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Financial determinants of corporate reputation: A short-term approach

1. Introduction

When observing companies listed on stock exchanges, it can be noticed that the gap between a company's book value (BV) and its market value (MV) is often significant. The fact that investors are willing to pay more for companies' assets is often explained using the concept of corporate reputation – an intangible additional asset of a company, which is worth to paying for.

Similarly, analysing literature in the corporate reputation problem, its strong connection with the value of a company is often underlined; it is even claimed that corporate reputation represents the value of a company (Marcellis-Warin and Teodoresco, 2012, pp. 7–17). Corporate reputation is often defined as the perception of a company among its stakeholders, the outcome of shared socially impressions of a firm (Fombrun and Van Riel, 1997). It is a function of collective judgements of a firm 'based on assessments of the financial, social, and environmental impacts attributed to the corporation over time' (Barnett et al., 2006). There are many definitions of corporate reputation based mainly in economics, management, sociology, and psychology. There are also different determinants and aspects of corporate reputation that matter while taking into consideration each stakeholder group. Corporate reputation is fundamental for creating and establishing appropriate relationships between a company and its stakeholders.

It is widely claimed that a higher corporate reputation can encourage stakeholders to undertake certain activities that improve a company's financial situation in terms of profit, market value, etc. (Roberts and Dowling, 2002, pp. 1077–1093; Harrington, 2003, pp. 52–61; Riahi-Belkaoui, 2003, pp. 1–22; Cox et al., 2004, pp. 27–47; Anderson and Smith, 2006, pp. 86–93; Smith et al., 2010, pp. 201–221 etc.).

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On the one hand, a better financial situation results in an increase in a company's reputation (especially while approaching the problem from an investor's perspective); but on the other hand, a better corporate reputation is supposed to improve a company's performance. Fombrun (1996, p. 72) states that corporate reputation is "a perceptual representation of a company's past actions and future prospects…". Following this definition, Roberts and Dowling created a model of reputation-financial performance dynamics, where past financial performance influences reputation, and a reputation influences future financial performance of a given company (Roberts and Dowling, 2002, p. 1078; Figure 1).

Moreover, they indicate that investors do not have access to all of the information about a company, so their decisions rely mostly on 'previous financial performance outcomes as signals of a firm's overall esteem.' The authors decompose an overall reputation into a financial reputation (predicted by its previous financial performance) and residual reputation ('left over'; Fig. 1).

Studies on relationships between corporate reputation and its performance mostly consider the impact of corporate reputation on a company's performance; as a result, the aim of this study was to examine the other part of the Roberts and Dowling model of reputation-financial performance dynamics. Particularly, the aim of this study was to verify the short-term impact of financial variables on corporate reputation perceived by investors.

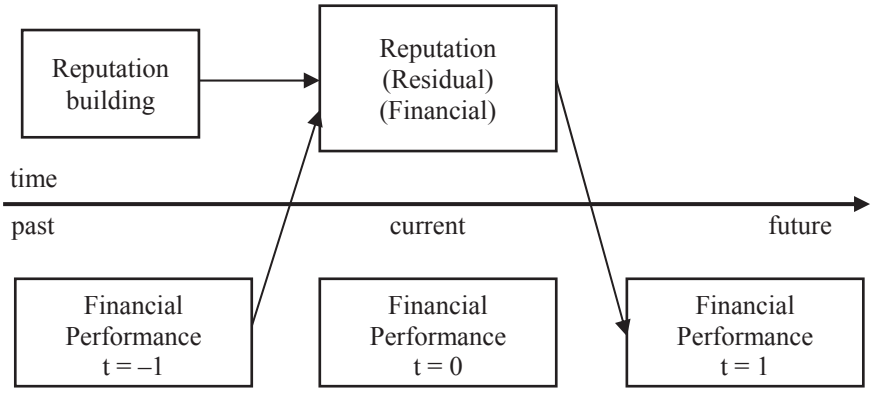

Figure 1. Roberts and Dowling's model of reputation-financial dynamics

Source: own compilation on the basis of Roberts and Dowling (2002, p. 1078)

In the study, we applied an assumption based on various business valuation theories and the literature in the subject, stating that overall corporate reputation

is reflected in the difference between the valuation of a company by investors and its book value.

In order to verify their impact, financial variables were grouped into three categories measuring the level of a company's profitability, stability, and risk. This division aims to verify the most important financial characteristics for investors in the process of building their perception of a company's reputation, and later in influencing their behaviour on the stock exchange. The methods applied in the study are multiple regressions on ranks and on first differences and an analysis of contingency tables (chi-squared tests of independence and Yule's coefficient of colligation).

The article proceeds as follows. The next section provides a brief overview of the literature on previous studies on relationships between corporate reputation and companies' financial performances, as well as concepts of business valuation incorporating the idea of corporate reputation. In the following section, the applied methodologies are outlined. In the penultimate section, findings on the short-term determinants of corporate reputation are presented and discussed. The final section provides conclusions, the study weaknesses, and establishes directions for future research.

2. Literature review

As mentioned above, there is a wide array of studies on the impact of corporate reputation on a company's performance. According to Beatty and Ritter (1986, pp. 213–232) as well as Riahi-Belkaoui (1999, pp. 25–36), a better reputation can create a better image of a company in capital markets and a more-correct valuation by investors. In sociology and social psychology, an impression management theory suggests that the process of creating positive reputation leads to tangible benefits. This kind of management is a process in which one attempts to influence the perceptions of stakeholders about a company.

Some research also suggests that positive information (concerning reputation) is often overestimated, while negative information is either ignored or underestimated by stakeholders (Brennan et al., 2008, pp. 789–832). Positive financial information about a corporation's reputation increases the probability of buying its shares much more than positive information about corporate ethics (Blajer-Gołębiewska and Kos, 2016, pp. 11–31).

Moreover, corporate reputation may be relative. Roberts and Dowling (2002, pp. 1077–1093) suggest that a company's higher performance results from its advantages in its relationship with its competitors. Results of their study show that companies with superior reputations are better able to maintain superior profitability over time. Similar conclusions were drawn from the study of Smith

and others. They compared high reputation firms to a control sample of firms and found that firms with high reputations receive a market value premium ($1.3 billion on average; Smith et al., 2010, pp. 201–221). In this context, the important fact is that "each corporate reputation is unique and impossible to copy" (Marcellis-Warin and Teodoresco, 2012, p. 7), so each company has to work for its own good reputation.

According to Riahi-Belkaoui (2003, pp. 1–22), reputation explains relative market value for multinational firms. Moreover, the higher the corporate reputation, the greater is the impact of multinationality on the q-Value of the company.

In the studies on relationships between corporate reputation and financial variables, the proxies applied for corporate reputation were mainly points/numbers in rankings of companies with the best reputations (Black et al., 2000, pp. 31–42; Roberts and Dowling, 2002, pp. 1077–1093; Brammer et al., 2006, pp. 1–28; Smith et al., 2010, pp. 201–221; Cole, 2012, pp. 47–68; Blajer-Gołębiewska, 2014a, pp. 194–207 etc.). The most common is the list of America's Most Admired Companies, published by Fortune.

In the corporate reputation perspective, return on assets (ROA) is the most common proxy for financial performance (Black et al., 2000, pp. 31–42; Roberts and Dowling, 2002, pp. 1077–1093; Smith et al., 2010, pp. 201–221). Not only does it show a company's ability to generate profits, but it can also be used for comparisons across industries that are crucial while analysing companies from different sectors (Sabate and Puente, 2003, pp. 161–177). Similarly, a proxy for financial performance is sometimes a company's efficiency at generating profits from every unit of shareholder equity, which is represented by a return on equity indicator ROE (Smith et al., 2010, pp. 201–221; Blajer-Gołębiewska, 2014a, pp. 194–207). In their research, Smith and others (2010) used a wide range of financial indicators, which included cost of capital, volatility in sales, volatility net income, current ratio, and financial leverage. They found that companies with better reputations experienced superior financial performance and lower risk (measured as a lower cost of capital, less volatility in sales, and net income).

There were also other variables included in studies on corporate reputation, such as the size of a company (Black et al., 2000 pp. 31–42; Roberts and Dowling, 2002, pp. 1077–1093), relative market-to-book value (market value divided by total shareholder equity; Roberts and Dowling, 2002, pp. 1077–1093), stock price volatility (the standard deviation of the monthly logged price relatives; Hillier et al., 2008 Smith et al., 2010, pp. 201–221), and credit score – a measure calculated as the combination of main financial variables used also to predict bankruptcy and cost of debt issuances (Altman, 2000; Smith et al., 2010, pp. 201–221).

Studies on the value of corporate reputation show evidence of 'an invisible intangible asset that is value-relevant in explaining the market value of the firm'

(Black et al., 2000, pp. 31–42). As mentioned above, it is often stated that corporate reputation is reflected in the relationship between a company's market value and its book value (Riahi-Belkaoui, 2003, pp. 1–22; Marcellis-Warin and Teodoresco, 2012, pp. 2–43). It may be also perceived as a representation of the validity of decisions on reputation-enhancing expenditures. Certainly, there is a gap between the book value of a company and its valuation by investors (market value). In the theory of business valuation, there are models aiming to calculate the value of corporate reputation on the basis of the gap.

There is a group of business valuation methods called the mixed methods, reputation-based methods, or goodwill-based methods. These include the Indirect Method, Direct Method (also called Anglo-Saxon Method), Union of European Accounting Experts Method (UEC Method), Risk-Bearind and Risk-Free Rate Method, and others. They are based on the assumption that a firm's real value consists of its book value and the value of its reputation/goodwill (Machała, 2011, pp. 506–508; Fernández, 2005, pp. 128–141). The value of reputation in these models is based on the difference between book value and other valuations. There is also a parameter that is explained differently in each of the mixed methods and represents the share of reputation in the difference between book value and the other valuations. In a basic approach, the parameter is assumed to be constant . In others, such as the UEC Method, the parameter is based on annuity calculation (Jaki, 2008, pp. 108–117). In the popular Gref Method, a discount rate and the amortization of reputation are also taken into consideration. There are also other mixed methods of different explanations of a parameter; in other words, explanations of a share of reputation is the excess of a company's market value over its book value (Jaki, 2008, pp. 108–117). Construction of the parameter is not the subject of this study, however; what is important is the idea that corporate reputation is related to the value of a company above its book value (above the net asset value).

Following the above-mentioned studies, it would be beneficial for understanding the problem of corporate reputation to identify financial determinants influencing investors' decisions to buy shares of a company and to place a certain value on a share that, very often, is higher than its results from book value. Therefore, in this study, the impact of financial determinants on corporate reputation, measured as a difference between its book value and market value, was analysed.

3. Methods of the research

In order to find an impact of financial variables on the perceived corporate reputation, the following stages of research were conducted: (1) selection of proxy for corporate reputation; (2) selection of proxies for a company's

financial performance; (3) sectors and firms selection; (4) statistical analyses of panel data.

In this research, the impact is put on investors and their perception of corporate reputation as a result of a belief that a company is able to generate profits in the future. As a result, the chosen proxy for reputation is the difference between a firm's valuation by investors in the stock market (reflected in share prices and capitalization) and the value of a company's assets (book value). In order to achieve a comparable measure, a relative indicator was applied which is the MV to BV ratio.

This choice of proxy for corporate reputation is also driven by the lack of reputational rankings for most Polish companies. For example, in the Responsible Company ranking, the number of firms included is higher each year, but it reached only 72 firms in 2015.

While considering financial determinants that could influence corporate reputation, we took into consideration literature analyses and the availability of data. As a result, three groups of variables were selected, representing:

- profitability: net profit, ROA, ROE, earnings per share;
- stability/size of a company: assets, equity, book value per share;
- level of risk: financial leverage, debt to assets, debt to equity, long-term liabilities, short-term liabilities.

We analysed the impact of selected financial variables and indicators on differences in the valuation of selected companies listed on the Warsaw Stock Exchange. Particularly, we analysed companies operating in the construction and IT sectors. These sectors were chosen for three reasons. Firstly, they represent different types of activities (industry vs. services), which impacts the diversity in the structure of their financial statements. Secondly, the sectors are suitable for data analysis, because each of them encompasses a relatively high number of companies, and there is a stock index for the sector. Lastly, the homogeneity of companies is relatively higher than in other sectors in their groups, which should enhance the stability of the estimated models. Initially, there were 35 companies listed in the construction sector and 36 IT companies. Some companies were excluded in the data-collecting process due to being in liquidation processes, which results in equivocal changes in financial indicators.

Finally, the data pertains to 62 companies: 27 listed in the construction sector and 35 IT companies. The time range spans from the first quarter of 2009 to the fourth quarter of 2015, which gives us a maximum of 28 quarterly observations. Not every company included in the data set was listed on the stock exchange from the first period of our analysis, resulting in unbalanced panel data. The basic information about the size of the panel data was included in Table 1.

Table 1

Size of the panel data

Statistics	Overall	Construction sector	IT sector
Number of observations	1512	670	842
Length of time series	13–26	16–26	13–26
Number of companies	62	27	35

Source: own compilation

Financial indicators are published after the period they concern; thus, their impact on market value is shifted over time. In the case of the analysed companies (listed on the Warsaw Stock Exchange), the quarterly and consolidated quarterly reports shall be submitted at the same time (on the date specified by the issuer, but no later than within 45 days after the end of the quarter to which it relates). However, a company is not obligated to submit quarterly reports for the second and fourth quarters of the financial year, so companies do it voluntarily, often while submitting half-yearly reports and reports considering the whole fiscal year (*Rozporządzenie Ministra*…, 2014).

It was not our intention to analyse the short-term impact of earnings announcement on share prices, and consequently on market valuation, as it usually considers a few days after the announcement and may be biased by short-term behavioural anomalies. In order to analyse the changes in corporate reputation, we needed to check the effect after a longer term, which allows us to omit short-term volatilities caused by the announcements.

As mentioned above, the impact of financial indicators on market value is shifted in time. To reflect this lag, we adjusted the Roberts and Dowling's model matching financial indicators from one quarter with the market value of the second quarter after the one in question (Fig. 2). Market value itself was computed as a product of mean share prices from a quarter and the number of shares. Due to the shifting, the maximum length of time series is 26.

The data about financial performance consists of observations from the same set of companies over multiple time periods. This is panel data, also known as longitudinal data.

The analysis was made so to reflect the intrinsic structure of the data. Therefore, the main focus of the analysis was on panel data models. Because of some features of the date described below, real values were replaced by various transformations. We have distinguished four approaches to the analysis: (1) multiple regression on ranks across time and companies; (2) multiple regression on ranks made separately for each period, (3) multiple regression on first differences; (4) analysis of contingency tables (chi-squared tests of independence and Yule's coefficient of colligation).

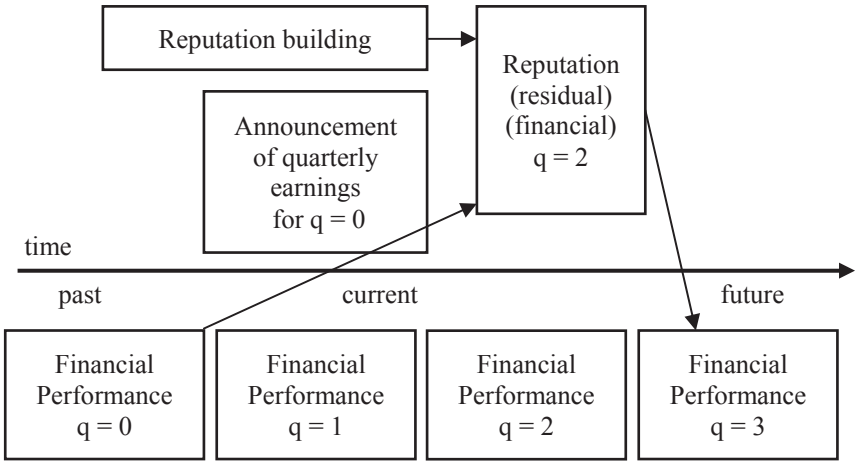

Figure 2. The applied stylization of the Roberts and Dowling model of reputation-financial dynamics (adjusted for quarterly observations)

Source: own compilation on the basis of Roberts and Dowling (2002, p. 1078)

4. Findings

Overall, the data consists of 1512 unit observations, 670 belonging to the construction sector and 842 to the IT sector. Some basic descriptive statistics of the data set are shown in Table 2. All values with dimensions are expressed in thousands of PLN.

Table 2

Summary statistics of the data

Variable	Sector	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
Net profit	constr.	−593 000	−266	1 124	935	4 491	190 200
	IT	−44 890	−55	516	4 342	2 575	241 300
ROA	constr.	−0.5184	−0.0030	0.0059	0.0007	0.0162	0.1636
	IT	−0.2763	−0.0013	0.0086	0.0122	0.0225	0.4801
ROE	constr.	−107.7000	−0.0048	0.0118	−0.2921	0.0335	0.5678
	IT	−4.9110	−0.0017	0.0126	0.0018	0.0318	0.6384
Earnings per share	constr.	−26.9100	−0.0119	0.0538	0.1547	0.3153	7.6150
	IT	−3.7760	−0.0041	0.0603	0.3548	0.2865	14.5200

Table 2 cont.

Assets	constr.	7 199	102 300	242 900	501 700	523 300	3 859 000
	IT	1 304	26 750	79 720	313 800	249 300	5 595 000
Equity	constr.	427	55 650	119 900	172 000	233 700	1 115 000
	IT	396	16 720	54 980	246 200	179 200	5 097 000
Book value per share	constr.	0.00	1.90	7.98	14.49	18.69	95.76
	IT	0.00	1.77	6.69	16.48	13.92	158.20
Financial leverage	constr.	1.0640	1.4560	1.7890	9.3530	2.5760	2 475.0000
	IT	1.0050	1.1960	1.3890	1.9710	1.7840	110.5000
Debt to assets	constr.	0.0601	0.3097	0.4404	0.4604	0.6097	0.9996
	IT	0.0046	0.1582	0.2724	0.3085	0.4349	0.9910
Debt to equity	constr.	0.0642	0.4495	0.7875	8.3400	1.5760	2 474.0000
	IT	0.0046	0.1880	0.3785	0.9694	0.7840	109.5000
Long-term liabilities	constr.	0	2 565	11 520	62 280	62 780	1 222 000
	IT	0	365	2 084	22 360	8 518	416 500
Short-term liabilities	constr.	730	19 870	66 320	266 400	187 700	3 075 000
	IT	32	4 823	14 500	43 890	53 500	503 400
Market value	constr.	830	45 850	138 800	1 745 000	365 100	109 000 000
	IT	635	17 830	69 330	419 800	259 800	25 500 000
Market value / Equity	constr.	0.07	0.68	1.17	13.12	2.08	3705.00
	IT	0.08	0.65	1.07	6.78	2.19	965.90

Source: own compilation

The most important feature of these empirical distributions is the presence of outliers. Almost every variable contains values that dramatically exceed the typical range of variability. Not only are minimal and maximal values far from average values, but also there are substantial differences between mean and median, indicating huge skewness, usually positive. For instance, the mean net profit for the IT sector is 4,302,000 PLN, while the median barely exceeds 500,000 PLN – there are a few cases where net profit was much larger than the other ones, and they pull the mean far to the right on the axis.

Out of all of the companies in all time periods, corporate reputation, as defined above, was positive, i.e., the ratio of the market value to the book value was greater than one in 516 cases (34%), of which, 193 concerned the construction sector and 323 concerned the IT sector.

Because of the presence of outliers and, thus, considerable asymmetry in the variable distributions, parametric methods for analysing the data would be inappropriate. Although one can remove the outliers from the data and perform classical parametric analysis, the criteria for exclusion are always subjective to some extent. Therefore, we decided to keep all observations and (in order to minimize the impact of outliers) transform real values from a ratio or interval scale to an ordinal scale. The transformation was made in several different ways.

