items (assets)—had a priority influence on the levels of sight deposits in the euro area countries in the surveying period?
– In the case of countries, in which annual gross incomes are proved to be the main determinant of the levels of sight deposits—which kinds of incomes are statistically significant incentives in this regard?
– In the case of the significance of pension incomes for the levels of sight deposits, does the pension type matter?

This paper fills the gap in the post-crisis literature regarding household sight deposits. It should be noted that these deposits were neglected for a long time in the studies on household finance due to their simplicity and almost risk-free nature. The regulatory stance on these deposits makes them return to being the subject of discussion, not only regarding household finance, but also credit institutions' liquidity and adequacy of the EU post-crisis regulations.

The paper is organized as follows :Related Literature, Data and Methodology, The Results, and Conclusions.

Related Literature

In the time of the development of financial markets, retail deposits remained outside the mainstream literature on household financial assets as well as banks' funding sources. Some changes in this regard could be seen in recent years when the EU banks faced severe liquidity problems, and post-crisis regulations were introduced. Moreover, the changes resulted from the increasing availability of household-level data. However, there is still a limitation of references in which retail deposits are subject to analysis.

Selected studies discuss the deposits as a component of household asset portfolios. The impact of socio-demographic characteristics on portfolio choices of the euro area households is analysed by Arrondel et al. (2014a). The results obtained allow concluding about the increase in the ownership rates of all asset categories with households' position in the income distribution. The ownership rate of deposits is recognised as high in the euro area countries. However, the main results of this study refer to the other portfolio components, which are real estate and risky financial assets. The conclusions from the study of Arrondel et al. (2014b) had an impact on econometric models applied in this paper. The authors discuss the influence of household's location in the income distribution on its location in the wealth distribution, accounting for intergenerational transfers, age, and household characteristics. The wealth is defined as "net wealth" and refers to balance sheet items of a household. The authors prove the discrepancy between two dimensions of households' financial well-being (incomes and wealth), emphasising the need for their common application in the models as independent variables. The results obtained for France, Finland, Germany, and Italy allow concluding that incomes do not have the same impact on the way to wealthiness. In Germany, Greece, Italy, Slovakia and Spain, intergenerational transfers influence differently household wealth along the wealth distribution. According to the results, when moving to the top of the wealth distribution, the probability to be in a wealth decile is increasing with income. A sharp increase in the probability to be in the 9th and 10th wealth deciles is observed in the top of the income distribution. However, in countries with heterogeneous accumulation behaviours, the impact of income on the way to wealthiness is not evident in the bottom and the middle of wealth distribution. Risk profiles of household financial asset portfolios and their determinants are subject to research conducted by Kochaniak (2017a). The financial assets relate to deposits, managed accounts, mutual fund units, bonds, shares, private lending, voluntary pension plans and whole life insurance contracts, private businesses, and others. The study recognises the importance of safe, relatively safe, and risky parts of portfolios for households in 15 euro area countries. The results prove the primary importance of deposits in almost all the member states. The features explaining portfolios' structure lead to the conclusion about the greater exposure to financial risks of wealthier respondents than those less affluent. However, the study identifies the countries where households with real assets of high value have different preferences. The study of Cussen et al. (2012) focuses on the impact of socio-demographic characteristics of Irish households on their preferences regarding the possession of financial assets (including deposits) under destabilisation. The considered determinants include, among others, wealth, declared risk attitudes, and age of respondents. The authors prove households' focus on cash and deposit instead other financial assets, due to elevated risks. The research conducted by Brandmeir et al. (2012) refers to the impact of the global financial crisis on households' well-being. They argue that there are almost no negative effects of the turmoil on poorer populations, due to the dominant position of deposits in the financial asset portfolios of their households.

Kochaniak (2017b) conducted a study solely dedicated to household deposits in the euro area countries. The author examines the determinants of the occurrence of guaranteed deposits, high value deposits, and very high value deposits, which are described by the EBA as separate categories due to their various sensitivity to outflows under stress. The main finding is that the impact of financial well-being and socio-demographic features of households on their propensity to possess the deposits was opposite regarding guaranteed and unguaranteed deposits. It proves two separate profiles of households who declared deposits in the euro area. For selected member states, the adoption of the single limit within guarantee schemes was assessed as an incentive which may strengthen the deposits' resilience on withdrawals, and thus positively influence the funding stability of credit institutions.