In the first approach, real values were replaced with their ranks across time and companies within a sector. A rank is the relative position of a value, if the data were sorted in an increasing way. With this solution, a company's performance is measured relative to its competitors' performance and to itself in different periods. The goal of the analysis was to model corporate reputation, defined as the ratio of MV to BV (the ratio is also ranked), against other variables. The first choice was to use multiple regression, considering the panel structure of the data. In the case of modelling panel data, two types of effects must be considered. One is the individual effect; i.e., the part of variability of the dependent variable that is specific to an individual (a company), causing a correlation in this individual's behaviour over time. Second is the time effect; i.e., the part of variability of the dependent variable that is specific to a time period, causing again a correlation in observations over the same period (Wooldridge, 2002, pp. 247–252). Each effect can be considered fixed (constant over time or across section) or random; i.e., as a realisation of a random variable with certain distribution. To test which approach is more suitable for each effect, the Hausman tests were performed (Hausman, 1978, pp. 1251–1271). The null hypothesis in the test states that the coefficients in both fixed and random effects models are consistent; but, the random effects model is preferred due to its higher efficiency. Under the alternative hypothesis, only a fixed effect estimator is consistent and, thus, preferred.

The other tests (which need to be done before choosing the final model) examine whether or not the individual and time effects are significant; otherwise, one can treat the data as homogeneous and fit the pooled model. These tests are the F test and Lagrange multiplier test (Breush and Pagan, 1980, pp. 239–253), for fixed and random effects, respectively.

The estimated fixed effects (two-way) model for the construction sector and the results for the accompanying tests are presented in Table 3.

The results for the Hausman tests suggest that it is more appropriate to treat both individual and time effects as fixed. The F test for two-way effects (individual and time simultaneously) proves that both effects are significant. This means that companies, as well as time periods, have their own specific effects that are constant over time and across sections and affect the relationship between reputation and its regressors.

Table 3

Fixed effects (two-way) model for the construction sector

Variable	Coefficient	Std. Err.	t-value	Pr(>|t|)	
Net profit	−0.2219	0.0766	−2.8974	0.0039	**
ROA	−0.3108	0.1216	−2.5557	0.0108	*
ROE	0.4156	0.1408	2.9526	0.0033	**
Earnings per share	0.1246	0.0664	1.8755	0.0612	·
Assets	−0.8375	0.1290	−6.4901	0.0000	***
Equity	0.3828	0.0844	4.5359	0.0000	***
Book value per share	−0.8526	0.0815	−10.4557	0.0000	***
Financial leverage	−0.8825	0.4847	−1.8208	0.0691	*
Debt to assets	0.9870	0.7832	1.2602	0.2081	
Debt to equity	−0.1187	1.1676	−0.1016	0.9191	
Long-term liabilities	0.0813	0.0801	1.0148	0.3106	
Short-term liabilities	0.3423	0.1455	2.3519	0.0190	*
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' '					
R-Squared: 0.3050 Adj. R-Squared: 0.2758					
Hausman tests for panel model (random vs. fixed effects)					
Effects	**test statistics (χ^2)**		**df**	**p-value**	
individual	67.42		12	0.0000	
time	133.03		12	0.0000	
F test for two-way effects (fixed)					
F	**df1**		**df2**	**p-value**	
21.15	51		606	0.0000	

Source: own compilation

Since each value is replaced by rank, interpretation of the coefficients in terms of nominal impact of certain variables on the dependent variable is not possible. However, thanks to ranks, each variable is expressed on the same scale; thus, estimated coefficients allow for the comparison of the magnitude and direction of impact for each variable. The highest impact on reputation occurred in the cases of book value per share and assets, both variables being negatively correlated with reputation. Among other variables that are significant (i.e., with p-value less than 0.05) are net profit, ROA, ROE, equity, and financial leverage. However, the model is not well-fitted to the data; the adjusted R^2 is 0.28, which is very low.

The same procedure was done with the IT sector as with the construction sector. This time, Hausman tests suggested that the random effects model would be more suitable for individual effects and the fixed effect model would be more suitable for time effects. The F test indicated, however, that the time effect is not significant. This means that, unlike the construction sector, the IT sector could be perceived as homogenous over time. Nevertheless, each company has a somehow different relationship between reputation and financial indicators due to strong individual effects. Therefore, the random effects (individual) model was fitted to the data from the IT sector. The estimated model is presented in Table 4.

In the model above, four variables turned out to be significant: equity, book value per share, long-term liabilities, and financial leverage. The greatest impact on reputation has book value per share (negative), same as in the construction sector. The financial leverage, which was significantly positively correlated with reputation in the construction sector, is also significant in the IT sector, but its correlation is negative. Again, interpretation of the coefficient is to be done with caution, because the model is not well-fitted to the data (adjusted $R^2 = 0.2769$).

Table 4

Random effects (individual) model for the IT sector

Variable	Coefficient	Std. Err.	t-value	Pr(>|t|)	
(Intercept)	632.9484	42.6315	14.8470	0.0000	***
Net profit	0.0136	0.0563	0.2417	0.8091	
ROA	−0.0364	0.1295	−0.2810	0.7788	
ROE	0.0419	0.1258	0.3334	0.7389	
Earnings per share	0.0787	0.0611	1.2889	0.1978	
Assets	0.0773	0.1642	0.4706	0.6380	
Equity	0.4615	0.1379	3.3465	0.0009	***
Book value per share	−0.9107	0.0603	−15.0983	0.0000	***
Financial leverage	−0.1902	0.3152	−0.6033	0.5465	
Debt to assets	0.1425	0.8086	0.1762	0.8602	
Debt to equity	0.2921	1.0650	0.2743	0.7840	
Long-term liabilities	−0.1500	0.0453	−3.3149	0.0010	***
Short-term liabilities	−0.3080	0.0672	−4.5806	0.0000	***
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' '					
R-Squared: 0.2812 Adj. R-Squared: 0.2769					

Table 4 cont.

Hausman tests for panel model (random vs. fixed effects)			
effects	**test statistics (χ^2)**	**df**	**p-value**
individual	0.07	12	1.0000
time	27.6	12	0.0063
Tests for individual and time effects			
test	**test statistics**	**df**	**p-value**
individual – random (Lagrange multiplier test, Breush-Pagan)	$\chi^2 = 4632.5$	1	0.0000
time – fixed (F test)	F = 1.25	df1 = 25, df2 = 804	0.1857

Source: own compilation

The second approach to the analysis consisted in replacing real values with ranks, similar to the first approach; but this time, the ranks have been made separately for each period. This means that, for each quarter, companies have been sorted by every variable, and ranks have been assigned ranging from one to a number of companies. The same panel data models as in the first approach were tested for each sector. The results of these analyses are shown in Tables 5 and 6.

Table 5

Fixed effects (individual) model for the construction sector (second approach)

Variable	**Coefficient**	**Std. Err.**	**t-value**	**Pr(>|t|)**	
Net profit	−0.1651	0.0726	−2.2749	0.0232	*
ROA	−0.2297	0.0970	−2.3682	0.0182	*
ROE	0.2925	0.1094	2.6730	0.0077	**
Earnings per share	0.1219	0.0693	1.7595	0.0790	·
Assets	−0.8444	0.1388	−6.0816	0.0000	***
Equity	0.3960	0.0865	4.5778	0.0000	***
Book value per share	−0.5496	0.0853	−6.4456	0.0000	***
Financial leverage	−0.4533	0.3676	−1.2332	0.2180	
Debt to assets	0.0300	0.4897	0.0613	0.9512	
Debt to equity	0.5203	0.6786	0.7668	0.4435	

Table 5 cont.

Variable	Coefficient	Std. Err.	t-value	Pr(>|t|)	
Long-term liabilities	−0.0364	0.0899	−0.4043	0.6861	
Short-term liabilities	0.3772	0.1362	2.7706	0.0058	**
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' '					
R-Squared: 0.1569 Adj. R-Squared: 0.1478					
Hausman tests for panel model (random vs. fixed effects)					
Effects	**test statistics (χ^2)**	**df**	**p-value**		
individual	108.55	12	0.0000		
F test for individual effects					
F	**df1**	**df2**	**p-value**		
20.29	26	631	0.0000		

Source: own compilation

Table 6
Fixed effects (individual) model for IT sector (second approach)

Variable	Coefficient	Std. Err.	t-value	Pr(>|t|)	
Net profit	0.0114	0.0513	0.2218	0.8246	
ROA	0.0280	0.1023	0.2733	0.7847	
ROE	−0.0019	0.0993	−0.0188	0.9850	
Earnings per share	0.0580	0.0565	1.0278	0.3044	
Assets	0.1789	0.1396	1.2817	0.2003	
Equity	0.4194	0.1177	3.5645	0.0004	***
Book value per share	−0.6759	0.0584	−11.5759	0.0000	***
Financial leverage	−0.0027	0.2065	−0.0131	0.9895	
Debt to assets	0.1049	0.4059	0.2585	0.7961	
Debt to equity	0.2405	0.5182	0.4641	0.6427	
Long-term liabilities	−0.1718	0.0445	−3.8632	0.0001	***
Short-term liabilities	−0.2931	0.0628	−4.6670	0.0000	***
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' '					
R-Squared: 0.1945 Adj. R-Squared: 0.1836					

Table 6 cont.

Hausman tests for panel model (random vs. fixed effects)			
effects	**test statistics (χ^2)**	**df**	**p-value**
individual	37.03	12	0.0002
F test for individual effects			
F	**df1**	**df2**	**p-value**
40.38	34	795	0.0000

Source: own compilation

Because of the way the data has been ranked, there is no point in taking time effects into consideration. Therefore, one Hausman test has been made for individual effects only. It indicated that the fixed effects model would be more appropriate. The F test strongly suggested that individual effects are significant. The fitted model has more or less the same estimated coefficients as the corresponding one from the first approach to data transformation. The same variables are significant and with the same direction. However, the model is poorly fitted to the data; the adjusted R^2 do not exceed 0.15.

The fixed effects (individual) model for the IT sector in the second approach shares the same characteristics as the random effects (individual) model in the first approach to data transformation (Tables 4 and 6). It has the same four significant variables with the same signs of coefficients. However, this model is weaker due to the lower R^2.

In the third approach to modelling reputation, the first difference of real values were used instead of any transformation changing scale. The motivation of this operation was the assumption that investors tend to invest in companies that are able to improve their financial positions in terms of profitability, stability, and to lower their levels of risk. These positive changes could influence investors' decisions more than just single numbers. For instance, a higher profit in a given quarter does not guarantee a company's better performances in the future. A natural consequence of the introduction of differences is that the time dimension of data becomes shorter. Here, the length of data set became shorter by the number of companies.

The same procedure as previous was applied to fitting panel data models. For the construction sector, Hausman tests suggested using the random effects approach for both effects. The Lagrange multiplier tests proved only the individual effects to be significant. Therefore, the random effects (individual) model has been fitted, and the estimates are presented in Table 7.

Again, the model is not well-fitted to the data. Also, the differences are expressed in the units of variables; thus, the above-mentioned influence of outliers might be substantial. As a consequence, the estimated coefficients for the models presented in Tables 7 and 8 are unreliable.

Table 7

Random effects (individual) model for the construction sector (third approach)

Variable	Coefficient	Std. Err.	t-value	Pr(>|t|)	
(Intercept)	−1.1031	4.2695	−0.2584	0.7962	
Net profit	0.0016	0.0002	6.8389	0.0000	***
ROA	8.8470	144.8367	0.0611	0.9513	
ROE	12.1070	3.2716	3.7007	0.0002	***
Earnings per share	−12.7691	4.2771	−2.9855	0.0029	**
Assets	−0.0003	0.0030	−0.0977	0.9222	
Equity	−0.0001	0.0030	−0.0347	0.9723	
Book value per share	−0.2578	2.3082	−0.1117	0.9111	
Financial leverage	100.8556	347.5211	0.2902	0.7717	
Debt to assets	−33.7633	93.9449	−0.3594	0.7194	
Debt to equity	−100.3062	347.5238	−0.2886	0.7730	
Long-term liabilities	0.0008	0.0030	0.2681	0.7887	
Short-term liabilities	0.0001	0.0030	0.0386	0.9692	
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' '					
R-Squared: 0.2556 Adj. R-Squared: 0.2505					
Hausman tests for panel model (random vs. fixed effects)					
effects	**test statistics (χ^2)**		**df**	**p-value**	
individual	1.91		12	0.9995	
time	4.6		12	0.9701	
Lagrange multiplier (Breush-Pagan) tests for individual and time effects					
effects	**χ^2**		**df**	**p-value**	
individual – random	12.29		1	0.0005	
time – random	0.07		1	0.7914	

Source: own compilation

Another approach to the analysis could be the use of ranks of first differences. This approach was tested by the authors, and the results are very poor (R^2 less than 0.05); therefore, they will not be presented in this paper.

Table 8

Random effects (individual) model for the IT sector (third approach)

Variable	Coefficient	Std. Error	t-value	Pr(>|t|)	
(Intercept)	−0.3316	0.6860	−0.4835	0.6289	
Net profit	0.0000	0.0001	0.3660	0.7144	
ROA	−121.3203	30.2496	−4.0106	0.0001	***
ROE	54.2505	5.2296	10.3737	0.0000	***
Earnings per share	0.5539	1.2823	0.4320	0.6659	
Assets	0.0000	0.0002	0.1186	0.9057	
Equity	0.0001	0.0002	0.3641	0.7159	
Book value per share	−0.3385	0.6944	−0.4874	0.6261	
Financial leverage	13.6253	16.2168	0.8402	0.4011	
Debt to assets	54.3012	18.0786	3.0036	0.0028	**
Debt to equity	−17.4093	16.2219	−1.0732	0.2835	
Long-term liabilities	0.0000	0.0002	−0.0926	0.9262	
Short-term liabilities	−0.00 01	0.0002	−0.3704	0.7112	
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’					
R-Squared: 0.2809 Adj. R-Squared: 0.2764					
Hausman tests for panel model (random vs. fixed effects)					
effects	**test statistics (χ^2)**		**df**	**p-value**	
individual	6.1		12	0.9109	
time	15.76		12	0.2026	
Lagrange multiplier (Breush-Pagan) tests for individual and time effects					
effects	**χ^2**		**df**	**p-value**	
individual – random	16.1		1	0.0001	
time – random	0.03		1	0.8738	

Source: own compilation

The last approach to the analysis was to compare companies with positive reputations (i.e., where market value is greater than book value) to companies with negative reputations. Because of the presence of outliers and highly skewed distributions, the comparison was based on counts, and well-known chi-squared tests for independence were performed. Each variable was divided in half by median, and 2×2 contingency tables were created. To assess the magnitude of correlation, Yule’s coefficients of colligation were also computed. The results of these computations are presented in Tables 9 and 10.

Table 9

Chi-squared independence tests for the construction sector

Variable		Reputation		χ^2	p-value	ϕ
		MV < BV	MV > BV			
Net profit	bm	152	183	2.70	0.1003	0.067
	am	130	205			
ROA	bm	155	180	4.46	0.0346	0.085
	am	127	208			
ROE	bm	162	173	10.29	0.0013	0.127
	am	120	215			
Earnings per share	bm	133	202	1.38	0.2405	−0.048
	am	149	186			
Assets	bm	174	161	25.87	0.0000	0.200
	am	108	227			
Equity	bm	164	171	12.40	0.0004	0.139
	am	118	217			
Book value per share	bm	108	227	25.87	0.0000	−0.200
	am	174	161			
Financial leverage	bm	172	163	22.79	0.0000	0.187
	am	110	225			
Debt to assets	bm	173	162	24.30	0.0000	0.193
	am	109	226			
Debt to equity	bm	173	162	24.30	0.0000	0.193
	am	109	226			
Long-term liabilities	bm	169	166	18.52	0.0000	0.169
	am	113	222			
Short-term liabilities	bm	169	166	18.52	0.0000	0.169
	am	113	222			

am – above median; bm – below median;
ϕ – Yule's coefficient of colligation

Source: own compilation

The results presented in Tables 9 and 10 show that being either above or below median for almost every variable is significantly associated with having a positive or negative reputation. Nevertheless, such outcomes partially result from relatively high counts, which make small percentage differences statisti-

cally significant. Yule's coefficients, showing the scale of correlation irrespective of number of observations, are relatively low; i.e., not far from zero. In the case of the construction sector, the highest absolute value of Yule's coefficient is 0.2 for assets and −0.2 for book value per share. In the case of the IT sector, book value per share is even more negatively associated with reputation, with the coefficient's value of −0.424.

Table 10

Chi-squared independence tests for the IT sector

Variable		Reputation		χ^2	p-value	ϕ
		MV < BV	MV > BV			
Net profit	bm	213	208	4.01	0.0452	0.071
	am	183	238			
ROA	bm	219	202	8.01	0.0046	0.100
	am	177	244			
ROE	bm	229	192	17.74	0.0000	0.148
	am	167	254			
Earnings per share	bm	195	226	0.12	0.7299	−0.014
	am	201	220			
Assets	bm	177	244	8.01	0.0046	−0.100
	am	219	202			
Equity	bm	175	246	9.65	0.0019	−0.109
	am	221	200			
Book value per share	bm	109	312	149.36	0.0000	−0.424
	am	287	134			
Financial leverage	bm	219	202	8.01	0.0046	0.100
	am	177	244			
Debt to assets	bm	218	203	7.25	0.0071	0.095
	am	178	243			
Debt to equity	bm	218	203	7.25	0.0071	0.095
	am	178	243			
Long-term liabilities	bm	189	232	1.38	0.2405	−0.043
	am	207	214			
Short-term liabilities	bm	185	236	2.98	0.0843	−0.062
	am	211	210			

am – above median; bm – below median;
ϕ – Yule's coefficient of colligation

Source: own compilation

Despite not being very high, Yule's coefficients of colligation are in line with most of the regression coefficients from the panel data models in the first and second approaches. In both sectors, book value per share seems to have the strongest influence on perceived reputation, and it is negative (which means the greater the book value per share, the smaller the reputation). Book value (equity) itself is positively correlated with reputation. Other than these two factors, there are more differences than similarities between the sectors. According to regression analysis, profitability has more impact on reputation in the construction sector, whereas it is irrelevant in the IT sector.

5. Conclusions, study weaknesses, and directions for future research

In the study, we wanted to verify short-term impacts of selected financial determinants on corporate reputation (as perceived by investors) in the context of Roberts and Dowling's model of reputation-financial performance dynamics. In the model, it is assumed that past financial performance influences reputation, and reputation influences future financial performance of a given company (Roberts and Dowling, 2002, pp. 1077–1093). As the influence of reputation on financial performance was widely investigated and presented within the literature, we wanted to focus on the other part of the model: financial determinants influencing corporate reputation.

In order to find an indicator for corporate reputation (as perceived by investors), we applied an approach from the field of business valuation assuming that corporate reputation is reflected in the gap between the book value of a company and the value that investors put on it (market value of a company).

Regarding quarter-to-quarter observations, analysed financial factors either weakly affect or do not affect corporate reputation. In both analysed sectors changes in profitability significantly affected corporate reputation. Nevertheless, it is clear that the two analysed sectors have somehow different relationships between financial determinants and corporate reputation. Generally, it seems that other determinants of corporate reputation in the construction sector are stability and profitability. For corporate reputation as perceived by investors in the IT sector, significant determinants are stability and the level of financial risk (measured with long- and short-term liabilities and changes in the debt-to-assets ratio).

The main weakness of the study is that the above findings are limited to the two examined sectors – the estimated relationships in the construction sector differ from those in the IT sector (and the same probably applies to other sectors). Also, the estimated models are not well-fitted to the data, which may mean

either financial factors do not influence corporate reputation at all, or the type of relationships is different than examined.

The popular sentence says that reputation takes time to build up, but it is easily damaged (Scott and Walsham, 2005, pp. 308–322). Data analyses conducted for the purpose of this study seems to be consistent with this thesis. The fact that there are only weak influences of financial variables on corporate reputation could be explained by the fact that reputation building is a long process, taking place in many small steps.

Therefore, it is necessary to conduct a similar study taking into account the long-term impact of financial factors on the development of the reputation of stock listed companies. Moreover, it would be beneficial to conduct analyses of impacts of other factors that may influence corporate reputation, which constitute the residual reputation in Roberts and Dowling. Such analyses should be conducted not only in the long-run, but also in the short-run (for example, by applying an event study methodology).

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Evaluation of training programs by medical employees in a chosen hospital in Poland

1. Introduction

Commitment in the professional role is undoubtedly a factor that influences professional success. A person who is well-equipped to perform their organizing role accepts the aims and duties set by the employees, acknowledges social norms of performance, and has the ability of satisfactory discharge of the duties, in aspect of their aims as well as the team's aims (the team it cooperates with).

Monitoring the degree of involvement and satisfaction with the tasks performed in the hospital should be one of the manager's tasks. The systematic assessment of work quality, according to the authors, can become a source of knowledge about the employee's needs. This, in turn, gives a chance to adjust motivational stimulus. One of them is purposeful training offer, accepted by the employees. It has a great importance in medical care facilities, where the health and lives of patients depend on the knowledge and skills of medical workers.

A hospital that intends to manage quality effectively should create appropriate working conditions for its employees and properly manage personal relations. The quality of medical services is in the interest of all organization members. If the employees are not convinced about the significance of management quality and do not support the hospital's mission of implementating improvement quality systems, then it will not make any sense. This is due to the fact that employees realize the quality policy and care about the enhancement of quality of work and service provision processes (Karniej, 2010). The managing staff is responsible for

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initiating and coordinating actions, as well as motivating the employees to be more resourceful for the sake of the patients and the hospital. Each employee should feel that they are an integral part of a chain of values, which is created as a result of the cooperation of all people employed in an organization.

A frequent cause of external customer (patient) dissatisfaction is the employee. The medical equipment and modern technologies make the medical staff concentrate on technical aspects of medical care, forgetting that a patient is a living human, full of fear for his life and health. A patient is a person who expects an individual approach. When analyzing the quality of medical services, it would be worth the managing staff to consider negative opinions. Could the impersonal treatment of a patient by an employee be caused by professional burnout triggered by long-term fatigue and stress? Perhaps a cause of such behavior could be not adjusting the manager's requirements to the employee's abilities. In relation to the considerations above, a hospital should develop a staffing strategy that would meet its mission and would be based on the following aspects:

– proper selection of employees (recruitment criteria are significant),
– aimed training and development of employees (investing in knowledge and skills that will increase the organization's competitiveness),
– regular assessment of employees,
– development of individual career plans,
– proper (effective) motivation system,
– creating meaningful culture of organization.

Continuous professional development requires the preparation of an annual training schedule as well as hiring professional and competent training staff (Lee et al., 2012; Skiba et al., 2008). Training offered by the hospital should be evaluated by the participants and the organizers. Work results (improvements) and employee evaluation should measure the effectiveness of a training program (Aggarwal et al., 2010; Moyer-Childress et al., 2007). It is important to remember that the best way to involve the staff in the process of improving quality and triggering development is to create a special team (e.g., quality team). Not all training for employees to satisfy their needs will bring the expected results (Elbadri, 2001). Regular monitoring of employee stress level can produce much better results. (see Williams and Cooper, 2002; Jeffcott et al., 2008). According to B. Gilbreath and M.U. Montesino, a stress audit can significantly help eliminate barriers that limit employees performance (see Gilbreath et al., 2006).

Employee satisfaction (from the tasks they are performing) and customer satisfaction (patient satisfaction) are crucial for the hospital's high quality that can be measured (Green and Skinner, 2005). One of the tools of such measurement will be presented in this article (a map of training program quality).

2. Research methodology

In this article, an assessment of the training programs addressed to medical employees of the selected Polish specialist hospital has been presented. The hospital has an accreditation certificate issued by the Center for Monitoring HealthCare Quality (CMJ Krakow). The hospital obtained ISO 9001:2000 certificate in 2009 for hospital treatment, in the areas of hospital treatment, ambulatory specialist healthcare services, medical rehabilitation, dialysis therapy, image and laboratory diagnostics, as well as prophylactic health programs.

The analysis was carried out among doctors and nurses working in 24 wards. The survey resulted in a "quality map" on which vital aspects (requirements) concerning the training programs offered by the hospital were presented (see Detyna and Detyna, 2011; Detyna and Detyna, 2012). The location of points on "quality maps" indicates the critical elements that managers should improve on in the first place.

In order to evaluate the training program of a chosen specialist hospital, a survey was prepared. Up to 300 surveys were distributed in hospital wards. Up to 131 surveys were collected, which constitutes 43.7% of all questionnaires. Unfortunately, many participants (mainly doctors) refused to complete the survey. The reasons were:

– lack of time,
– fear of disciplinary consequences from employers (although the survey was anonymous),
– lack of interest in such analysis,
– lack of knowledge about the authors of the publication.

The questionnaire was prepared with reference to creating a "quality map" of the training program. In the first part of the survey, the respondents were asked to indicate (from 1 to 5) the significance and evaluation of a given aspect (requirement). The table includes eight factors that determine the level of satisfaction with the course or training:

– subject area,
– length of training,
– time of training,
– price of training,
– competencies of trainers,
– obtaining a certificate/diploma of completing the training,
– gaining new knowledge,
– gaining new skills.

The second part of the study contained 12 questions, which included 6 alternative questions, 2 open questions, 2 questions in which respondents could give only one answer, and 2 partly open questions.

After gathering and processing the data, a statistical analysis was carried out. The numerical data from the table allowed us to calculate a **Training Offer Assessment Index** (*TOAI*). Two "quality maps" of the specialist hospital's training program have been drawn, on which all of the studied aspects (requirements) evaluated by doctors and nurses were marked with points. Responses from the medical employees to the questions in the second part of the survey led to a graphic presentation, in the form of tables and diagrams. C

A complementary part of the statistical description includes results that apply separately to doctors and nurses.

Data concerning the satisfaction level of medical employees can be obtained from a variety of surveys. In Tables 1 and 2, the authors have placed the results of surveys that helped to calculate the **Indexes of Training Offer Assessment – *TOAI* (Training Offer Assessment Index)**.

Following the calculation of averages significance w_k (on a scale of 1–5, the staff evaluated the validity of various aspects of the assessment of the training offer) and assessment c_k (assessment of the degree of satisfaction of employees from eight mentioned aspects) of particular aspects regarding the training offered by the hospital, indicators for training assessment *TOAI* for nurses and doctors have been calculated according to the formula (Detyna and Detyna, 2012):

$$TOAI = \sum_{k=1}^{k} w_k \cdot c_k$$

It is beneficial to gain a higher and higher *TOAI*. It would be a good idea to carry out such an analysis periodically. This way, unfavorable tendencies can be quickly identified and prevented (see book Detyna and Detyna, 2011).

The average weights of particular aspects of training offer and average assessment of these aspects as coordinates formed points, which were placed on the quality map (see Figs. 1 and 2). A simplified interpretation of the location of points put on the map is as follows:

- Points that are located in the bottom left quarter of a map should be improved in the last instance – their significance and evaluations are relatively slight.
- Points that are located in bottom right quarter should be improved on in the first instance.
- Points that are located in top left quarter indicate that it is possible to relocate financial resources to other fields that need more urgent action.
- Points that are located in top right quarter of a map show that both the significance and evaluation of the aspects are on a high level, and it would be appropriate to maintain this position in the future.

The "quality map" tool is universal and can be effectively used in different studies. Its fundamental advantages are its simplicity and short time of data processing. The value is a two-dimensional representation of the issue (problem). The graphic presentation is easy to interpret, and in a convincing way appeals to managing staff who can see the critical points that should be improved on in the first place. The sequence of improvements should be related to the significance of a particular aspect (requirement) for respondents (employees, patients). If a particular factor is very important, then it is undoubtedly the reason for taking immediate improvement actions.

3. Short description of a chosen specialist hospital

The hospital's mission is to "Rescue, treat and always give hope." The hospital is a multidisciplinary institution providing medical services in compliance with European standards. The quality of services was acknowledged by an ISO certificate and national accreditation. Thanks to European Union funds, the hospital is developing continuously through investments in medical equipment and new wards. The managing staff attempts to adjust their services to the needs of the patient. The hospital also supports innovative solutions in medical research.

The main aim of the specialist hospital is to provide healthcare services in the following areas: inpatient healthcare and ambulatory specialist healthcare services provided by specialist outpatient clinics and other organisational units. The range of healthcare services provided by the hospital is determined by contracts with health insurance institutions, with individuals, body corporate, and other organisational units. The operating range of the hospital in 2014 can be shown by the following numbers:

– medical staff (doctors and nurses) – 1293,
– planned hospitalization – 35,627,
– emergency hospitalization – 8086,
– deaths – 1001,
– autopsies – 143,
– total number of admitted and treated patients – 5871,
– ambulatory advice – 3730,
– approximate length of patient staying at a ward – 2.5 nights,
– hospital wards – 24,
– specialist outpatient clinic – 18,
– specialist unit – 7,
– laboratories – 1,
– therapeutic healthcare programs – 8.

At present, the hospital employs 1415 people, out of which 91.4% (1293 people) are "white coat" employees (doctors and nurses). The hospital runs educational specialist programs in 23 specializations. It cooperates with universities, and has a vision of strengthening its position as a medical research center.

4. Results of surveys – case study

The analysis of surveys was divided into two parts. The interpretation of the data for doctors and nurses was analyzed separately. In Table 1, the authors placed the collective results of significance and assessment of particular training options that were addressed by the hospitals to doctors.

Average significances and assessments were presented on a quality map (see Fig. 1). All the points were located in the part of the diagram that indicates that the condition should be maintained.

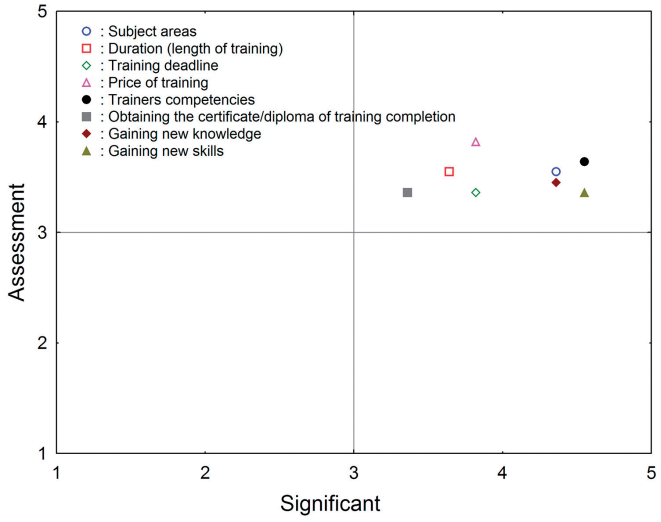

Figure 1. Quality map of the training offer – assessment of doctors

Source: own work

The evaluation is satisfactory, yet the managing staff can try to improve the obtained results. None of the aspects of the training offer were evaluated above 4.0 by doctors. The highest was the price of training (approx. 3.82). A relatively high note was given for the trainer competencies (approx. 3.64). The lowest

Table 1

Summary poll research results of doctors

Significance						**Aspects (requirements) of the training offer**	**Assessment**					
Average significance of aspect	Very important	Important	Neither important nor important	Unimportant	Not at all important		Very poor	Poor	Satisfactory	Good	Very good	Average assessment of aspect
	5	**4**	**3**	**2**	**1**		**1**	**2**	**3**	**4**	**5**	
4.36	18	12		3		Subject areas			15	18		3.55
3.64	3	18	9	3		Duration (length of training)		3	15	9	6	3.55
3.82	3	24	3	3		Training deadline		6	9	18		3.36
3.82	9	15	6		3	Price of training			12	15	6	3.82
4.55	18	15				Trainer competencies			12	21		3.64
3.36		18	9	6		Obtaining the certificate/diploma of training completion		6	12	12	3	3.36
4.36	15	15	3			Gaining new knowledge			18	15		3.45
4.55	18	15				Gaining new skills			21	12		3.36

Source: own work

scores (approx. 3.36) were given for two aspects: the certificates/diplomas and the skills gained. The subject area of the training and its length received the same score (approx. 3.55).

What distinguishes doctors from nurses, among others, is the significance of some aspects. For the surveyed doctors, the most important elements of the mentioned aspects were trainer competencies and gaining new skills (approx. 4.55). For nurses, the price of the training was the most important (approx. 4.57). The lowest value (significance) assigned by doctors was for certificates/diplomas (approx. 3.36). The Training Offer Assessment Index (TOAI) for the occupational group of doctors amounted to 113.99.

Results of the surveys for nurses are presented in Table 2.

Similar to doctors, all average assessments were below 4.0. A significant difference is the evaluation of the price of the offered training. Surveyed nurses are not as willing as doctors to pay for development courses. Since this aspect is the most important for nurses (and at the same time its score was the lowest), the managers of the hospital should do their best to improve the situation. The location of this critical aspect is presented on the quality map (see Fig. 2).

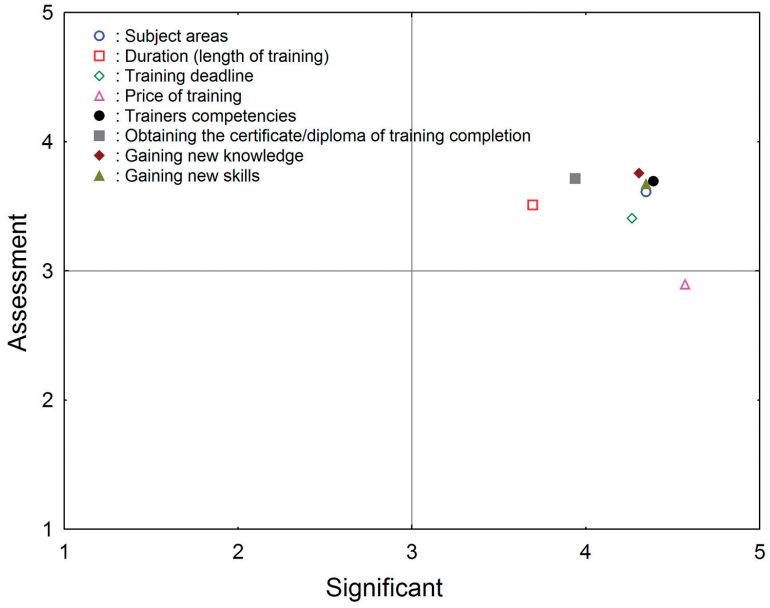

Figure 2. Quality map of the training offer – assessment of nurses

Source: own work

Table 2

Summary poll research results of nurses

Average significance of aspect	Significance: Very important	Important	Neither important nor important	Unimportant	Not at all important	Aspects (requirements) of the training offer	Assessment: Very poor	Poor	Satisfactory	Good	Very good	Average assessment of aspect
	5	**4**	**3**	**2**	**1**		**1**	**2**	**3**	**4**	**5**	
4.35	42	50	4	2	0	Subject areas	0	0	38	60	0	3.61
3.69	6	68	18	0	6	Duration (length of training)	0	2	44	52	0	3.51
4.27	58	16	18	4	2	Training deadline	0	8	42	48	0	3.41
4.57	58	38	2	0	0	Price of training	6	38	14	40	0	2.90
4.39	42	52	4	0	0	Trainer competencies	0	2	28	66	2	3.69
3.94	24	56	10	4	4	Obtaining the certificate/diploma of training completion	2	0	26	66	4	3.71
4.31	46	42	4	6	0	Gaining new knowledge	0	2	22	72	2	3.76
4.35	42	50	4	2	0	Gaining new skills	2	0	26	70	0	3.67

Source: own work

For nurses, the least significant requirements regarding the training offer are the length of the training (approx. 3.69) and the obtained certificates/diplomas (approx. 3.94). The most important, apart from the cost of the training (approx. 4.57), were the following elements: trainer competencies (approx. 4.39), subject areas (approx. 4.35), and new skills gained (approx. 4.35). The aspect that regarded gaining new knowledge was scored the highest by nurses (approx. 3.76). A relatively good score was given for gaining new skills (approx. 3.67) and subject areas (approx. 3.61). The location of points on the quality map indicates, as in the case of doctors, that the evaluation of the training offer of the hospital is relatively good and worth maintaining at a similar level – although assessment could be higher (it is worth trying to improve it). The Training Offer Assessment Index (TOAI) for the occupational group of nurses amounted to 119.43 and is a little higher than the TOAI for physicians.

To illustrate the similarities and differences in the evaluations of the training offer and to present characteristic features of medical employees of the described hospital, we have presented the respondents' answers to alternative questions in Table 3.

Table 3
Responses to alternative questions from doctors and nurses of the general hospital

Survey questions	Doctors		Nurses	
	% response rate		% response rate	
	yes	no	yes	no
Have you ever participated in a training/course organized by the hospital?	90,9	9,1	91,8	8,2
Do you think health professionals should take participate in training?	100	–	100	–
Would you be interested in attending training for which the employer would pay only part of the fee?	100	–	26,5	73,5
Are all of the training courses free?	45,5	54,5	14,3	85,7
Do you expect to receive a broader training offer by the hospital for health professionals?	90,9	9,1	91,8	8,2
Would you be willing to take part in consultations concerning the training needs of health professionals? If there were any?	63,6	36,4	89,8	10,2
Are the subject areas of the training offered by the hospital adjusted to staff expectations? (consulted before)?	9,1	90,9	24,5	75,5

Source: own work

As a result of the analysis, it is observed that all surveyed medical employees think that professional development is necessary in their profession. More than 90% of the respondents participated in one or more training courses organized by the employer. The same number of people expect that the hospital's offer in this matter will improve and will be broader. All surveyed doctors are willing to cover a part of the cost of training, while only 26.5% of the nurses are willing to participate in the cost of training. The majority of the training offer addressed to nurses required covering the costs (85.7%). Only 14.3% of the surveyed nurses participated in free training. The research showed that there is a disproportion in the training offer for medical employees (45.5% of the doctors indicated that they participated in free training). Responses to alternative questions showed that the group that is more willing to take part in consultations regarding the training needs is the group of nurses (89.8%). As many as 36.4% of the doctors claimed that they were not interested in such arrangements. Surprisingly, the majority of them (90.9%) think that, when organizing the training, the hospital does not take into account their opinions. Different responses were given by nurses, who in a vast majority (75.5%) claimed that the training offer met their expectations

The basis for some findings (e.g., regarding the willingness of participating in covering the training costs) can be a comparison of the total number of workplaces for doctors and nurses. A vast majority of the surveyed nurses earn their livings working in the specialist hospital (85.7%). Only 12.2% of the nurses were employed in two places, a marginal group (2.1%) work in three places. Among doctors, as many as 18.2% provide medical services in four places, 18.2% in three, 45.4% in two, and only 18.2% work in one place.

Differences between the two professional groups can also be observed after the analysis of the age and length of professional activity in the specialist hospital. People of the ages of 20–40 (in the case of nurses) constitute only 20.4%; in the case of doctors, it is well over 63.7%. Nurses at the age of 51 and over constitute a numerous group (30.6%). Also, the number of young graduates of nursing schools can be worrying. In the age group of 20-30, it is only 4.1% of the surveyed nurses. Among doctors, the dominant group (54.5%) constitutes people who have worked in the hospital quite briefly (0–5 years). For nurses, 46.7% have a length of professional activity of longer than 26 years, and only 12.2% for 0–10 years.

Both doctors and nurses indicated many training subject areas in which they would be interested. The subject areas that the surveyed doctors hope to find in the training offer are:

– operating medical equipment,
– practical medical knowledge, compatible with the profile of the ward,
– work organization,
– interpersonal relations.

For nurses these would be:

– bullying and coping with stress,
– work ethics,
– professional burnout,
– practical knowledge related to the job characteristics,
– medical rescue.