Retail deposits in the role of banks' funding are discussed by McQuinn and Woods (2012). They compare the volatility of retail and corporate deposits in Irish banks in the years 2009–2011. The authors identify retail deposits as stable while corporate ones are identified as responsive to outflows, similarly to wholesale funding. According to the results presented by Brown et al. (2014), retail deposits are subject to withdrawals from distressed banks, especially when they receive a public bailout. However, the withdrawal risk for such banks could be mitigated by strong bank–client relationship and high household-level switching costs. Thus, households with one deposit account or loans taken are significantly less likely to withdraw deposits. The findings provide empirical support to the Basel III liquidity regulations which emphasise the role of well-established client relationships for the stability of bank funding. In turn, Bologna's (2011) study examines the relationships between the use of different types of deposits as banks' funding and banks' insolvency. The owners of large sight deposits and sums placed on managed accounts are recognised as the ones who are willing to monitor the banks' financial standing and withdraw funds in the case of increased risks.

This paper fills the gap in the literature regarding household deposits, in particular, the mechanisms of the formation of the levels of sight deposits in the euro area countries during the period of destabilisation. It verifies the compliance of the EBA stance regarding the dominant influence of household incomes on the deposits' levels with the circumstances prevailing in individual countries. The results display not only statistically significant similarities but also the differences among the countries, which emerge particularly relevant in the context of the harmonisation of the EU regulations for credit institutions.

Data and Methodology

The study is based on quantitative and qualitative data about 56,225 individual euro-area households who possessed sight deposits. These data stem from the first wave of the Eurosystem Household Finance and Consumption Survey (HFCS), which was conducted in Austria (*AT*), Belgium (*BE*), Cyprus (*CY*), Germany (*DE*), Spain (*ES*), Finland (*FI*), France (*FR*), Greece (*GR*), Italy (*IT*), Luxembourg (*LU*), Malta (*MT*), the Netherlands (*NL*), Portugal (*PT*), Slovenia (*SI*), and Slovakia (*SK*). The surveying periods relied on individual decisions of their central banks and statistical offices.[1] Regarding the whole group, these periods are covered by the years 2008–2011, thus the time of macroeconomic and financial instability. The HFCS is a source of micro-information regarding the distribution of particular household features in populations. However, in cross-country analyses the institutional and macroeconomic heterogeneity of the member states should be borne in mind (ECB 2013).

The variables applied in the study comprise quantitative data regarding households' financial well-being (in EUR): sight deposits (*DS*); total financial assets without deposits (*TFA*)[2]; total real assets (*TRA*)[3]; net wealth (*NW*)[4]; annual gross incomes (*GI*)[5]; annual gross incomes from employment (*IE*); annual gross incomes from self-employment (*IS*); annual gross pensions (*IP*); annual regular social transfers (*IR*). Thus, the above variables refer to different approaches of financial well-being of a household, which on the one hand, is expressed by assets resulting from long-life saving, bequests, loans taken etc., and on the other hand, recent cash inflows in the form of incomes received during 12 months prior to the survey. Additionally, the qualitative data are introduced, which refer to the following: the pension sources—public pension schemes (*PU*) and private or occupational pension plans (*PO*); country of residence of a household (*AT*; *BE*; *CY*; *DE*; *ES*; *FI*; *FR*; *GR*; *IT*; *LU*; *MT*; *NL*; *SI*; *SK*).

The complexity of the problem analysed contributes to three steps of the study, which allow the results to be progressively detailed. In each step, certain regression models are used to evaluate the impact of households' well-being on the levels of their sight deposits in individual countries and the entire group. All the models are subject to verification.[6]

[1]Domestic samples—numbers of households surveyed and surveying periods: AT-2097, 09.2010-05.2011; BE-2224, 04.2010-10.2010; CY-757, 04.2010-01.2011; DE-3193, 04.2010-01.2011; ES-5776, 11.2008-07.2009; FI-10,989, 01.2010-05.2010; FR-14,319, 10.2009-02.2010; GR-2168, 06.2009-09.2009; IT-5905, 01.2010-05.2010; LU-920, 09.2010-04.2011; MT-586, 10.2010-02.2011; NL-1076, 04.2010-12.2010; PT-4080, 04.2010-07.2010; SI-279, 10.2010-12.2010; SK-1856, 09.2010-10.2010.