5. Conclusion

The use of an assessment tool of the training program in the form of quality maps allows us to inform the managing staff about the aspects that should be dealt with in the first place. The fact that most points on the map are located in the same quarter of the chart indicating a good assessment of the training offer does not prove that there are no areas for improvement. In the case of the specialist hospital, it would be worth considering a training program for nurses who are not willing to cover extra expenses. This is probably due to low income and a lack of possibilities for employment in additional places. The training program should be adjusted to the needs of the employer and employees. Perhaps offering different routes for a professional development career could be a solution to the problem. For people with the lowest income, it is worth preparing a broader offer of cost-free courses. The training anticipated by nurses could be a vital element of a motivating system.

The hospital should take into account the age and length of professional activity when planning staffing strategy. Different offers are interesting for experienced nurses who have a longer period of professional activity and who are over 50 years old. Different topics will be suitable for graduates of nursing schools or residents. Training in coping with long-term stress and professional burnout would be suitable for employees with long professional activity. As far as less-experienced workers are concerned, more significant would be training related to hospital work organization, interpersonal communication, or operating medical equipment.

The authors think that, in 10-15 years' time, the hospital's managing staff will be dealing with the problem of a lack of nursing personnel. A worrying disproportion is observed as far as the age is observed. Nurses who are over 40 years old constitute 80% of nursing staffs. Could it be the key element that will decide the future development of the hospital?

The results of the survey interchangeably show that all medical employees expect a well-considered staffing strategy that is adjusted to their needs. Both doctors and nurses realize the necessity of professional development that will

trigger their well-being in their organizational roles. The hospital training program was assessed well, but many areas of improvement have been indicated in the questionnaires.

The authors hope that the research will help increase the awareness of managing staff in health-care-providing institutions. Although the staffing strategy was assessed well, it may have weaknesses; and it is worth using the knowledge of the employees.

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Linear and nonlinear intraday causalities in response to U.S. macroeconomic news announcements: Evidence from Central Europe**

1. Introduction

The main goal of this paper is to analyze the information flow on and between the three stock markets in Frankfurt, Vienna, and Warsaw. These markets are rather different, since the capitalization of the Frankfurt Stock Exchange (FSE) is about ten times greater than that of the Warsaw Stock Exchange (WSE) and the Vienna Stock Exchange (VSE)[1]. There are, however, many facts that suggest that the FSE, VSE, and WSE may be strongly interrelated. First, the VSE and WSE are similar in some aspects, since the main indices of these markets have been quoted for a similar period of time and are among the largest stock markets in Central and Eastern Europe[2]. Second, the VSE and WSE have been competing markets in recent years. On the other hand, the FSE and VSE are developed markets, while the WSE is still an emerging market. Last but not least, Germany is the most important trading partner for both the Austrian and Polish economies.

The **Sequential Information Arrival Hypothesis** (SIAH), introduced by Copeland (1976), assumes that not all traders receive new information at exactly the same time (they receive it sequentially), while the **Mixture of Distribution Hypothesis** (MDH) from Clark (1973), in turn, assumes that new public information is received by

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[1] For more details, see Federation of European Securities Exchanges: www.fese.eu.

[2] The ATX20 index (VSE) is quoted from January 2, 1991, and the WIG20 index (WSE) is used from April 16, 1994.

all investors contemporaneously; these are the two main conjectures about the way that new information impacts the dynamic relationships between the variables that describe stock prices. Usually, the purpose of an analysis of the linear and nonlinear causal relationships between returns, volatility, and trading volume on a given stock market and between different markets in the presence of public news and without them is to judge which of the above-mentioned hypotheses is supported by empirical evidence. Such an analysis also reflects the behavior of investors and allows for an analysis of cross-country dependencies. This, in turn, can help to describe information flows between different stock markets and answer the question of which market is the one that primarily generates signals to investors on the other stock markets.

Besides examining linear and nonlinear causalities between returns, volatility, and trading volume on the three markets, we also analyze the reaction time to news releases as well as the changes in the duration of all of the causal relationships uncovered. The latter may help to answer the question of whether news announcements have an impact on the number of significant causal links and their profile.

This paper extends the current literature in several ways. First of all, we do not restrict the empirical study solely to the analysis of linear causal links, but we also examine nonlinear causalities on and between the three markets under study. Moreover, we try to estimate the time of reaction to a news release and changes in the duration of causal interference by using different lags in respective multidimensional time-series models[3].

The rest of the paper is organized as follows. In the next section, we provide an overview of the economic literature on the relationships between returns, volatility, and trading volume and about the impact of U.S. macroeconomic news on CEE markets. In Section 3, we present the data used in this study and give a brief description of the methodology applied. The empirical findings as well as discussion are presented in Section 4. The final section concludes the paper and provides some suggestions for future research.

2. Literature overview

2.1. Links between financial variables on stock markets

Establishing the nature, direction, and strength of dynamic interrelations between stock prices, volatility, and trading volume improves our understanding of information flows on financial markets and helps reveal their structure. In

[3] Recently, Gurgul and Lach (2015) have also focused of causalities on and between the stock markets operating in Frankfurt, Warsaw, and Vienna. They also divided the sample into periods with and without announcements of macroeconomic news from the U.S. economy. However, the authors did not discuss the issue of time of reaction to a news release and changes in the duration of causal interference and did not analyze the structure of nonlinear causal links.

this context, the detecting the channels of the transmission of this information between different groups of investors and between particular stock markets becomes a very important issue.

The investigation of return-volatility-trading volume links is often based on the notion of *Granger causality* (Granger, 1969). The concept of causality developed by Granger relates the concept of conditional dependency. There are numerous contributions conducted in the framework of Granger causality and its various extensions. Some results obtained via this approach are contradictory; e.g., the linear and nonlinear Granger causality tests applied by Hiemstra and Jones (1994) to daily Dow Jones returns and relative changes in NYSE trading volume detected bi-directional nonlinear causality between returns and volume, while Gallant et al. (1992) report a one-way strong nonlinear impact of lagged stock returns on current trading volume based on the daily S&P 500 index returns and NYSE trading volume. The causality in the opposite direction (from lagged trading volume to current stock returns) is weak.

Lee and Rui (2002) used daily data to test the dynamic relationships between the three largest stock markets; namely, those operating in the US, UK, and Japan. The main result was that U.S. financial market variables (trading volume in particular) have predictive power for price, trading volume, and volatility movement in the UK and Japan.

Gurgul and Majdosz (2005) took into account calendar effects and repeated the causal analysis in various sub-samples. They detected robust and significant bi-directional linear causality between daily stock returns and trading volume on the Warsaw Stock Exchange (WSE). Gurgul and Majdosz (2005) found that the U.S. and German returns (volatility) have predictive power in describing fluctuations in Polish trading volume. However, they did not find a similar connection on the Austrian stock market.

More recent contributions dedicated to interrelations between financial variables better reveal the characteristics of information flow because they are based on intraday data. Rossi and de Magistris (2010) focus on the link between the realized volatility and trading volume of four stocks listed on the NYSE. The authors find that trading volume and volatility exhibit long memory. However, these variables are not fractionally cointegrated. In this way, the results contradict the MDH in the version of Bollerslev and Jubinski (1999). The fractionally integrated VAR models supply evidence that a filtered log-volume probably has a positive impact on the current filtered log-volatility.

Darrat et al. (2003) used intraday data on 30 selected stocks from the DJIA. Based on the empirical results, they claim that high trading volume causes high return volatility, which is in accordance with the SIAH but not the MDH.

This direction of research was continued in the contribution by Gurgul and Wójtowicz (2008). In the framework of event-study methodology, the authors defined events as appearances of extreme high trading volume. They examined high volume premium hypothesis for companies listed on the WSE. The results were in line with the high volume premium conjecture, since the occurrences of high trading volume implied high returns (especially in the case of small companies) on the following days, especially one day afterwards. The results were not only in favor of the high trading volume premium hypothesis but also suggested the construction of profitable investment strategies. In the case of small trading volume, the mean abnormal returns were not statistically significant.

Darrat et al. (2003) were not able to distinguish between the SIAH and other plausible explanations of the observed causal relationships (e.g., the overconfidence hypothesis). To make such a distinction, it is important to know whether causality is implied by an announcement of public news. The contributors take for granted that, in the absence of public signals, rational investors do not change their positions. Therefore, under the rationality assumption, no causal link between volume and volatility is predicted. However, in the behavioral approach, it is assumed that investors trade even without the presence of public signals. Quasi-rational investors can ignore the absence of public signals and may still overreact to their own (private) signals, causing them to trade.

In a more-recent contribution, Darrat et al. (2007) reexamined lead-lag relations between the trading volume and volatility of large and small stocks from the NYSE. Causality was tested in two subperiods, with and without identifiable public news. The study by Darrat et al. (2007) was based on an idea of Fama (1998). They suggested a similar procedure, although in different contexts[4]. Darrat et al. (2007) supplied evidence in favor of the SIAH during periods with public news. However, they also detected causality running from trading volume to return volatility, even during periods without public news. In addition, return volatility was found to rise during periods with public news, while trading volume was higher during periods without public information announcements. The contributors stressed that the results are invariant with respect to different times of day. Some of the results of Darrat et al. are in favor of the self-attribution model of Daniel et al. (1998), which suggests overconfidence of the investors.

In a more-recent contribution, Bouezmarni et al. (2012) suggested a nonparametric test based on the Bernstein copula. Using high-frequency data, the authors

[4] Based on a subset of stocks from the time period of 1990–1992, Pritamani and Singal (2001) checked the predictability of returns following announcements and large price changes. Chan (2003) collected news headlines for a subset of Center for Research in Security Prices (CRSP) stocks from 1980 to 2000. He addressed monthly returns following public news and returns after similar price movements in the absence of public news.

tested for causality between stock returns and trading volume. The contributors have found that, at a 5% significance level, the nonparametric test clearly rejected the null hypothesis of no-causality running from returns to volume. This was in line with the conclusion that followed from the outcomes of the linear causality test. In addition, their nonparametric test detected a non-linear feedback effect between trading volume and returns at a 5% significance level.

A widely accepted point of view in the economic literature it that macroeconomic data announcements can be seen as important news for stock market participants. In the next section, we review some contributions devoted to the analysis of the impact of macroeconomic data announcements on the performance of certain stock markets.

2.2. U.S. macroeconomic news announcements and their impact on causalities between European stock markets

Several contributors have focused on an examination of the impact of U.S. macroeconomic news on European stock markets (see: e.g., Nikkinen and Sahlström, 2004; Nikkinen et al., 2006; Hanousek et al., 2009; Harju and Hussain, 2011; Gurgul and Wójtowicz, 2014, 2015). In general, the results are somewhat contradictory.

Nikkinen and Sahlström (2004) provided evidence that volatility on the German and Finnish stock markets is affected only by U.S. announcements about the unemployment rate and PPI. In addition, domestic macroeconomic data does not influence either of the markets.

Nikkinen et al. (2006) demonstrated that announcements of some U.S. macroeconomic news are the sources of a rise in volatility on developed European stock markets. However, the reaction of CEE economies in transition (including the Czech Republic, Hungary, Poland, Russia, and Slovakia) seems to be negligible. Nikkinen et al. (2006) suggested the possibility of significant differences in the reaction to U.S. macroeconomic news between developed and emerging markets in Europe.

Singh et al. (2013) found that U.S. macroeconomic news has a more-frequent effect on volatility than on returns on European developed markets. According to this study, unexpected macroeconomic news impacts volatility on the stock markets in the UK, France, Germany, and Italy. However, in these cases, returns are influenced only on the German stock market. Cakan et al. (2015) suggested that there is a strong impact of U.S. news on volatility in emerging markets (including Poland, Russia, and Turkey). However, Gümüş et al. (2011) are convinced that U.S. data announcements have no effect on stocks listed on the Istanbul Stock Exchange.

Harju and Hussain (2011) used high-frequency data and reported that U.S. macroeconomic news announcements cause an immediate and statistically significant response of intraday volatility and the returns of the CAC40, DAX30, FTSE100, and SMI.

The reaction of stocks listed on the Frankfurt Stock Exchange on macroeconomic news was tested by Dimpfl (2011). The author found that 1-minute returns of the DAX30 react immediately after a news release. This significant reaction was observed in the first ten minutes.

Hanousek et al. (2009) checked the reaction of emerging markets in the Czech Republic, Hungary, and Poland to various macroeconomic announcements. The contributors detected that the strongest reaction of 5-minute returns takes place on the stock market in Prague. Stocks listed in Budapest respond significantly only to negative news. However, the Warsaw Stock Exchange does not react significantly to U.S. macroeconomic news. Hanousek et al. (2009) detected significant spillover effects on the emerging markets under study, as their main indices influence each other. They are also significantly influenced by preceding returns of the DAX30. The authors claim that the impact of the Frankfurt Stock Exchange (via the DAX30) is stronger than the impact of any of the emerging markets.

Significant causality from the FSE to stock markets in Prague and Warsaw was also reported by Černý and Koblas (2005). An important role of developed European markets for CEE emerging markets in Budapest, Prague, and Warsaw was also indicated by Égert and Kočenda (2007). They showed significant causalities between the returns of CEE markets and from developed to emerging European stock markets. Opposite causalities running from stocks listed on Eastern European stock markets to stocks on Western European stock markets were insignificant. Similar links could be observed for volatilities with two exceptions. According to Égert and Kočenda (2007), volatility in Budapest and Warsaw is a significant cause of volatilities on stock markets in Frankfurt and London.

The thorough analysis of intraday relationships between CEE markets conducted by Égert and Kočenda (2011) shows very little positive time-varying correlations among the returns of the BUX, PX50, and WIG20. The contributors stress that correlations between these indices and Western European stock markets are not pronounced.

The response of the Polish stock market to U.S. announcements was checked in detail by Gurgul and Wójtowicz (2014). Based on intraday data for the WIG20, a significant response to unexpected news from the U.S. economy in the first minute after a news announcement was detected. The cause of significant reactions are announcements regarding industrial production, durable goods orders, retail sales, and nonfarm payrolls. The last type of announcement incurs the strongest reaction.

3. Methodology and dataset

3.1. Testing for linear Granger causality using big data

The concept of Granger causality (Granger, 1969) is one of the most-common approaches in research concerning returns, return volatility, and trading volume interrelations. This concept can be understood as a special kind of conditional dependency. There is no need to explain it in detail, since this idea is rather well-known nowadays and has been widely used in previous studies. By and large, this concept is used to investigate whether knowledge of the past values of one (stationary) variable is helpful in predicting the future values of another one or not. In practical applications, one should test the statistical significance of the coefficient estimators of the potentially causal (explanatory) variable in respective Vector AutoRegression (VAR). A statistically significant test outcome implies the existence of linear causality running from an explanatory variable to the endogenous variable. As underlined by Granger and Newbold (1974) and Phillips (1986), when dealing with nonstationary time series, the results of the traditional (VAR-based) test for linear Granger causality can be spurious (which implies the need for an alternative approach). The modified approach depends on whether the time series under study are cointegrated (when it is recommended to test for causality using Vector Error Correction Models) or not (differencing the data and using the Toda-Yamamoto (1995) approach).

Among the special problems that arise when using traditional asymptotic-based tools for linear causality testing in the case of large data, one should list the issue of overrejection (Darrat et al. 2007). It is clear that the larger the sample, the more significant the size distortion, although one may ask an interesting question about the critical sample size above which the overrejection issue becomes a serious problem. By means of Monte Carlo simulations, Gurgul and Lach (2015) proved that increasing sample size and lag length leads to more-significant size distortion in the asymptotic variant of the Granger causality test. It is important to underline that the authors showed that size distortion becomes a serious problem even for around 400–600 observations[5]. Taking these outcomes into account, we followed the suggestions of Darrat et al. (2007); but instead of asymptotic critical values, we applied Bayesian critical values. Using critical values is recommended in order to avoid the problem of overrejection implied by the large size of the data in the causality tests.

[5] Gurgul and Lach (2015) ran Monte Carlo simulations in order to shed some light on the issue of overrejection. They designed the simulation scheme in a way that would ensure comparability of their results with previous papers dealing with the size performance of a linear Granger causality test (e.g., Dolado and Lütkepohl, 1996; Hacker and Hatemi, 2006; Mantalos, 2000; Lach, 2010, among others).

3.2. Nonlinear Granger causality

Let us now shed some light on the concept of testing nonlinear Granger causality used in this paper. In recent years, the well-known nonlinear test proposed by Baek and Brock (1992) has been modified several times. In this paper, we use the approach proposed by Diks and Panchenko (2006). We will focus on the problem of investigating whether one time series (denote it as $\{Y_t\}$) nonlinearly Granger causes another time series (denote it as $\{Y_t\}$). For the present purposes, let us define for $t = 1, 2\ldots$ the $L_X + L_Y + 1$ dimensional vector $W_t = (X_{t-L_X}^{L_X}, Y_{t-L_Y}^{L_Y}, Y_t)$[6]. The null hypothesis that $\{Y_t\}$ does not Granger cause $\{Y_t\}$ may be written in terms of density functions in the following way:

$$f_{X,Y,Z}(x,y,z) = f_{X,Z}(x,z) f_{Z|X,Y}(z \mid x,y) = f_{X,Z}(x,z) f_{Z|Y}(z \mid y) \tag{1}$$

where $f_X(z)$ stands for the probability density function of random vector X at point z, $X = X_{t-L_X}^{L_X}$, $Y = Y_{t-L_Y}^{L_Y}$, $Z = Y_t$, for $t = 1, 2,\ldots$. The last equation may be rewritten in more convenient forms:

$$\frac{f_{X,Y,Z}(x,y,z)}{f_{X,Y}(x,y)} = \frac{f_{Y,Z}(y,z)}{f_Y(y)} \tag{2}$$

and

$$\frac{f_{X,Y,Z}(x,y,z)}{f_Y(y)} = \frac{f_{X,Y}(x,y)}{f_Y(y)} \frac{f_{Y,Z}(y,z)}{f_Y(y)} \tag{3}$$

Next, for the multivariate random vector W, let us define correlation integral $C_W(\varepsilon)$ by the following expression:

$$C_W(\varepsilon) = P[\|W_1 - W_2\| \le \varepsilon] = \iint I(\|s_1 - s_2\| \le \varepsilon) f_W(s_1) f_W(s_2) ds_2 ds_1 \tag{4}$$

where W_1, W_2 are independent with distributions in the equivalence class of distribution of W, letter I denotes the indicator function (equal to one if the condition in brackets holds true; otherwise, equal to zero), $||x|| = \sup\{|x_i| : i = 1,\ldots, d_W\}$ denotes the supremum norm (d_W is the dimension of sample space W), and $\varepsilon > 0$.

Hiemstra and Jones (1994) claimed that testing the null hypothesis in Granger's causality tests implies for every $\varepsilon > 0$:

[6] Symbol $X_{t-L_X}^{L_X}$ denotes L_X – lagged vector of X_t; i.e., $X_{t-L_X}^{L_X} := (X_{t-L_X}, X_{t-L_X+1},\ldots, X_{t-1})$.

$$\frac{C_{X,Y,Z}(\varepsilon)}{C_{X,Y}(\varepsilon)} = \frac{C_{Y,Z}(\varepsilon)}{C_{Y}(\varepsilon)} \tag{5}$$

or equivalently:

$$\frac{C_{X,Y,Z}(\varepsilon)}{C_{Y}(\varepsilon)} = \frac{C_{X,Y}(\varepsilon)}{C_{Y}(\varepsilon)} \frac{C_{Y,Z}(\varepsilon)}{C_{Y}(\varepsilon)} \tag{6}$$

The authors put pressure on calculating sample versions of correlation integrals and then tested whether left-hand- and right-hand-side ratios differ significantly or not. They proposed the use of the following formula as a correlation integral estimator:

$$C_{W,n}(\varepsilon) = \frac{2}{n(n-1)} \sum_{i<j} \sum I_{ij}^{W} \tag{7}$$

where $I_{ij}^{W} = I(\left\| W_i - W_j \right\| < \varepsilon)$. As shown by Diks and Panchenko (2006), testing relations (5) or (6) is not equivalent, in general, to testing the null hypothesis of Granger causality. The authors found exact conditions[7] under which the HJ test is useful in investigations concentrated on causality and provided a modified tool for testing nonlinear causal links.

3.3. Empirical applications

In order to describe information flow on the stock markets under study and between them, it is necessary to examine causal relationships in the presence of important public information and during periods without such information. Ongoing globalization leads to a continuous inflow of new information, which implies difficulties in indicating periods without inflow of important information (understood here as news essential to investors) on all three stock markets. The previous literature (see: e.g., Gurgul and Wójtowicz, 2015; Gurgul and Lach, 2015) suggests that, among many possible candidates, macroeconomic news announcements from the U.S. economy seem to be a suitable choice. This prediction follows from previous contributions that supplied evidence that macroeconomic news announcements significantly impact stock markets. Macroeconomic news from the U.S. economy is often thought the most influential, since this economy plays a predominant role over the whole world. Henceforward, we define **trading**

[7] Since this property is not the main point of our research, we refer to Diks and Panchenko (2006) for more details on this issue.

session with information when at least one of the following U.S. macroeconomic indicators was announced: Consumer Price Index, Producer Price Index, Industrial Production, Retail Sales, Durable Goods Orders, Nonfarm Payrolls, Existing Home Sales, Housing Starts, New Home Sales, and Consumer Confidence[8]. In this paper, we apply intraday data covering the period of May 2013 – August 2013[9]. We consider 1-minute log-returns of the main index of each of the markets; namely, the DAX30 (FSE), ATX20 (VSE), and WIG20 (WSE)[10]. In order to obtain conditional variances (used as proxies of return volatility in causality analysis), we use the ARMA(1,1)-EGARCH-M(1,1) model (as in Darrat et al., 2007).

There are several measures of investor trading activity in the economic literature. These include trading volume (the number of shares traded) and turnover (the total value of shares traded), which are used quite often in practical applications. In order to allow comparability with the outcomes of previous studies in the empirical part of our study, we use intraday trading volume[11]. More precisely, we compute the difference between the total trading volume index at the end and beginning of each 1-minute interval. Such a quantity describes the number of shares from a given index traded during a given 1-minute interval. This 1-minute trading volume, however, is highly skewed. To deal with this issue in further analysis, we apply natural logarithms of 1-minute trading volume.

One cannot forget that the stock markets under study are open at different hours and that there are intraday auctions at different times during the day[12]. On the other hand, the causal relationships must be analyzed only during the periods when all three markets are open and, thus, may influence each other. Taking these facts into account, as well as the increased return volatility observed at the beginning and at the end of trading session, we study relationships between intraday returns, return volatility, and trading volume of the DAX30, ATX20, and WIG20 during two periods during trading days. The first period ranges from 9:20 to 11:45, and the second lasts from 14:35 to 16:45. These periods start at least 15 minutes after the beginning of continuous trading on each of the markets and end

[8] These macroeconomic indicators are released monthly on different days of the month between 14.00 and 16.00 CET. The latter ensures that the impact of these announcements can be directly observed in stock prices, particularly in the values of all indices.

[9] The data comes from the Vienna Stock Exchange, Warsaw Stock Exchange, and Bloomberg databases.

[10] We apply 1-minute returns (instead of, for example, 5-minute returns) because, as indicated by the literature (Dimpfl, 2011; Gurgul and Wójtowicz, 2014), new public information on efficient stock markets implies investor reaction as soon as it is announced (often even in the first minute after the release of news).

[11] See: e.g. Bollerslev and Jubinski (1999); Lobato and Velasco (2000); Darrat et al. (2007); Rossi and de Magistris (2010).

[12] On the FSE, there was the intraday auction from 13:00 to 13:02. On the VSE, the intraday auction lasts from 12:00 to 12:07:30 on settlement days and from 12:00 to 12:04 on non-settlement days of the derivatives market.

at least 30 minutes before the end of trading sessions. We also apply 15-minute gaps before and after the intraday auctions in order to avoid potential problems with modeling the increased volatility just before or just after intraday auctions on the Frankfurt or Vienna Stock Exchanges

In order to test changes in the duration of causal interference, we proceeded with four different lag lengths in the underlying VAR models; for each pair of variables, we examined four windows of possible causal interference of lengths of 1, 5, 10, and 20 minutes, respectively.

4. Empirical results

Henceforward, we will refer to the first period (9:20–11:45) as the **morning period.** In this period, there are no available U.S. news announcements; whereas, during the second period (14:35–16:45, henceforward referred to as the **afternoon period**), U.S. stock markets are open and U.S. macroeconomic news is announced. In order to describe causality in the presence of public information and without it (which is particularly important in the context of the SIAH and the overconfidence hypothesis), one should analyze the domestic and cross-country relationships between returns, volatility, and trading volume on each market during these two periods on days when U.S. macroeconomic news is announced and on days without such announcements.

4.1. Linear causality analysis

4.1.1. Morning session

In the first step, we analyzed linear causalities during the morning sessions on days without important U.S. macroeconomic news announcements. During that time, trading is based on private information only. As a consequence, it is possible to examine the rationality of investors. In the next step, we focused on days with U.S. news announcements (so that we could test the effects of public news announcements on the structure of causal links on and between the markets under study).

Figure 1 presents the results of linear Granger causality tests during the morning period on days without news announcements[13]. The empirical results indicate the dominant role of the Frankfurt Stock Exchange among the stock

[13] In this paper, we present the results of causality analysis in the form of directed graphs. Since the sample size exceeds 600 by far in this paper, we rely only on the Bayesian critical values in order to avoid the overrejection.

markets under study, especially when it comes to the number of linear causal links running from DAX30 returns. If stock exchanges in the U.S. are closed and no important news from the U.S. economy is expected, traders in Vienna and Warsaw make their investment decisions by observing price movements on the larger and more-liquid stock exchange in Frankfurt. Hence, prices on the VSE and WSE simply follow the prices on the FSE.

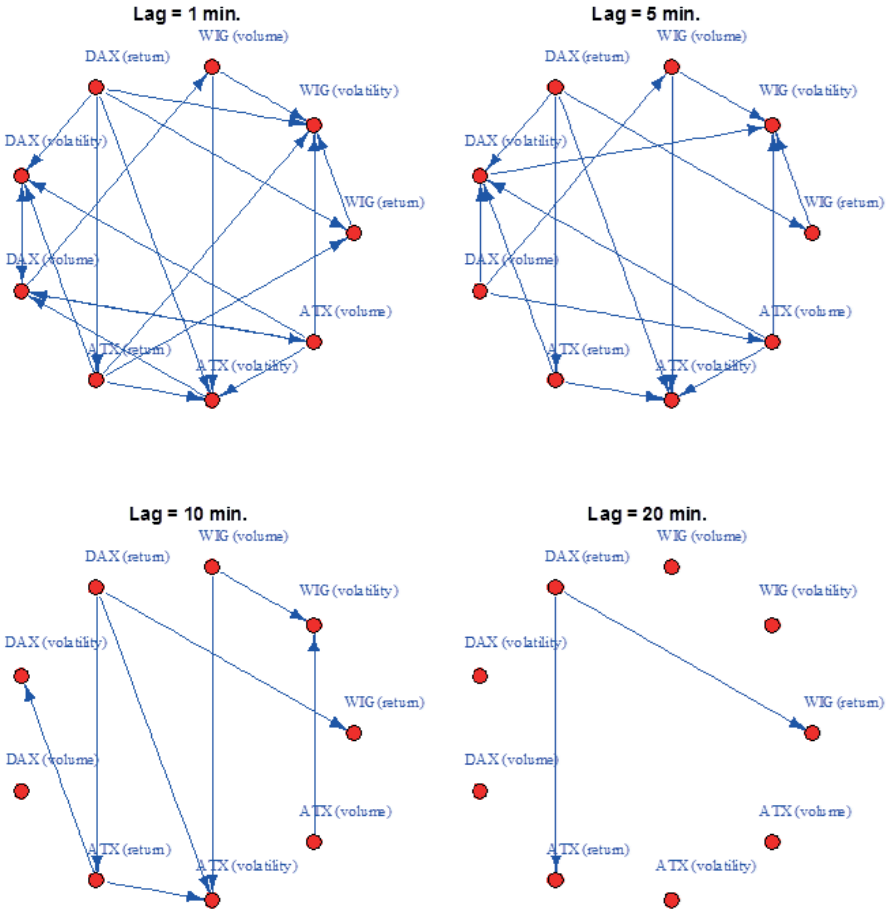

Figure 1. The results of linear Granger causality tests (morning session, days without news announcements)

When important macroeconomic data from the U.S. economy is expected to be announced (Fig. 2), linear causalities on the FSE, VSE, and WSE do not change significantly during the morning period from 9:20 to 11:45. As in the previous case, significant linear Granger causality from DAX30 returns to the returns of the ATX20 and WIG20 is observed regardless of the lag length considered; one may claim this is the main way that information from the FSE is transmitted to the CEE stock markets under study.

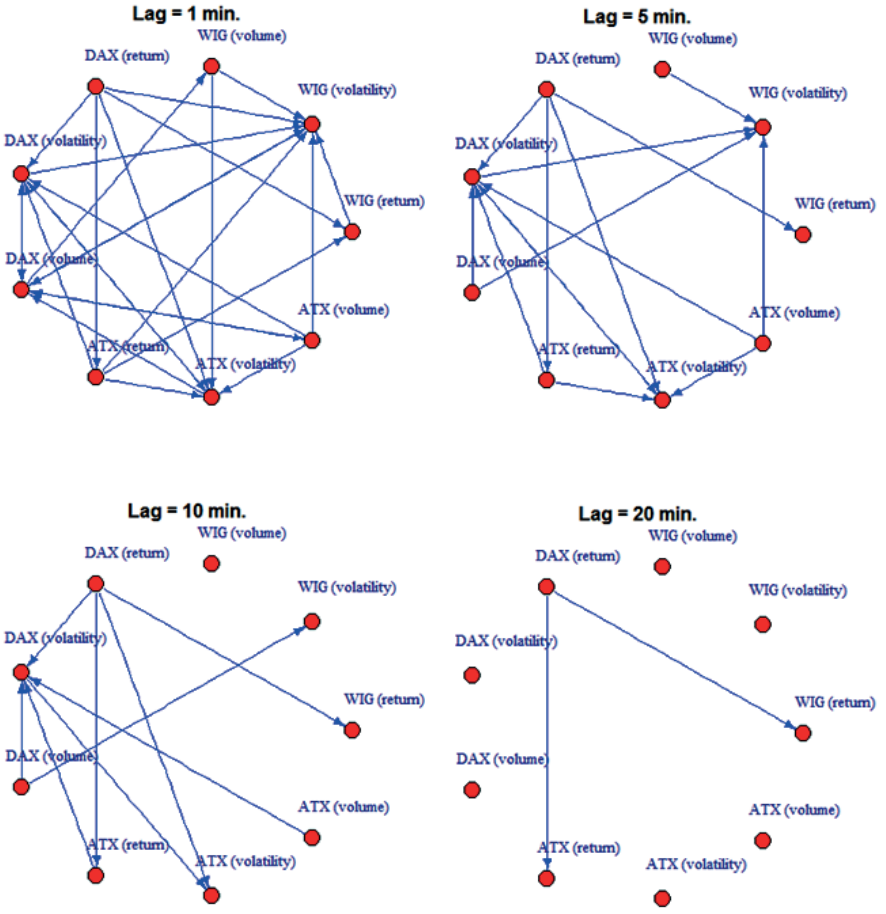

Figure 2. The results of linear Granger causality tests (morning session, days with news announcements)

To summarize, one may claim that only a few new significant linear causal links occur on days with U.S. macroeconomic news announcements. There are additional causal links that turned out to be significant only on days with U.S. macroeconomic news announcements (i.e., feedback between DAX volatility and ATX volatility as well as between DAX volume and WIG volatility)[14]. Moreover, a comparison of Figures 1 and 2 supports the claim that, on days with news announcements, the duration of significant causal interferences decreases[15]. The latter follows from the fact that, in the case of linear causal links identified for both types of days, the arrival of new information means that significant results are confirmed only in models with smaller lags. In other words, the linear causal impact represented in higher lags in the underlying VARs is too weak to lead to statistically significant results of the overall causality test (taking the form of the joint significance test). Therefore, evidence of intensive linear causality is observed only for relatively small lags of the potentially causal factor.

4.1.2. Afternoon session

Analyzing the results presented in Figure 3 (linear causalities during the afternoon period without important U.S. macroeconomic news announcements), one can notice one important fact. In general, during the afternoon sessions on days without important U.S. macroeconomic announcements, one may notice more-significant linear causal links as compared to the morning period (Fig. 1 and Fig. 2). First of all, regardless of the lag length assumed, significant causalities from DAX30 the returns to returns of the ATX20 and WIG20 are always observed. When important macroeconomic data from the U.S. economy is announced (Fig. 4), linear causalities on the FSE, VSE, and WSE change significantly during the afternoon period. First of all, regardless of the lag length assumed, we can see an increased causal impact running from DAX30-related variables to the variables describing the stock markets in Warsaw and Vienna. For example, for a lag length of ten minutes, there are only three causalities from the FSE to other markets during afternoon sessions without news. On the other hand, the number of these increases to seven in afternoon sessions with news announcements. On days with new information announcements, one can also notice that causal links between WIG20- and ATX20-related variables become significant with a stronger impact (occurring in more causal links) of the Warsaw Stock Exchange on the Vienna Stock Exchange. For example, on days without announcements, the models with lag lengths equal to 20 minutes

[14] The significance refers to the outcomes obtained for at least one of the four lags considered.

[15] This was confirmed in the case of causal links running from DAX volume to WIG volume, DAX volume to ATX volume, ATX returns to ATX volatility, ATX volume to WIG volatility, WIG volume to ATX volatility, WIG volume to WIG volatility, and WIG returns to WIG volatility.

allow the claim that there is one causal relation from WSE variables to VSE and one running in the opposite direction, while on days with announcements, the number of causal links running from the WSE is twice as large (but there are no causal links from the VSE to WSE).

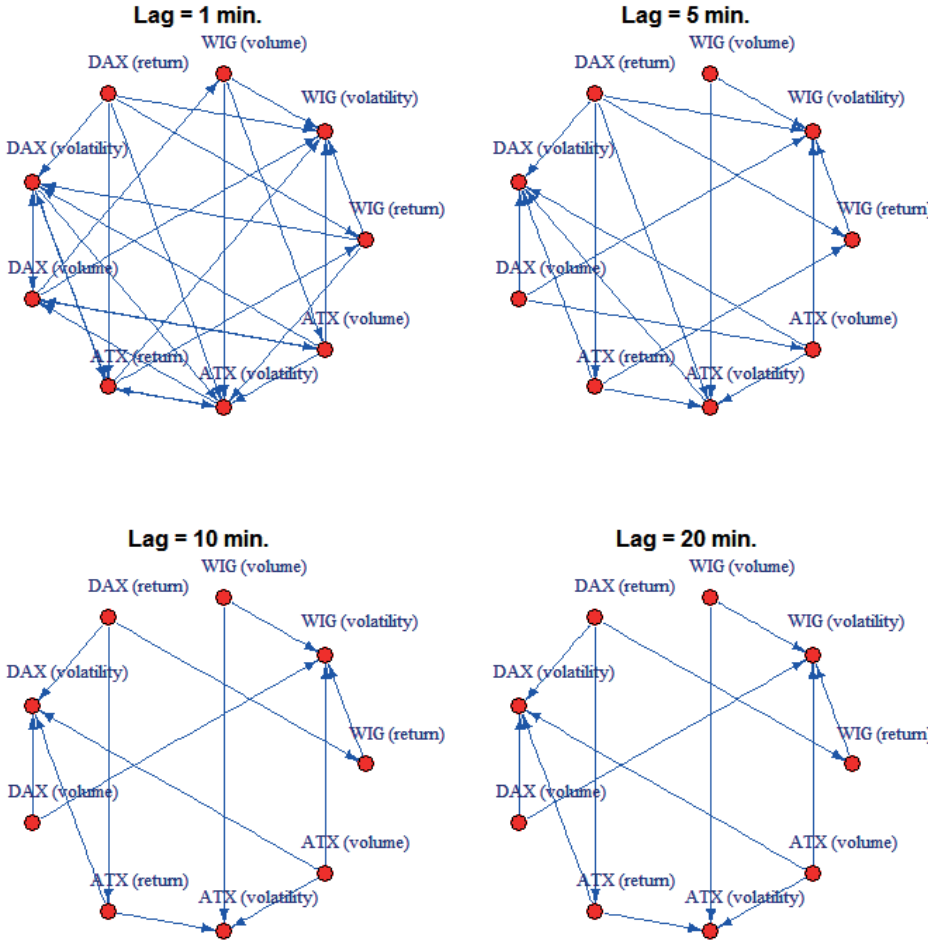

Figure 3. The results of linear Granger causality tests (afternoon session, days without news announcements)

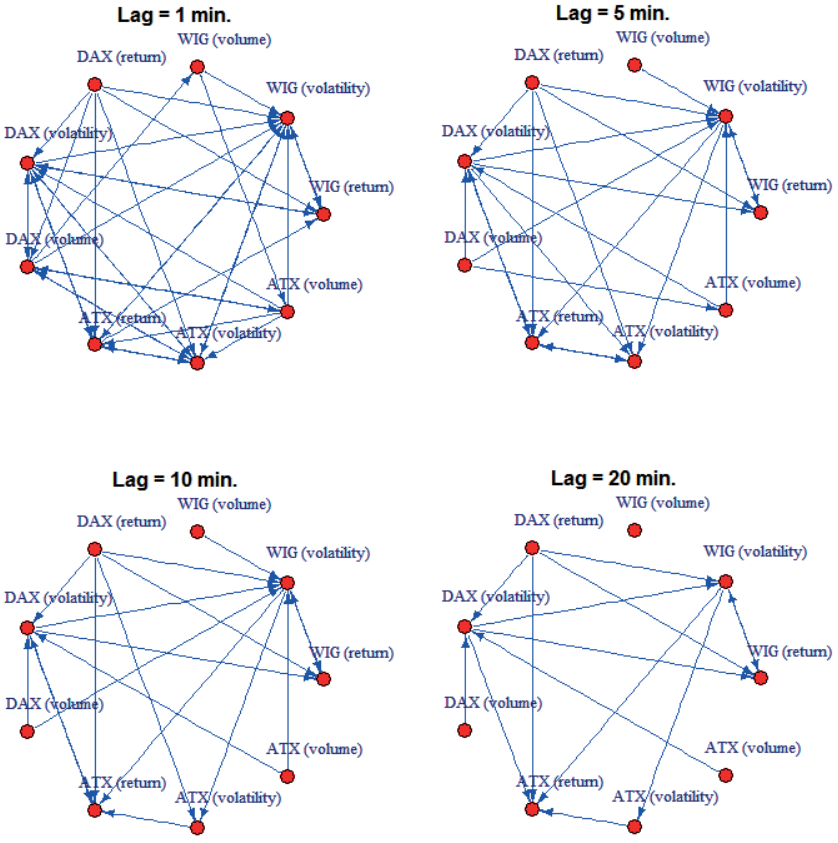

Figure 4. The results of linear Granger causality tests (afternoon session, days with news announcements)

To summarize, one may claim that, as compared to the morning period, there are many more new significant linear causal links that occur during the afternoon period with U.S. macroeconomic news announcements[16]. These additional links are presented in Figure 5 (left panel). Moreover, a comparison of Figures 3–4 (afternoon session) with Figures 1–2 (morning session) supports the claim that, on days with news announcements, the duration of linear causal interference during the afternoon session decreases in many more cases than during the morning session (Fig. 5, right panel).

[16] In general, the number of significant causal links during the afternoon period is much higher than during the morning period.