[2]*TFA* denotes the value of all financial assets of a household except its deposits.

[3]*TRA* represents the value of all real assets (real estate, vehicles, etc.) of a household.

[4]*NW* refers to the sum of *TFA* and *TRA* of a household deducted by its liabilities from loans.

[5]*GI* are annual gross incomes of a household from 12 months prior to the survey.

[6]The Akaike (*AIC*) and Schwartz-Bayes (*SBC*) information criterions are used to validate the selection of explanatory variables for models and to evaluate goodness-of-fit of the models to empirical data. The variance inflation factor (*VIF*) is used to check the collinearity of the explanatory variables, while White's test is used to verify the homoscedasticity of the variance. In the case of heteroscedasticity, the generalised least squares method (Heteroscedasticity Consistent Covariance Matrix—*HCCM*) is used to evaluate model parameters (T. Kufel 2013). Verification of the significance of the structural parameters of the models is carried out by the Student's *t*-distribution. The Doornik-Hansen test is applied to verify the distribution of residues. It should be noted that the study is based on household-level data. Therefore, the coefficients of determination (R^2) are lower than in case of the use of aggregated data.

Step 1: This considers the comprehensive impact of the financial well-being of a household on the level of its deposits. The independent variables refer to the values of total real assets, total financial assets, net wealth, and annual gross income—the most general components of household financial situation. The study is conducted for the entire group and individual countries. Taking into account the formal and statistical criteria, if the annual gross incomes turn out to be the feature which describes best the level of sight deposits, then an attempt is made to detail the results in steps 2 and 3. Step 1 applies the models (1) and (2). The power-exponential model (1) is used to describe the formation of the deposits in the full set of 56,225 households. It can be presented as follows:

$$ln\_DS_i = \alpha_0 + \alpha_1 ln\_TRA_i + \alpha_2 ln\_TFA_i + \alpha_3 ln\_GI_i + \alpha_4 ln\_NW_i + \sum_{k=2}^{15} \beta_k c_{ik} + \varepsilon_i, \quad (1)$$

where: ln_DS_i, ln_TRA_i, ln_TFA_i, ln_GI_i, ln_NW_i—natural logarithms of the variables' values in the *i*-th household ($i = 1, 2, \ldots n$); α_j—parameter of the *j*-th explanatory variable ($j = 1,2,3,4$); β_k—parameter of the *k*-th dummy identifying the country of residence of the household; c_{ik}—a dummy identifying the country of residence[7]; ε_i—random component for *i*-th household. Due to the confirmed heteroscedasticity, a generalized least squares method is used to estimate the model parameters (*HCCM*). The power model (2) is used in the analyses relating to national subsets of households and can be presented as follows:

$$ln\_DS_i = \alpha_0 + \alpha_1 ln\_TRA_i + \alpha_2 ln\_TFA_i + \alpha_3 ln\_GI_i + \alpha_4 ln\_NW_i + \varepsilon_i, \quad (2)$$

where the symbols are as in model (1). It is applied 15 times. In the case of 14 countries, the occurrence of heteroscedasticity resulted in the use of generalized least squares method (*HCCM*) to estimate the model's parameters. Only for the Netherlands could the model be based on *CLS*.

Step 2: Its aim is to assess the significance of the levels of particular kinds of households' incomes for the levels of their sight deposits. The independent variables refer to incomes from employment, self-employment, pensions, and regular social transfers. The study is conducted for selected countries in which annual gross incomes are recognised to have a dominant impact of the dependent variable (results from step 1). In step 2, the following exponential model (3) is applied:

$$ln\_DS_i = \alpha_0 + \alpha_1 IE_i + \alpha_2 IS_i + \alpha_3 IP_i + \alpha_4 IR_i + \varepsilon_i, \quad (3)$$

where: ln_DS_i, IE_i, IS_i, IP_i, IR_i—the values of the variables observed in the *i*-th household ($i = 1, 2, \ldots n$). The remaining symbols as in model (2), with a note that model (3) is used nine times, individually for each country. The estimation of the parameters of the model for the Netherlands was carried out by *CLS*, while for the

[7]If the *i*-th household is from *k*-th country $c_{ik} = 1$, otherwise $c_{ik} = 0$. Germany is the reference country.

remaining countries it was carried out by *HCCM* due to confirmed heteroscedasticity.

Step 3: If step 2 confirms the statistically significant impact of households' revenues from pensions on the levels of their sight deposits, an attempt is made to assess the relevance of their sources (private or occupational plans; public schemes) in this regard. This part of the analysis is conducted with the use of data on 20,958 euro-area households who declared such incomes. The following exponential model (4) is applied:

$$ln\_DS_i = \alpha_0 + \alpha_1 PO_i + \sum_{k=1}^{9} \beta_k c_{ik} + \varepsilon_i \quad (4)$$

where: PO_i—dummy identifying the fact that retirement benefits come from private or occupational plans[8]; other variables as above. The set of dummies denoting the country of residence includes only those in which the level of overall incomes predominantly influenced the formation of sight deposits (in step 1) and the importance of pensions is proved (in step 2). The remaining countries are the basis for comparison. The estimation of model parameters is based on *HCCM*.

The Results

The results from Step 1 (Table 1) proved that all the considered variables describing the financial well-being of households are statistically significant and positively influence the amounts of their sight deposits in the euro area. However, attention should first be paid to the effects of the annual gross incomes and net wealth. Their increase by 10% resulted in an increase in sight deposits on average by 2.5% and 2.0%, respectively. In the case of total financial assets without deposits and total real assets, their impact was apparently weaker. Their doubled values led to noticeable changes in deposit levels on average by 4.5% and 0.8%, respectively. Assuming the constancy of the financial well-being of the households, it was possible to indicate the countries like Finland and Italy, where respondents possess the greatest sums on sight accounts in the group. Their deposits were higher on average by 258.3%[9] and 269.4%, respectively from the deposits placed in Germany. Also, the sums declared by Cypriots, Greeks, Luxembourgians, Portuguese, Slovakians and Spaniards distinguished themselves if we compare them to the basis. However, this subset was not uniform regarding respondents' preferences. The deposits of Greeks and Spaniards were at least 100% higher than Germans' deposits. In the remaining countries, this surplus ranged from 46.9% in Cyprus to 10.5% in Portugal. In Austria, Belgium, the

[8]If the *i*-th household receives such benefit $PO_i = 1$, otherwise $PO_i = 0$. Thus, the basis for comparison are pensions from public pension schemes.

[9]$(e^{1.276160}-1) * 100\% = 258.3\%$.

Table 1 Parameter estimates of the model (1) of sight deposits (*ln_DS*) in the group of the euro area countries

Variable	Coef.	Std. error	Statistics *t*	*p*-Value
Constant	2.185850	0.102909	21.2406	0.00001
ln_GI	0.253420	0.010114	25.0572	0.00001
ln_NW	0.195137	0.004135	47.1915	0.00001
ln_TRA	0.008494	0.003229	2.6306	0.00852
ln_TFA	0.044723	0.001522	29.3907	0.00001
AT	−0.336907	0.044326	−7.6007	0.00001
BE	−0.310942	0.047001	−6.6157	0.00001
CY	0.384753	0.071247	5.4003	0.00001
ES	0.791072	0.034925	22.6509	0.00001
FI	1.276160	0.032608	39.1366	0.00001
FR	0.015749	0.030352	0.5189	0.60384
GR	0.880499	0.049223	17.8881	0.00001
IT	1.306730	0.032344	40.4012	0.00001
LU	0.258081	0.072442	3.5626	0.00037
MT	−0.604337	0.102021	−5.9236	0.00001
NL	−0.154000	0.053367	−2.8857	0.00391
PT	0.099850	0.037312	2.6761	0.00745
SI	−0.535677	0.123241	−4.3466	0.00001
SK	0.158810	0.046211	3.4366	0.00059

R-squared = 0.33; AIC = 203792; SBC = 203962; Std. dev. of residual comp. = 1.48168; F (18, 56206) = 1410.71 ($p < 0.00001$)

Netherlands, Malta and Slovenia, sight deposits were the lowest in the group. It should be noted that the deposits held by Maltese and Slovenian households were almost half of those declared in Germany. There were no statistically significant differences regarding the deposits of the French and Germans.