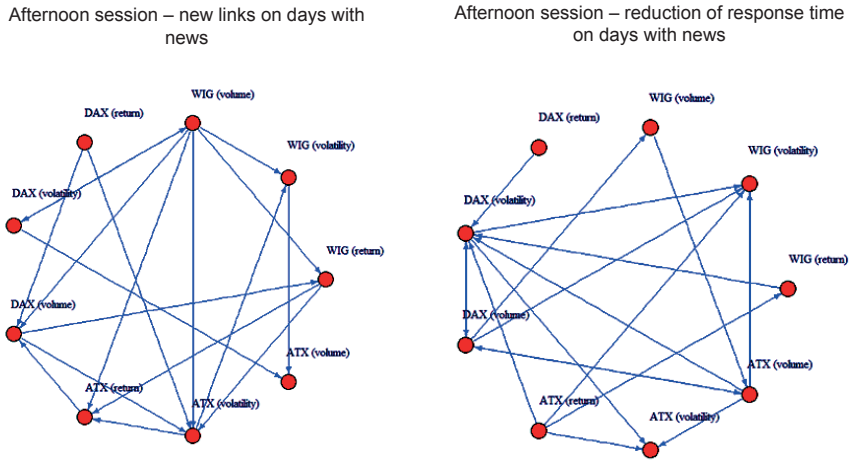

Figure 5. Afternoon session: linear causal links significant only on days with news announcements (left plot) and causal links with decreasing duration on days with news announcements (right plot)

The results for the afternoon session confirm the dominant role of the Frankfurt Stock Exchange. On days with the arrival of new information, both returns and return volatility on smaller markets are strongly influenced by the corresponding variables on the FSE.

4.1.3. Robustness analysis

In order to test the stability of the linear causalities established in the previous subsection, we conducted a number of additional computations. Taking into account the dominant role of the German stock exchange, we first re-estimated all of the VAR models describing FSE-related variables, adding lagged DAX30 returns, volatility, and turnover. The results proved that most of the cross-country causal links presented in Figures 2–4 running to DAX30-related indicators become insignificant on both types of days examined. In the next step of the stability analysis, we re-estimated all of the VAR models for the two subsamples covering the periods of May 2013 – June 2013 and July 2013 – August 2013, respectively. We once again focused on the benchmark case (non-augmented VAR models) and augmented models (with DAX30-related variables). In general, the results confirmed the previous findings; i.e., a lack of solid evidence supporting the impact of the VSE and WSE on the German stock market on both days with and without U.S. macroeconomic news announcements.

4.2. Nonlinear causality analysis

In addition to the analysis of linear causal links, we also conducted an analysis of nonlinear causal links using the procedure of Diks and Panchenko (2006). Figures 6–9 contain the results of the nonlinear test[17]. In order to test for nonlinear Granger causality, we conducted our calculations on the basis of residual time series resulting from the respective VAR models. Residual time series reflect strict nonlinear dependencies, since the linear causality has been filtered out by VAR estimation. We set up the common lag parameter (denoted as l_{DP}) at levels of 1 and 5[18] while the bandwidth (denoted as b_{DP}) was set at levels of 0.5, 1, and 1.5[19]. The nonlinear causality is said to be significant if it is found statistically significant for at least one combination of parameters b_{DP} and l_{DP}. The detailed description of the role of these technical parameters and formula for the test statistic may be found in Diks and Panchenko (2006)[20].

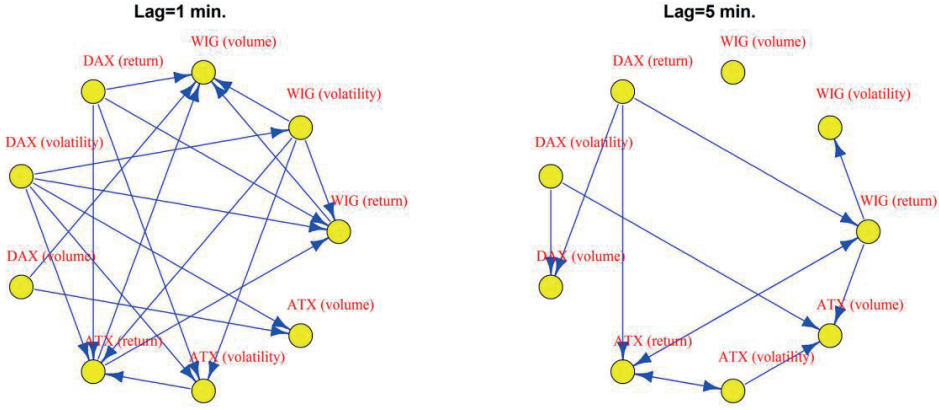

Figure 6. The results of nonlinear Granger causality tests (morning session, days without news announcements)

[17] As in the previous case, we use graphs to visualize the structure of statistically significant causal links. Each arrow represents a significant nonlinear causal link established at a 1% significance level.

[18] Since we did not report any significant nonlinear causal links for common lags higher than 5, we restrict the presentation of results of nonlinear causality for $l_{DP}=1$ or $l_{DP}=5$.

[19] These values of b_{DP} have been commonly used in previous papers (see: e.g., Diks and Panchenko, 2006; Gurgul and Lach, 2010).

[20] In practical applications of the discussed nonlinear test, heteroscedasticity is also a problem, which may lead to over-rejection (Diks and Panchenko, 2006). Therefore, before conducting nonlinear tests, we additionally tested all examined time series for the presence of various heteroscedastic structures (using, among others, White's test and a Breusch–Pagan test).

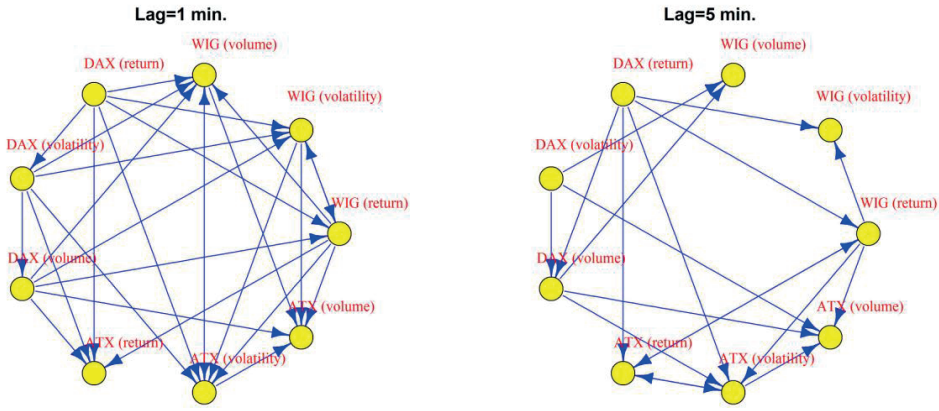

Figure 7. The results of nonlinear Granger causality tests (morning session, days with news announcements)

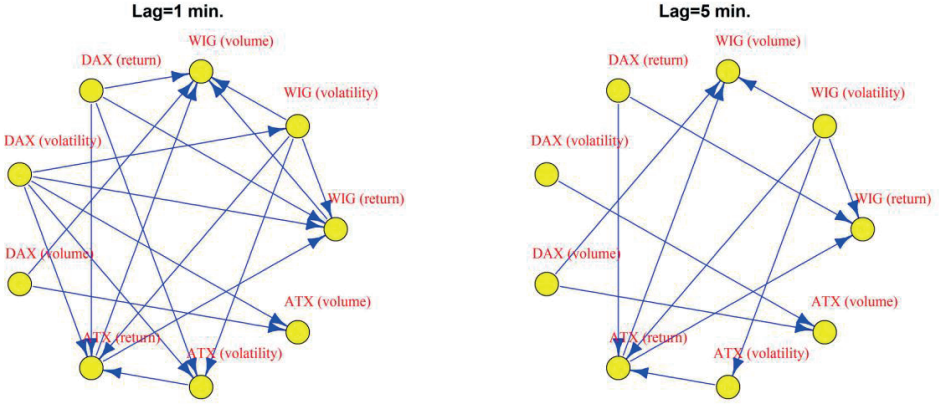

Figure 8. The results of nonlinear Granger causality tests (afternoon session, days without news announcements)

Similar to the results of analysis of linear causal links, one may claim that, as compared to the morning period, there are many more new significant nonlinear causal links that occur during the afternoon period on days with U.S. macroeconomic news announcements. Moreover, on days with news announcements, the duration of causal interference during the afternoon session seems to decrease in more cases than during the morning session.

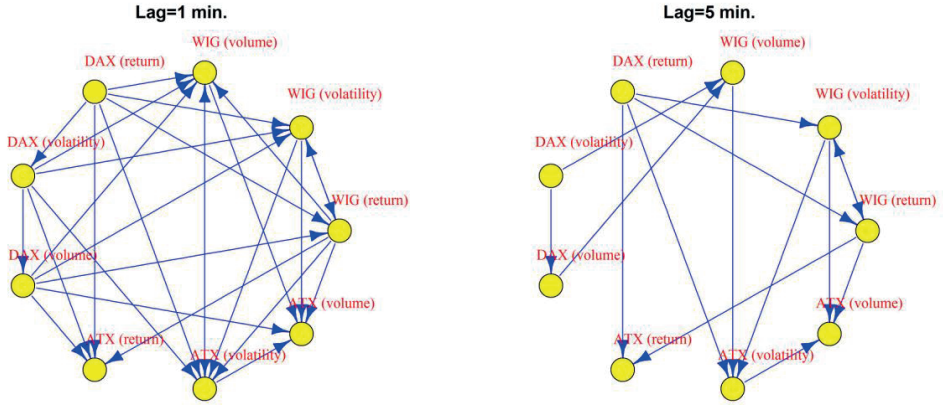

Figure 9. The results of nonlinear Granger causality tests (afternoon session, days with news announcements)

The results presented in Figures 6–9 once again confirm the dominant role of the Frankfurt Stock Exchange, especially during the afternoon session on days with US macroeconomic news announcements. These results provide some evidence to claim that, on days with the arrival of new information, smaller markets seem to be strongly influenced by the corresponding variables on the FSE.

5. Final remarks

We use ARMA(1,1)-EGARCH-M(1,1) to model conditional variance and then investigate linear and nonlinear Granger causalities on the three stock exchanges operating in Frankfurt, Vienna, and Warsaw, with Bayesian large sample correction of the critical values in significance tests. Based on the suggestions of Diks and Panchenko (2006), who found that the null hypothesis in the HJ (Hiemstra and Jones, 1994) test for nonlinear causality is generally not equivalent to Granger non-causality, we applied a modified variant of the nonlinear causality test. The modified test outperforms the HJ test, especially in terms of over-rejection and size distortion.

Besides examining linear and nonlinear causalities between returns, volatility, and trading volume on the three markets, we also analyze the changes in the duration of all of the causal interferences established.

The results of our study confirm the dominant role of the Frankfurt Stock Exchange, since the most significant relationship is the linear causality running

from DAX30 returns to the returns of the ATX20 and WIG20 (which is observed irrespective of the time of the day, presence of important public news, and lag of the underlying VAR model). The significant linear causalities form DAX30 returns to the returns of the WIG20 and ATX20 indicate the possibility of using the DAX30 data to improve modeling and forecasts of stock prices on CEE stock markets.

When it comes to the two remaining markets, one should underline that some WIG20-related variables impact ATX20-related ones during periods with U.S. news announcements and that this underlines the non-omittable role of the Warsaw Stock Exchange in the process of shaping cross-country relationships between stock markets in this part of Europe. Finally, we should underline that the results of the stability analysis refuted the possibility that the Vienna Stock Exchange significantly impacts the DAX30 and WIG20 on days with news announcements.

The second important conclusion relates to the role of public news announcements on the structure of causal links on and between the markets under study. The empirical results of this paper confirm the strong impact of announcements of macroeconomic news from the U.S. economy on the structure of the linear and nonlinear causal links between returns, volume, and return volatility on the European stock markets under study. On days with new information, more linear and nonlinear causal links become significant, especially those running from DAX30-related variables to the corresponding variables on the remaining two markets. It should be underlined that U.S. macroeconomic news announcements not only increase the number of significant causalities but also shorten the duration of both linear and nonlinear causal interferences, especially during the afternoon session. Finally, we may claim that the existence of lead-lag relationships between returns, volatility, and turnover observed on the FSE and WSE during periods with important news announcements supports the SIAH.

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Price duration versus trading volume in high-frequency data for selected DAX companies

1. Introduction

The properties of the time series of durations between consecutive trades of a particular stock have been studied by many contributors in the literature of financial econometrics. Among them are highly prominent scientists like Engle (2000) and Gourieroux and Jasiak (2001). The importance of this topic, accompanied by the growing availability of (ultra-)high-frequency data, has prompted an increase of contributions in recent years. Intensive research based on high-frequency data has several financial motivations. First of all, it is linked with microstructure theory. Secondly, it contributes to the literature on stochastic time deformation. But the most important need for research on the dynamics of trade durations is the necessity to manage liquidity risk. The reason is that durations between the following trades are a widely accepted measures of market liquidity. In addition, their volatility reflects the liquidity risk.

The results of empirical investigations of trade durations suggest several stylized facts typical of high-frequency data. The knowledge of empirical facts is a precondition of the proper specification of econometric models. The most-important stylized facts include positive serial autocorrelations and clustering effects; i.e., the propensity of extremely long durations and extremely short-to-build clusters; the persistence of dependence in time; i.e., autocorrelations tend

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to decrease slowly, which indicates the possible existence of long memory. Further features are significant nonlinearities in the dynamics, reflected in nonlinear autocorrelograms. In addition, in high-frequency data, there is path-dependent (under-)overdispersion in the conditional distribution. Moreover, one can detect significant departures from an unconditional exponential distribution, negative duration dependence, and fat tails. In order to take into account these empirical facts, the researcher should assume flexible specifications for conditional mean and conditional variance. This is necessary for the proper management of liquidity risk. In many situations, extreme liquidity risks must be calculated. In this case, the first conditional moments may not be enough. Therefore, for some research questions, measures that reflect the entire conditional distribution are advisable. According to Ghysels et al. (2004), this situation may occur in the case of Time-at-Risk (TaR(t)). Time-at-Risk denotes the minimal time without a trade that can take place with a given probability. The mentioned measures need the most-flexible specifications possible for the entire conditional distribution of the duration process.

One the most-frequently used dynamic models for intertrade durations is the famous Autoregressive Conditional Duration (ACD) model formulated by Engle and Russell (1998). This model involves an accelerated hazard specification with conditional mean that underlines a deterministic autoregression. As demonstrated by Ghysels et al. (2004), the different stylized effects observed in the data can be replicated in the framework of the ACD. The drawback of this specification is the number of restrictive assumptions on the conditional distribution of the duration process. In this model, the dynamics of the conditional mean determines the dynamics of conditional moments of any order and of liquidity risk measures (e.g., TaR(t)). However, most of these restrictions are not reflected in empirical facts. The reason is that they imply a path-independent conditional dispersion. Moreover, they are not necessary for the management of liquidity risk. In order to avoid these problems, Ghysels et al. (2004) suggested a new specification of accelerated hazard. They derived the Stochastic Volatility Duration (SVD) model. In this model, the authors included two underlying factors; the conditional mean and conditional variance follow two independent dynamics.

The main goal of our paper is to analyze the dependence structure between duration and trading volume visible in high-frequency data.

The remaining part of the paper is scheduled as follows. In the following section, we give a brief literature overview that focuses on known empirical results concerning duration in the framework of the microstructure dynamics of tick-by-tick stock data. Section 3 outlines the basics of models of duration and dependence measures based on copulas. In the fourth section, we provide

descriptive statistics of the intraday dataset and then present empirical results (especially on the dependence between duration and trading volume reflected in intraday data). Finally, we draw conclusions.

2. Literature overview

Over the last two decades, an essential part of the literature devoted to market microstructure has analyzed intraday prices and the process of their formation. De Jong and Rindi (2009), like many other authors, focused on theoretical deliberations especially concerned with market structure and market designs. The most important question was the impact of these factors on intraday price formation. In recent years, intraday high-frequency data has become increasingly available. Therefore, contributors started to empirically test some of the known theories of market microstructure. It was also possible to model the observed facts within the intraday price dynamics. Empirical studies on trading volume in the US equity markets (based on tick-by-tick data) showed the intraday behavior of stock prices. Engle (2000) found that the biggest increase in the volume of transactions takes place at the opening and closing of the market, so there is a U-shaped pattern of volatility over the day. The financial literature provides evidence that, for traditional stock price models, the size of time intervals is usually not important on long-time scales. However, for HF data modeling, this observation is not true. Diamond and Verrechia (1987), Easley and O'Hara (1992), Engle and Russell (1998), Engle (2000), Dufour and Engle (2000), Manganelli (2005), and Cartea and Meyer-Brandis (2010) show that, at high frequencies, the duration between trades supplies relevant information about the dynamics of tick-by-tick trades, including the behavior of the market, activity of uninformed or informed traders, volatility of price changes, and implied volatility from the option markets.

Therefore, duration (being a random variable) is one of the most important factors in stock-price behavior. It is extremely important over short periods of time. This random variable was frequently neglected in the past in most asset-pricing models with horizons of a few days or more. The reason for this was the widespread conviction that any effect of durations is dissipated very quickly. However, at present, the majority of trades are conducted by algorithmic trading processing information on a tick-by-tick level. Nowadays, duration is widely accepted as an essential random variable supplying important information about the behavior of the stock market over short-time intervals.

From a statistical point of view, the calendar-time distribution of stock price dynamics on small scales of time depends on both the distribution of price

changes and the distribution of duration. The aim of trading strategies is to profit from recognized price patterns and behavior over ever-shrinking scales of time. Empirical observations show that the speed of trading has shortened by a factor of 10 in the last five years. Trading very quickly over short periods of time has become the main kind of trading (including algorithmic trading). There are many factors that support the expansion of algorithmic trading. One of them is the introduction of limit order markets. The second factor arises from changes in market structure. Both factors have lowered the entry barriers to new participants. In recent years, the capacity of computers has significantly increased. At the same time, its cost has significantly decreased. This has resulted in a rise in the number of market participants as well as a significant increase of the speed at which trading takes place.

The econometric literature on duration starts with the paper of Engle and Russell (1998), who derive the autoregressive conditional duration (ACD) model to capture the time of the arrival of financial data. Based on this seminal work, most contributors tried to generalize the ACD framework in different directions. The best-known of these are the logarithmic model of Bauwens and Giot (2000) and the extended class of models by Fernandes and Grammig (2005). Other extensions are based on regime-shifting and mixture ACD models, presented in Maheu and McCurdy (2000), Zhang et al. (2001), Meitz and Terasvirta (2006), and Hujer et al. (2002). A more-recent paper by Renault et al. (2012) suggests a structural model for the durations between events and associated marks. A detailed review of different ACD models is given in Bauwens and Hautsch (2009).

Cartea and Jaimungal (2013) stress the role of algorithmic trading (AT) and high-frequency (HF) trading (which is responsible for over 70% of the US stock trading volume). In the opinion of the contributors, both kinds of trading have greatly changed the microstructure dynamics of tick-by-tick stock data. The authors employ a hidden Markov model to examine changes in the intraday dynamics of the stock market. They try to find out how to exploit this information to develop the best trading strategies at high frequencies. The contributors demonstrate how to employ their model to submit limit orders and to profit from the bid–ask spread. They also provide evidence on how HF traders may profit from liquidity incentives (liquidity rebates). Based on data from between February 2001 and February 2008, they demonstrate that, while in 2001, the intraday states with the shortest average waiting times between trades (durations) were also the ones with very few trades; in 2008, the vast majority of trades took place in the states with the shortest average durations. In addition, the authors claim that, in 2008, the states with the shortest durations had the smallest price impact as measured by the volatility of price innovations.

3. Methodology

In our paper, we use the dynamic parametrization of the conditional mean function (Engle and Russell, 1998)

$$\psi_i := \psi_i(\theta) = E[x_i \mid \mathcal{F}_i; \theta]$$

where $\mathcal{F}_i$ stands for the information set including the observation from t_{i-1} (duration x_i between two events noticed at times t_{i-1} and t_i), and θ stands for vector of parameters.