Subsequently, attempts were made to apply model (2) for individual countries. In Austria, Finland, France, Italy, Portugal, Slovakia, and Spain all the considered dimensions of financial well-being affected the levels of households' sight deposits (Table 2). In Austria, Finland, France, and Slovakia, the strongest impact in this regard was assigned to annual gross incomes, while in Italy, Portugal, and Spain it was assigned to net wealth. In Slovenia, the relevance of any explanatory variable has not been confirmed. Regarding the rest of the countries, the significance of selected independent variables was proven. In this subset, the priority influence of annual gross income was recognised in Cyprus, Germany, Luxembourg, Malta, and the Netherlands, while in Belgium and Greece it was net wealth. The above results prove that the mechanisms of sight deposit formation were not the same in the countries analysed. At a national level, the role of primary determinant was assigned to gross annual incomes or net wealth. On the basis of the above outcomes the countries are classified into two sub-groups:

1. Austria, Cyprus, Finland, France, Germany, Luxembourg, Malta, the Netherlands, and Slovakia, where annual gross incomes predominantly affected the

Table 2 Parameter estimates of the model (2) of sight deposits (*ln_DS*) in individual euro area countries

Country	*ln_GI*	*ln_NW*	*ln_TRA*	*ln_TFA*
AT	0.364807 (***)	0.144342 (***)	0.027807 (**)	0.027376 (***)
BE	0.103366 (***)	0.325805 (***)	−0.031814	0.005468
CY	0.225072 (**)	0.089016 (**)	0.091979 (**)	0.009845
DE	0.232238 (***)	0.183229 (***)	0.017922	0.027403 (***)
ES	0.250589 (***)	0.289041 (***)	−0.030151 (**)	0.053300 (***)
FI	0.341413 (***)	0.173453 (***)	0.026524 (***)	0.068707 (***)
FR	0.307472 (***)	0.154483 (***)	0.021883 (***)	0.052983 (***)
GR	0.217475 (***)	0.389394 (***)	−0.117142 (***)	0.022590
IT	0.325553 (***)	0.348647 (***)	−0.133449 (***)	0.015375 (***)
LU	0.281609 (***)	0.256382 (***)	0.002900	0.010318
MT	0.315140 (**)	0.155098	−0.012553	−0.004498
NL	0.129383 (**)	0.080575 (***)	0.018899	0.011860
PT	0.158588 (***)	0.249087 (***)	−0.040249 (***)	0.042141 (***)
SK	0.297215 (***)	0.294891 (***)	−0.036901 (**)	0.044713 (***)

Notes: structural parameter estimates; p-value: *** for $p < 0.01$; ** for $0.01 < p < 0.05$ the remaining $p > 0.1$

levels of deposits, assuming *ceteris paribus*. Their greatest influence was recognised in Austria, in which a 10% increase in household's incomes resulted in an increase in the level of the deposits on average by 3.6%. It should be noted that in Finland, France, and Malta, the income elasticity of the deposits was relatively high (exceeding 3%). The opposing observations were made for the Netherlands, where the influence of the incomes was the weakest (1.3%).

2. Belgium, Greece, Italy, Portugal, and Spain, where the dominant variable was net wealth, assuming *ceteris paribus*. In this subset, Greece emerged as the country of the most responsive deposits. In this case, a 10% increase in the net wealth of a household resulted in an increase of its sight deposits on average by 3.9%. Also, the relatively strong impact of the independent variable can be recognised in Belgium and Italy, in which the same change in incomes led to an increase in the deposits by 3.3% and 3.5%, respectively, assuming *ceteris paribus*. In Portugal and Spain, the impact of net wealth was slightly lower—2.5% and 2.9%, respectively.

It is worth noting that in some countries, households' investments in real assets should be perceived as a negative stimulant of their sight deposits. Such an impact was identified in Greece, Italy, Portugal, Slovakia, and Spain. However, the greatest one (*ceteris paribus*) was recognised in Greece and Italy, where the doubled value of such items in a household corresponded to a decline in its deposits by 11.7% and 13.3%, respectively. In the remaining countries, the scale of the changes was limited to 4%. For some euro area countries, like Belgium, Cyprus, Greece, Luxembourg, Malta, the Netherlands, and Slovenia, the significance of total financial assets other

Table 3 Parameter estimates of the model (3) of sight deposits (*ln_DS*) in individual euro area countries

Country	*IE*	*IS*	*IP*	*IR*
AT	1.037e-05 (***)	1.7503-05 (***)	6.433e-06 (***)	−1.618e-05
CY	7.671e-06 (***)	8.263e-06 (***)	1.995e-05 (***)	−8.237e-06
DE	7.072e-06 (***)	5.791e-06 (***)	1.407e-05 (***)	−4.841e-05 (***)
FI	1.244e-05 (***)	1.643e-05 (***)	3.417e-05 (***)	−9.626e-06 (***)
FR	8.375e-06 (***)	6.867e-06 (***)	2.429e-05 (***)	−3.007e-05 (***)
LU	6.343e-06 (***)	6.490e-06 (***)	9.902e-06 (***)	−5.842e-05 (***)
MT	2.014e-05 (***)	2.091e-05 (*)	5.537e-05 (***)	1.080e-05
NL	6.697e-06 (***)	1.342e-05 (***)	1.563e-05 (***)	8.645e-06
SK	5.146e-05 (***)	2.675e-05 (***)	7.006e-05 (***)	−1.300e-04 (**)

Notes: structural parameter estimates; p-value: *** for $p < 0.01$; ** for $0.01 < p < 0.05$; * for $0.05 < p < 0.1$, the remaining $p > 0.1$

than deposits has not been confirmed. In the remaining ones, such involvements had only a slight effect on the dependent variable.

Step 2 aimed to verify the importance of the levels of particular kinds of households' revenues for the levels of their deposits in countries assigned to sub-group 1. The incomes from employment arose as statistically significant in all of them (Table 3). The greatest impact of this variable was noticed in Slovakia, where its increase by EUR 10,000 resulted in an increase in household's deposits on average by 67.3%, assuming the constancy of the remaining variables. Its weakest influence could be recognised in Austria (1.0%). It should be emphasised that pensions emerged as important for the accumulation of deposits and having the strongest impact in individual countries. An annual increase of pensions by EUR 10,000 led to growth of deposits from 6.6% in Austria to 101.5% in Slovakia. Apart from the latter, relatively high changes in this regard were recognised in Finland, France and Malta (40.7%, 28.3% and 74.0%, respectively). Luxembourg should be indicated as the country of the slightest significance (10.0%) of this income. In most of the member states, annual incomes from self-employment influenced the formation of sight deposits. Malta was the only exception in this regard. Out of the remaining countries, their greatest impact was recognised in Slovakia, while the least impact was in Germany. An increase in household's incomes from self-employment by EUR 10,000 was accompanied in Slovakia by an increase in deposits by 30.7%, while in Germany the increase 6.0%. The significant impact of the levels of regular social transfers was confirmed only in Finland, France, Luxembourg, Germany and Slovakia. It should be emphasised that this variable was the only one of negative influence. The strongest effect of this variable appeared in Slovakia, where an increase in annual social transfers of a household by EUR 10,000 resulted in a decrease in its sight deposits on average by 72.8%, assuming the constancy of the other variables.