The standardized durations

$$\varepsilon_i = \frac{x_i}{\psi_i}$$

are the sequence of independent and identically distributed random variables with $E[\varepsilon_i] = 1$. The reasons for the variation in autoregressive conditional duration models are different choices of functional form for the conditional mean function and the selection of the distribution of standardized durations.

The most-common specification suggested by Engle and Russell (1998) is linear parametrization.

Bauwens and Giot (2000) suggest two extensions of the linear ACD model. These models (known as logarithmic ACD) are of the forms

$$\ln \psi_i = \omega + \sum_{j=1}^{P} \alpha_j \ln \varepsilon_{i-j} + \sum_{j=1}^{Q} \beta_j \psi_{i-j}$$

and

$$\ln \psi_i = \omega + \sum_{j=1}^{P} \alpha_j \varepsilon_{i-j} + \sum_{j=1}^{Q} \beta_j \psi_{i-j}$$

In our contribution, we call these specifications $LACD_1$ and $LACD_2$, respectively. In these models, there are no sign restrictions on parameters to ensure the positivity of conditional duration.

We restrict our attention to cases where $P = Q = 1$, which is sufficient in our analysis. In this case, inequality $\alpha + \beta < 1$ ensures the existence of an unconditional mean of duration of the ACD model. The covariance-stationarity of $LACD_1$ is ensured by $|\beta| < 1$, whereas for $LACD_2$, we have $|\alpha + \beta| < 1$.

Another specification that researchers have to choose is the distribution for standardized durations. In their seminal paper, Engle and Russel (1998) study exponential and Weibull distributions (the exponential distribution is used in a quasi-maximum likelihood estimation).

In our contribution, we are going to fit generalized gamma, Burr distributions, and q-Weibull to the tick-by-tick data for selected German companies. The formula for the density of the generalized gamma distribution is given in Lunde (2000),

whereas Gramming and Maurer (2000) consider properties of the Burr distribution. The exponential and Weibull distributions are special and limiting cases.

The q-Weibull distribution is considered by Vuorenmaa (2009) with density

$$f(\varepsilon) = (2-q)\frac{\alpha}{\beta^{\alpha}}\varepsilon^{\alpha-1}\left[1-(1-q)\left(\frac{\varepsilon}{\beta}\right)^{\alpha}\right]^{\frac{1}{1-q}}$$

with $\beta = \dfrac{(q-1)^{\frac{1+\alpha}{\alpha}}}{2-q}\dfrac{\alpha\Gamma\left(\dfrac{1}{q-1}\right)}{\Gamma\left(\dfrac{1}{\alpha}\right)\Gamma\left(\dfrac{1}{q-1}-\dfrac{1}{\alpha}-1\right)}$ and for our purposes $1 < q < 2$ and $\alpha > 0$.

When $q = 1$, the q – Weibull distribution includes the standard Weibull distribution, and for $\alpha = 1$, it is equivalent to an exponential distribution. Similar specifications of models and distributions are used by Gurgul and Syrek (2016).

The series of trading volumes have similar characteristics to the duration series. For this reason, trading volume series can be modeled with ACD-type models. Following Manganelli (2005), we call these models ACV- autoregressive conditional volume models.

We now turn our attention to the contemporaneous dependence between modeled variables.

The analysis of dependence can be performed with different tools. In our research, we use quantile dependence and copulas. The strength of dependence measured by "quantile dependence" (in the joint lower or upper tails) is defined as:

$$\lambda^{q} = \begin{cases} P(U_{1t} \le q | U_{2t} \le q), & 0 < q \le 0.5 \\ P(U_{1t} > q | U_{2t} > q), & 0.5 < q \le 1 \end{cases}$$

where U_{1t} and U_{2t} are probability integral transforms. The estimators of quantile dependence are as follows

$$\hat{\lambda}^{q} = \begin{cases} \dfrac{1}{Nq}\sum_{t=1}^{N} 1\{U_{1t} \le q \,|\, U_{2t} \le q\}, & 0 < q \le 0.5 \\ \dfrac{1}{N(1-q)}\sum_{t=1}^{N} 1\{U_{1t} > q | U_{2t} > q\}, & 0.5 < q \le 1 \end{cases}$$

Using a quantiles dependence function, it is possible to test for (under the null) symmetric dependence (Patton, 2012) $\lambda^q = \lambda^{1-q}$ for every $q \in [0,1]$. To perform the test, the estimated quantile dependence measures are stacked in vector $\hat{\lambda}$ with $q_{k-j} = 1 - q_j$, for $j = 1, 2, ..., k$. The test is

$$H_0 : R\lambda = 0$$

against

$$H_1 : R\lambda \neq 0$$

with $R \equiv [k \vdots -I_k]$.

The test statistics proposed by Rémillard (2010) is based on bootstrap. Under the null, we have

$$N(\hat{\lambda} - \lambda)' R' (RV_{\lambda,S} R')^{-1} R(\hat{\lambda} - \lambda) \xrightarrow{d} \chi_k^2$$

where $V_{\lambda,S}$ denotes the bootstrap estimate of V_λ (for more details, see Patton (2013)).

Copulas are multivariate distributions with uniform margins. Sklar's theorem states that every multivariate distribution can be decomposed into two parts: marginal distributions and copulas that describe the dependence structure. There are many functional forms of copulas (see Nelsen, 1999). The usfulness of copulas comes from the disadvanages of the classic measure of dependence; i.e., Pearson's correlation coefficient. This measure is appropriate only in the case of elliptical distributions and measures only linear dependence (which is rather rare in real-world applications). One of the alternativies is to use concordance measures; for example, Kendall's coefficient, which is the probabability of concordance minus the probability of disconcordance, and can be expressed as

$$\tau = 4 \int_0^1 \int_0^1 C(u_1, u_2)\, dC(u_1, u_2) - 1$$

Kendall's τ coefficient is invariant under strictly increasing transformations, and this is not true in general for a linear correlation coefficient.

Obtaining the limit of (population) quantile dependence, we get measures of the dependence between extreme events; that is, tail-dependence coefficients. Formally for any copula C, we have

$$\tau^L = \lim_{q \to 0^+} \frac{C(q,q)}{q}$$

$$\tau^U = \lim_{q \to 1^-} \frac{1 - 2q + C(q,q)}{1 - q}$$

The specific copulas exhibit the degree of tail dependency. For example, a normal copula and Frank copula exhibit tail independence, whereas a t copula exhibits symmetric dependence. A Gumbel copula describes upper tail dependence and lower tail independence, whereas a Clayton copula describes the opposite pattern of dependence.

4. Empirical results

Our contribution is based on the tick-by-tick transactions of some DAX30 companies. The dataset includes the prices of companies from 2013-08-08 to 2013-09-24 (33 trading days). First, we calculate price durations whose threshold equals a 10-tick size. The overnight durations and durations corresponding to events recorded outside regular opening hours (9:00 to 17:30) are removed. We sum the number of shares traded within each price duration (trading volume, hereafter).

Table 1 shows the order statistics of the main descriptive statistics of plain-price durations and trading volumes. In addition, we include the values of Ljung-Box test statistics with 15 lags.

Table 1

The order statistics of plain-price durations and trading volumes (number of observations [*N*], mean, standard deviation, minimum, quantiles, maximum, and Ljung-Box test statistic)

Price durations					
statistics	**min**	**0.25q**	**median**	**0.75q**	**max**
N	1077	2509	3294	6361	10095
Mean	102.76	162.46	312.65	413.02	888.49
S.D.	140.43	241.79	434.57	524.06	1374.20
min	1	1	1	1	1
0.25q	21.0	27.0	52.0	80.8	133.0
Median	56.0	77.3	164.5	243.8	414.0
0.75q	129.0	198.5	392.0	539.5	1134.0
Max	1858.0	3548.8	5788.5	7763.5	18606.0
LB(15)	250.255	627.168	1312.157	2930.819	5816.247

Table 1 cont.

Trading volume					
statistics	**min**	**0.25q**	**median**	**0.75q**	**max**
N	1077	2509	3294	6361	10095
Mean	2351.86	8143.40	17903.64	56331.64	104757.02
S.D.	5689.24	14761.75	39404.04	82783.48	212405.76
min	1	3	21.5	42	880
0.25q	659	2301.625	4977	14682	36362
Median	1377	4949.75	10710.75	33119	70740
0.75q	2795.5	9782.375	21270	69070.06	131853
Max	273766	673582	1723156	2406367	8396198
LB(15)	12.84	32.64	65.00	119.86	1226.44

In both types of series, the results are in line with stylized facts about duration data. In the time series under study, both overdispersion and autocorrelation are shown. The series of price durations show a diurnal pattern. Many authors have noticed the intraday seasonality in a duration series called diurnality. Similar to Bauwens and Giot (2000) and Vuorenmaa (2009), we apply cubic splines to discover diurnal patterns. We set the nodes every 60 minutes. Two additional nodes are set ten minutes after the opening and ten minutes before close (in the case of non-positive adjusted durations, we introduced some modifications of node positions). In Table 2, we present the descriptive statistics of diurnally adjusted price durations and trading volumes (plain durations series divided by seasonal component).

Table 2

The order statistics of adjusted price durations and trading volumes (number of observations [*N*], mean, standard deviation, minimum, quantiles, maximum, and Ljung-Box test statistic)

Price durations					
Statistics	**Min**	**0.25q**	**Median**	**0.75q**	**Max**
N	1077	2509	3294	6361	10095
Mean	1.020	1.033	1.039	1.050	1.103

Table 2 cont.

Price durations					
statistics	**min**	**0.25q**	**median**	**0.75q**	**max**
S.D.	1.094	1.206	1.245	1.323	1.476
min	0.001	0.002	0.002	0.003	0.005
0.25q	0.182	0.241	0.255	0.268	0.303
Median	0.521	0.619	0.630	0.675	0.704
0.75q	1.283	1.338	1.358	1.385	1.426
Max	9.813	12.087	17.104	19.429	26.497
LB(15)	170.032	349.404	600.670	1346.109	3056.831
Trading volume					
statistics	**min**	**0.25q**	**median**	**0.75q**	**max**
N	1077	2509	3294	6361	10095
Mean	1.012	1.030	1.040	1.046	1.119
S.D.	1.043	1.145	1.241	1.419	1.714
min	0.001	0.001	0.001	0.004	0.017
0.25q	0.273	0.315	0.331	0.361	0.397
Median	0.591	0.651	0.674	0.716	0.759
0.75q	1.216	1.293	1.320	1.349	1.386
Max	11.827	17.548	23.852	39.406	76.195
LB(15)	36.980	78.002	268.750	378.102	1016.003

By construction, the mean of the adjusted series should be close to 1. The price durations have the well-known inverted U-shape type pattern for all days of the week, so we observe increasing activity at the beginning and end of the session. With the trading volumes series, we found instead an inverted V-shape pattern, but only on Friday (the peak is between 13:00 and 15:00). In Figures 1 and 2, we present typical shapes of diurnal patterns.

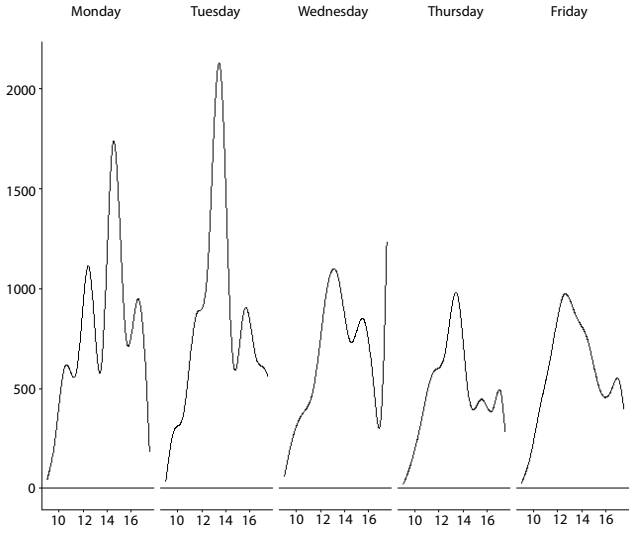

Figure 1. Diurnal pattern of price durations (Adidas)

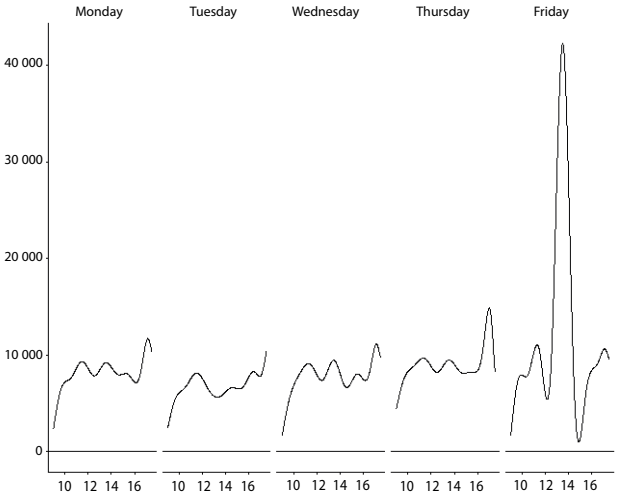

Figure 2. Diurnal pattern of trading volumes (BASF)

The autocorrelation of price duration series is now reduced (but not eliminated). In the case of trading volume series, there is no such reduction (surprisingly, we noticed a rise in some autocorrelation coefficients for some lags).

The estimation of the parameters of ACD and ADV models is carried out by the maximum likelihood method. We fitted different models combining conditional mean and distribution function. It turned out that the restriction $P = Q = 1$ is sufficient to describe the series characteristics mentioned above. The selection of models that best fit a given company is done by the Bayesian Information Criterion. We restricted our attention to the models that describe autocorrelation properly, and have uniformly distributed probability integral transforms (Diebold et. al. 1998). We checked this with the Ljung-Box test (applied to residuals and their squares) and the Anderson-Darling test (in testing for the uniformity of probability integral transform). In Table 3, we present the results of the estimation of conditional duration models.

For all of the series under study, the mean and standard deviation of residuals properly reflects characteristics from the descriptive statistics of adjusted durations. In most cases, the model that fits best is ; only in three cases is linear parametrization better. The sum of parameters α and β of the ACD model reflects the stationarity of the duration process, but the large value (at least 0.95) of this sum confirms the stylized fact of clustering of the durations. The same conclusions apply to the logarithmic model. Regarding the conditional distribution of residuals, there is no outstanding distribution. The test of parameter significance indicates a strong rejection of exponential and Weibull distributions.

Similar conclusions are drawn from the estimation results for trading volume series (Tab. 4). In four cases, linear parametrization fits better than logarithmic, and the small p-values in significance parameter testing reject exponential and Weibull distributions.

To obtain information about dependence structure st, we simply apply the sample Kendall's correlation coefficient for standardized residuals of price durations (p_t) and volumes (v_t). In Table 5, we also present the computational results for lagged variables. Numbers in bold indicate significance at a 5% level.

The dependence measured by the correlation coefficient is strong and significant only for contemporaneous variables. For the pair price duration – lagged trading volume, the dependence is significant but very weak in most cases. The results for the third pair indicate that the variables are uncorrelated. Next, we estimate quantile dependence and perform the test of symmetry (having in mind that this is only a test of the necessary condition for equality). Only in the case of companies Allianz, EON, Muenchner Rueck, and Thyssen do we fail to reject the null of symmetric dependence. The p-values based on 500 bootstrap samples equals at least 0.10. This concerns only contemporaneous dependence. If at least one variable is lagged, we fail the null for all companies. Figure 3 presents typical plot of price durations and associated trading volumes (transformed with estimated conditional distributions).

Table 3

Models for price durations

Company	Model	Dist.	LB(15)	A-D	ε	S_ε	ω	α	β	μ_1	μ_2
Adidas	ACD	G-G	0.27	0.48	1.00	1.15	0.04	0.13	0.84	1.73	0.69
Allianz	LACD1	Burr	0.81	0.63	1.02	1.11	0.08	0.17	0.82	1.22	0.23
BASF	LACD1	G-G	0.07	0.55	1.00	1.15	0.07	0.14	0.93	2.74	0.57
Beiersdorf	LACD1	q-Weibull	0.08	0.59	1.01	1.13	0.07	0.11	0.85	1.03	1.11
BMW	ACD	G-G	0.05	0.48	1.00	1.14	0.04	0.14	0.83	1.88	0.67
Commerzbank	LACD1	G-G	0.19	0.51	1.01	1.45	0.13	0.20	0.89	3.52	0.43
Deutsche_Lufthansa	ACD	G-G	0.08	0.80	1.02	1.10	0.06	0.17	0.78	2.05	0.66
EON	LACD1	Burr	0.78	0.51	1.02	1.28	0.07	0.13	0.90	1.04	0.17
Muenchner Rueck	LACD1	G-G	0.48	0.70	1.02	1.04	0.06	0.13	0.95	1.93	0.72
RWE	LACD1	Burr	0.10	0.77	1.01	1.17	0.11	0.18	0.72	1.16	0.25
SAP	LACD1	q-Weibull	0.27	0.54	1.01	1.25	0.08	0.15	0.92	1.20	1.25
Thyssen	LACD1	q-Weibull	0.10	0.33	1.08	1.66	0.20	0.34	0.84	1.07	1.23
VW	LACD1	q-Weibull	0.07	0.88	1.01	1.27	0.10	0.17	0.96	1.16	1.26

LB(15) denotes the value of the Ljung-Box test statistics applied to residuals. In A-D column is p-value in GOF testing, parameters μ_1 and μ_2 refer to κ and γ for generalized gamma distribution, κ and σ^2 for Burr distribution, and a and q for q-Weibull distribution, respectively; ε denotes mean of residuals, whereas S_ε is standard deviation of residuals

Table 4

Models of trading volumes

Company	Model	Dist.	LB(15)	A-D	ε	S_ε	ω	α	β	μ_1	μ_2
Adidas	LACD1	q-Weibull	0.90	0.31	1.00	1.85	0.07	0.11	0.89	1.34	1.35
Allianz	LACD1	G-G	0.84	0.95	1.01	1.02	0.05	0.12	0.68	8.75	0.38
BASF	LACD1	G-G	0.98	0.37	1.01	2.02	0.05	0.11	0.92	7.67	0.36
Beiersdorf	LACD1	Burr	0.75	0.28	1.00	1.30	0.05	0.09	0.88	1.42	0.50
BMW	LACD1	Burr	0.95	0.07	0.99	1.31	0.06	0.11	0.91	1.35	0.48
Commerzbank	LACD1	G-G	0.10	0.76	1.00	1.18	0.05	0.10	0.96	6.83	0.36
Deutsche_Lufthansa	ACD	q-Weibull	0.41	0.56	0.99	1.00	0.04	0.08	0.89	1.53	1.32
EON	LACD1	Burr	0.07	0.20	1.00	1.19	0.06	0.13	0.86	1.42	0.50
Muenchner Rueck	LACD1	q-Weibull	0.70	0.85	1.00	1.01	0.06	0.10	0.60	1.54	1.30
RWE	ACD	q-Weibull	0.80	0.96	1.00	1.22	0.33	0.16	0.54	1.44	1.33
SAP	LACD1	Burr	0.66	0.07	1.01	1.64	0.06	0.12	0.87	1.40	0.48
Thyssen	ACD	G-G	0.20	0.55	1.03	1.00	0.20	0.13	0.68	7.24	0.42
VW	ACD	q-Weibull	0.41	0.56	0.99	1.00	0.04	0.08	0.89	1.53	1.32

LB(15) denotes the value of the Ljung-Box test statistics applied to residuals. A-D shows p-values in GOF testing, parameters μ_1 and μ_2 refer to κ and γ for generalized gamma distribution, κ and σ^2 for Burr distribution, and a and q for q-Weibull distribution, respectively; ε denotes mean of residuals, whereas S_ε is standard deviation of residuals

Table 5
Sample Kendall's correlation coefficients

Company	$p_t - v_t$	$p_t - v_{t-1}$	$p_{t-1} - v_t$
Adidas	0.40	–0.03	0.02
Allianz	**0.57**	**–0.04**	0.02
BASF	**0.44**	**–0.04**	–0.01
Beiersdorf	**0.37**	**–0.04**	–0.01
BMW	0.41	–0.03	–0,02
Commerzbank	0.48	–0.05	0,05
Deutsche_Lufthansa	**0.41**	**–0.03**	0.00
EON	0.52	–0.05	–0.03
Muenchner Rueck	**0.49**	**–0.04**	–0.03
RWE	**0.41**	**–0.04**	–0.01
SAP	**0.47**	–0.01	0.00
Thyssen	0.48	–0.05	0.07
VW	**0.46**	**–0.07**	0.01

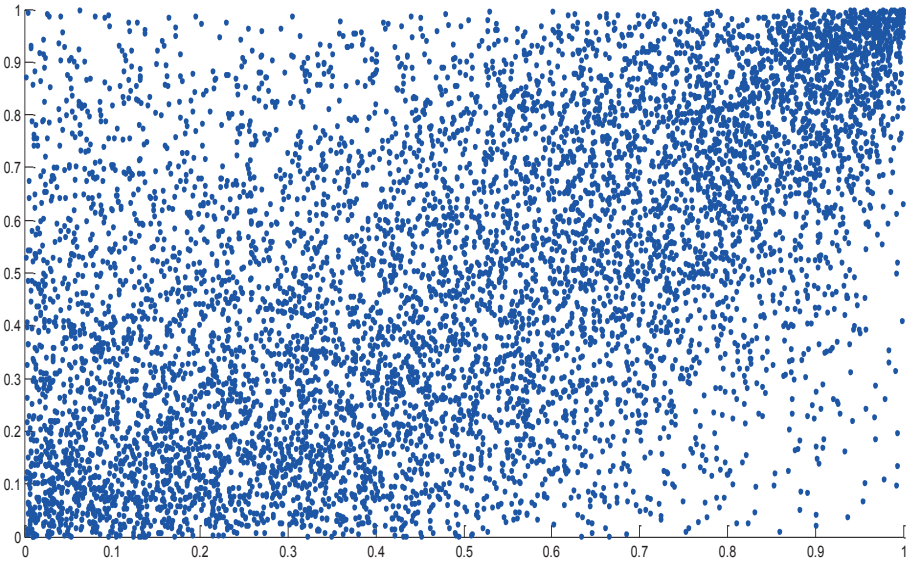

Figure 3. Price durations and trading volumes

We observe the concentration of points is in the upper-right corner, (that is, for simultaneously large values of both series). To gain more insight into the dependence structure, we use copula functions. Given the PIT series obtained from the ACD and ACV models, we use a maximum-likelihood method to estimate the parameters of copula functions. This one is the IFM method of Joe and Xu (1996). To select the copulas that fit best, we use the BIC criterion. The results of parameter estimation are in Table 6. In addition, we present dependence measures based upon the copula selected.