In step 3, attention was paid to the importance of particular sources of households' pensions for the levels of their sight deposits—private or occupational pension plans as well as public pension schemes. For this purpose, a subset of

Table 4 Parameter estimates of the model (4) of sight deposits (*ln_DS*) in the group of the euro area countries

Variable	Coef.	Std. error	Statistics *t*	*p*-Value
Constant	8.069330	0.019476	414.3177	0.00000
PO	0.522810	0.053554	9.7623	0.00000
AT	−1.478470	0.062046	−23.8286	0.00000
CY	−0.066086	0.154277	−0.4284	0.66839
DE	−0.592221	0.052212	−11.3426	0.00000
FI	0.324956	0.062793	5.1750	0.00000
FR	−0.474217	0.027277	−17.3854	0.00000
LU	0.115778	0.138285	0.8372	0.40246
MT	−1.240040	0.153212	−8.0936	0.00000
NL	−0.910941	0.079342	−11.4812	0.00000
SK	−1.233620	0.098350	−12.5432	0.00000

R-squared = 0.10; AIC = 80813.6; SBC = 80901.1; Std. dev. of residual comp. = 1.66343; F (10, 20947) = 214.311 ($p < 0.00001$)

20,958 households of retired residents of 15 euro area countries was identified. The results proved that households who retained on pensions from private and occupational programmes had deposits higher on average by 68.7% than households whose benefits were from public schemes, *ceteris paribus*. The national circumstances have partially explained the differences in deposit levels of retirees. Assuming the constancy of pension types in the euro area, only in Finland, were the levels of deposits assessed higher (by 38.4% on average) than in the basis for comparison. The levels of Cypriots' and Luxembourgians' deposits did not significantly differ from the levels of Germans' deposits. The lowest deposits (lower on average by 77.2% from the basis) were recognised in Austrian retiree households. Significant negative differences in this regard were also identified in Malta and Slovakia (Table 4).

Conclusions

The EBA's stance regarding the transactional nature of sight deposits implies their dependence on the financial well-being of the depositors. The results from step 1 of the study proved that at the group level, all the measures of general financial well-being of a household were the stimuli of these deposits. However, annual gross incomes arose as their key determinant. It should be noted that the above relations have not been fully confirmed by the results obtained for individual countries. In some of them (Austria, Cyprus, Finland, France, Germany, the Netherlands, Luxembourg, Malta, and Slovakia) the priority impact was assigned to annual gross incomes, while in the others (Belgium, Greece, Italy, Portugal, and Spain) it was assigned to net wealth. The outcomes for Slovenia were not statistically significant. All this proves the cross-country differences in the influence of the financial well-being of households on their decisions regarding the sums placed. Additionally, the strength of the impact of each independent variable differed in both subsets of countries. The most notable impact of annual gross income has been recognised in Austria, Finland, France, and Malta, while net wealth has been recognised in Belgium, Greece, and Italy. Moreover, in some countries, the financial involvement of households in real assets appeared as a negative stimulus of deposit levels. This happened in Greece, Italy, Portugal, Slovakia, and Spain. Conversely, the significance of financial assets other than deposits should rather be assessed as marginal for the analysed phenomenon. It is worth noting that apart from household's financial situation, the country of residence also influenced its preferences regarding the sum held on the sight account. Assuming the constancy of wealth and incomes of the euro area households, respondents from Finland, Greece, Italy, and Spain distinguished themselves by the largest sight deposits. The lowest could be observed in Malta and Slovenia. In the subset of countries in which annual gross incomes were a key independent variable, pensions emerged as the most important determinant of the levels of sight deposits. It should be added that incomes from employment and self-employment were also recognised as significant for the analysed phenomenon, however, their influence was much weaker. Moreover, the latter was assessed insignificant in one of the countries. The levels of regular social transfers turned out to affect deposit levels in five member states, but in a negative manner. The results obtained proved that the levels of sight deposits were shaped not only by the amounts of incomes from pensions but also by their types. Those held by beneficiaries of private or occupational pension plans were higher than those held by beneficiaries of public pension schemes. Besides, assuming the constancy of the pensions' structure in the euro area, Finnish respondents emerged as the most interested in owning such deposits, while Austrian respondents were the least interested.

In conclusion, the assumed impact of the financial well-being of households on the level of their sight deposits is considered to be statistically significant in the population of 15 euro area countries. However, the importance of individual wealth dimensions—based on balance-sheet components and income inflows—cannot be assessed as equal.

The results demonstrate that the EBA stance regarding the priority significance of households' incomes for the levels of their sight deposits mirrors general observations, but not necessarily the circumstances of individual countries. Thus, the EU regulatory approach should leave some space for the adequate adjustments of the single rules at the national level, due to the heterogeneity of the countries analysed.

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