Table 6

Copula estimation results and dependence measures

Company	Copula	τ	τ^L	τ^U
Adidas	Gumbel	0.37	0.00	0.46
Allianz	*t*	0.55	0.31	0.31
BASF	Gumbel	0.41	0.00	0.50
Beiersdorf	Gumbel	0.34	0.00	0.42
BMW	Gumbel	0.38	0.00	0.47
Commerzbank	Gumbel	0.46	0.00	0.54
Deutsche_Lufthansa	Gumbel	0.39	0.00	0.47
EON	*t*	0.50	0.25	0.25
Muenchner Rueck	*t*	0.47	0.25	0.25
RWE	Gumbel	0.38	0.00	0.46
SAP	Gumbel	0.45	0.00	0.53
Thyssen	*t*	0.46	0.11	0.11
VW	Gumbel	0.44	0.00	0.53

Contemporaneous price durations and associated trading volumes are dependent (as can be seen from the values of the Kendall correlation coefficient). In addition, the Gumbel copula fits best for most cases that exhibit positive upper tail dependence and lower tail independence. The coefficient of upper tail dependence equals at least 0.46 (for Adidas and RWE). In the remaining cases, elliptical copula *t* fits the data best. These results are in line with results from testing for symmetry using quantile-dependence measures. In these cases, the lower and upper tail dependence coefficients are equal and relatively low as compared to a nonsymmetrical copula. For the case of the lagged variable, the independence copula fits the best.

5. Conclusions

In this paper, we show the usefulness of the copula function in the description of the dependence structure of specific unevenly spaced time series. The behavior of the time series of price durations and trading volumes under study are in line with common observation from other empirical findings. We observe clustering, overdispersion, and diurnality. In most cases, the seminal model (linear parametrization with exponential or Weibull distribution) is displaced by a logarithmic specification with more-flexible conditional distributions. The price duration and trading volume associated with this duration are dependent in the tails of distribution. We may conclude that high cumulative volumes are associated with long durations, but also that dependence between short durations and low cumulative volumes can be observed. This is concerned with contemporaneous variables. For the case where one of the variables is lagged, we conclude that the dependence (if any) is very weak.

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Relationship between fiscal instruments and investments of industrial SMEs and LEs in Poland

1. Introduction

The European Union countries, including Poland, have supported investments of enterprises for many years. This is an important factor that influences Gross Domestic Product. However, enterprises are not a homogeneous group of entities. Small and medium-sized enterprises (SMEs) have significant contributions into employment, whereas large enterprises (LEs) introduce many innovations. Nevertheless, support for them is provided by both financially, like grants or subsidies and non-financial instruments (for example, technology parks). Fiscal instruments such as tax breaks or depreciation allowances belong to the first group; however, the effectiveness of these support instruments is still a subject of debate. Moreover, there is a dearth in the literature as to the relationship between fiscal instruments and investments in SMEs and LEs in Poland. This study seeks to address this gap by using statistical tools and trying to build an econometric model.

The paper is organized as follows: in Section 2 we scrutinize the findings of research that has already been published. Section 3 presents the research questions, the aim of the study, and the hypothesis. Section 4 describes how the data was collected, presents the process of statistical analysis, and attempts to build an econometric model. Section 5 shows the conclusions after the study.

2. Literature review

Most of the official reports in Poland about the impact of public policy on SMEs focus on grants (Pokorski, 2010, 2011) or microcredit funds (Analiza korzyści…, 2012). Many studies also concentrate on subsidies (Norman and Bager-Sjögren,

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2010; Karafolas and Woźniak, 2014b; Peszko, 2014), venture capital (Denis, 2004; Bertoni, Colombo and Grilli, 2011), loan guarantees (Riding and Haines, 2001; Boocock and Shariff, 2005; Karafolas and Woźniak, 2014a) or microcredits (Karlan, 2007; Newman, Schwarz, Borgia, 2014).

As fiscal instruments belong to tax expenditures, many authors have criticized their usefulness (Zbroińska, 2006; Wyszkowski, 2010; Goolsbee, 1997; Mintz, 1990). However, authors who research the impact of tax incentives on SMEs concentrate mainly on research and development activities (R&D). Banghan and Mohnen (2009) evaluated the effectiveness of R&D tax incentives in small and large companies in Quebec and concluded that there was a deadweight loss, particularly for large enterprises. Ortega et al. (2009) believes that R&D policy (including fiscal incentives) ought to be complemented with other policies favoring SMEs. Hendricks et al. (1997) made research on the potential impact of business taxation on SMEs in Canada using a longitudinal database. The findings reveal that the role of the small business deduction that was a fiscal incentive program as a source of financing growth was restricted to a small fraction of Canadian-controlled private companies. However, the subject of tax incentives is sometimes a part of wider works examining the impact of public policy on SMEs in countries like (for instance) Poland (Matejun, 2003, 2005; Wach, 2008; Woźniak, 2012), Malesia (Muhammad et al., 2010), or China (Chen, 2006).

Many SMEs regard fiscal requirements as very significant barriers of development. One of the main problems is that tax law is very complicated. In addition, tax offices present different interpretations of tax law. In connection to the above, a Polish entrepreneur has to make about 40 payments at constitute 40% of his profits and takes approximately 420 hours per year (Woźniak, 2012). Nevertheless, the survey made by Woźniak (2011) revealed that SMEs find fiscal incentives as very important for their development. Moreover, most of them regard tax breaks for investments as justified (Zbroińska, 2006). However, some authors argue the reason could be that SMEs just want to lower their tax liabilities and not focus on their efficiency (Zbroińska, 2006). In connection to the above, Gołębiowski (2009) proposes decreasing the tax level and eliminating other tax incentives.

Nevertheless, tax incentives seem to be more important for SMEs, as they face many more constraints in accessing bank loans than large enterprises (Wach, 2008; Woźniak, 2007; Duda, 2013). Therefore, there is a need to cover their comprehensive support system, including fiscal support instruments that should correspond to the needs of Polish SMEs (Woźniak, 2012).

Development of an enterprise is connected with investments. There are many factors that could influence them. According to the literature (Begg et al., 2005; Krugman and Wells, 2012), these could be consumer confidence, economic indi-

cators in the industry, interest rates on loans, the situation on the credit market, gross household savings, and the price of production goods.

There are important studies regarding the tax impact on enterprises that make a distinct contribution to the literature. However, most of them concentrate only on SMEs. Moreover, there is a shortage of similar research for Polish enterprises.

3. Starting point

The value of tax expenditures for enterprises in Poland has been increasing for many years (Preferencje podatkowe…, 2014) and nowadays is similar to the worth of microloans or loan guarantees (Raport o pomocy…, 2015, Mikropożyczki…, 2013). Taking also the literature review into consideration, the following questions have not been answered as of yet:

– Is there a relationship between fiscal incentives and the investments of industrial micro, small, and medium-sized companies, and large enterprises in Poland?
– If there is such relationship, is it stronger for industrial micro, small, and medium-sized companies than for large enterprises in Poland?
– If there is such relationship, is it stronger than other factors that are related to the investments of enterprises?

In connection to the above questions, the aim of this study is to analyze the relationship of fiscal support instruments and level of investments of industrial micro, small and medium-sized enterprises as compared to large companies in Poland during the years 2006–2014.

Based on the literature review, the following hypotheses were proposed:

H1. There is a relationship between fiscal incentives and the investments of industrial micro, small, medium-sized companies, and large enterprises in Poland.
H2. This relationship is stronger for industrial micro, small, and medium-sized companies than large enterprises in Poland.
H3. The relationship between other factors that are related to the investments is stronger than for the fiscal incentives, and the investments of industrial micro, small, and medium-sized companies as well as large enterprises in Poland.

The authors decided to apply mainly statistical analysis, both basic as well as multidimensional. It allows us to analyze the empirical data, interpret the results, and present our conclusions.

4. Analysis

4.1. Collecting data

In order to test the hypotheses, the authors collected and analyzed statistical data. The next stages of the research were as follows:

– collect statistical data that could potentially be useful in the analysis – the authors used suggestions of literature as well as their own experiences;
– simple statistical analysis in the form of calculating the Pearson correlation coefficients – this stage was to detect associations between the analyzed variables and discard the useless variables;
– the advanced (multivariate) statistical analysis in the form of cluster analysis and multidimensional scaling – this stage was to detect more–complex relationships between variables and to select independent variables for the econometric model;
– an attempt to construct an econometric model based on a multiple regression – as a model that shows the specific impact of several variables on the level of investments of companies.

First, the authors identified the tax expenditures in the area of economics in Poland. Then, the fiscal incentives that aim is to support the investments of enterprises were chosen. They are presented in Table 1.

Table 1

Fiscal incentives that support investments of enterprises in Poland

Type of tax	Name of incentive
Personal Income Tax (PIT)	special economic zones
	one-time depreciation
	allowances of expenses for acquisitions of new technology
	settlement of losses from previous years
	decreasing the maximum tax level
	decreasing the minimum tax level
Corporate Invome Tax (CIT)	special economic zones
	one-time depreciation
	allowances of expenses for acquisitionof new technology
	settlement of losses from previous years
	allowances for capital expenditure
	exemptions for companies with foreign shareholders
	decreasing tax level

After that, the following data for the years 2006–2014 was collected:

1) The level of investment in industry in the private sector for micro-, small-, medium-sized companies and large enterprises in Poland (Rocznik statystyczny przemysłu, 2007–2014) – dependent variables;
   Data concern economic entities conducting activity, in accordance with the Polish Classification of Activities – PKD 2007, within the scope of the following sections: "Mining and quarrying," "Manufacturing," "Electricity, gas steam and air conditioning supply," as well as "Water supply; sewerage, waste management, and remediation activities". In the scope of production of products data concern entities manufacturing industrial products, irrespective of their kind of activity classified according to PKD 2007 (Rocznik statystyczny przemysłu, 2007–2014).
   "The term economic entities is understood as entities conducting economic activity (production and services) on their own account in order to earn a profit" (Rocznik statystyczny przemysłu, 2014, p. 29).
2) The worth of fiscal instruments whose aim was to support the investments of enterprises and tax levels for Personal Income Tax (PIT) and Corporate Income Tax (CIT) (Ministerstwo Finansów, http://www.finanse.mf.gov.pl/cit/statystyki, http://www.finanse.mf.gov.pl/pit/statystyki) – potentially independent variables.
3) Other factors that should influence the level of the investments of enterprises:
   – potentially independent variables;
   – indicators of consumer confidence (Główny Urząd Statystyczny, http://stat.gov.pl/obszary–tematyczne/koniunktura/):
     • indicator of demand forecasts;
   – economic indicators in the industry (Narodowy Bank Polski, http://www.nbp.pl/home.aspx?c=/ascx/koniunktura_prezentacja.ascx):
     • indicator of economic outlook forecasts of enterprises,
     • indicator of new orders,
     • indicator of production forecasts,
     • indicator of new orders,
     • indicator of new investments;
   – interest rates on loans (Narodowy Bank Polski, http://www.nbp.pl/home.aspx?f=/statystyka/pieniezna_i_bankowa/oprocentowanie_n.html);
   – NBP surveys on the situation in the credit market (Narodowy Bank Polski, http://www.nbp.pl/home.aspx?f=/systemfinansowy/kredytowy.html);
   – gross household savings ("Rocznik statystyczny Rzeczpospolitej Polskiej" 2007–2014);
   – Production Price Index (PPI) (Główny Urząd Statystyczny, http://stat.gov.pl/obszary–tematyczne/ceny–handel/ceny/).

This allowed us to choose 37 variables, among which 35 could be explanatory variables that describe the change in the level of investments in the industry.

The variables denominated in PLN are given in nominal values. However, it can be assumed that the impacts of price changes on these variables are similar. These variables do not require a conversion on real values. Any conversion of the same inflation rates would not change the correlation values and the results of the model.

As far as the variables like consumer confidence, economic outlook, or surveys on the situation in the credit market are concerned, it can be assumed that the respondents know the overall economic outlook of Poland so they take into account the inflation rate. Any conversion of the nominal values could cause a distortion of correlation indicators.

4.2. Statistical analysis

First, the easiest stage of the analysis was to calculate the correlation coefficients of Pearson. Table 2 presents the significant correlations.

The results indicate that the level of investments in micro- and small-sized enterprises (MSEs) is significantly associated with the following variables:

1) Fiscal incentives under PIT:
   – allowances of expenses for acquisitions of new technology (WNT-PIT),
   – settlement of losses from previous years according to the general, progressive tax scale (SLU-PIT),
   – settlement of losses from previous years according to the flat tax (SLU-PIT19).
2) Fiscal incentives under CIT:
   – exemptions for companies with foreign shareholders (ZUZ-CIT),
   – special economic zones (SSE-CIT),
   – settlement of losses from previous years (SLU-CIT),
   – allowances of expenses for acquisitions of new technology (WNT-CIT).
3) Other factors: indicator of new orders (WNZ).

The level of investment in medium enterprises (MEs) is associated with:

1) Fiscal incentives under PIT:
   – allowances of expenses for acquisitions of new technology (WNT–PIT),
   – settlement of losses from previous years according to the general, progressive tax scale (SLU–PIT),
   – settlement of losses from previous years according to the flat tax (SLU–PIT19).

2) Fiscal incentives under CIT:
   – special economic zones (SSE–CIT),
   – settlement of losses from previous years (SLU–CIT),
   – allowances of expenses for acquisitions of new technology (WNT–CIT).
3) Other factors:
   – indicator of economic outlook forecasts of enterprises (WPSE),
   – indicator of demand forecasts (WPP),
   – indicator of new orders (WNZ),
   – indicator of production forecasts (WPPr).

Table 2

Significant correlations between the level of investment in the industry and the potential explanatory variables

Variables	Investments of MSEs	Variables	Investments of MEs	Variables	Investments of LEs
WNT-PIT	0,855794	SLU-PIT	0,799133	SLU-PIT	0,674747
SLU-PIT	0,919978	SLU-PIT19	0,758023	SLU-PIT19	0,717128
SLU-PIT19	0,893376	SSE-CIT	0,840132	SSE-CIT	0,781529
ZUZ-CIT	-0,755401	SLU–CIT	0,709321	WPSE	–0,744490
SSE–CIT	0,922358	WNT–CIT	0,714419	WPP	–0,803772
SLU–CIT	0,924018	WPSE	−0,763983	WNZ	–0,765059
WNT–CIT	0,819026	WPP	−0,730127	WPPr	–0,749511
WNZ	–0,674568	WNZ	−0,748817	WNI	–0,690088
WNT-PIT	0,751721	WPPr	−0,685153		

* MSEs – micro– and small–sized enterprises, MEs – medium enterprises, LEs – large enterprises. Level of significance: $p = 0{,}05$

Finally, the level of investment in large enterprises is associated with:

1) Fiscal incentives under PIT:
   – settlement of losses from previous years according to the general, progressive tax scale (SLU–PIT),
   – settlement of losses from previous years according to the flat tax (SLU–PIT19).
2) Fiscal incentives under CIT: special economic zones (SSE–CIT).

3) Other factors:
   – indicator of economic outlook forecasts of enterprises (WPSE),
   – indicator of demand forecasts (WPP),
   – indicator of new orders (WNZ),
   – indicator of production forecasts (WPPr),
   – indicator of new investments (WNI).

The analysis of correlation coefficients allows for the following conclusions:

– three fiscal incentives: SLU–PIT, SLU–PIT19, and SSE–CIT are correlated with the investments of both MSEs, MEs, and LEs;
– the correlation coefficient is higher for MSEs than for MEs and LEs;
– the investments of MSEs, MEs, and LEs are also significantly correlated with each other;
– the relationship between investments of MSEs with ZUZ–CIT is negative, which probably stems from a smaller and smaller field of application of the tax exemption referred to in Article 23 of the law on companies with foreign participation (Dz.U. 1991 Nr 60, poz. 253), and this article was repealed in 1996;
– interesting fact is that the correlations between the levels of investment and both the indicators of consumer confidence and business prosperity in the industry are negative. One may say that the expectations of consumers and producers are different from their decision about investments.

Although the calculated correlations are evidence of a significant relationship between dependent variables and some potential independent variables, one cannot formulate on this basis the decisive conclusions. The relationship between variables can be random, even if there is a cause-and-effect relationship; at this point, the authors could not state which variable is "a cause" or „an effect." Correlation analysis does not provide a full basis for grouping the potential independent variables and assess their overall impact on the dependent variables. Therefore, it is possible (the hypothesis may be true), and it is necessary to continue advanced analysis. However, the authors could not state that some of the variables will not be useful in the construction of an econometric model (which is a normal statistical inference).

The next stage was a cluster analysis. This analysis is used to organize observed data (potential independent variables) in a meaningful structure or grouping the data (StatSoft, 2014). In order to form a vertical **hierarchical tree**, the method of Ward was chosen. This method is considered to be very efficient (Ward, 1963). As a unit of distance **measure, 1–r Pearson's** was used. After determining the upper limit of distance **measure** at 2, a division into groups was received. This is shown in Figure 1.

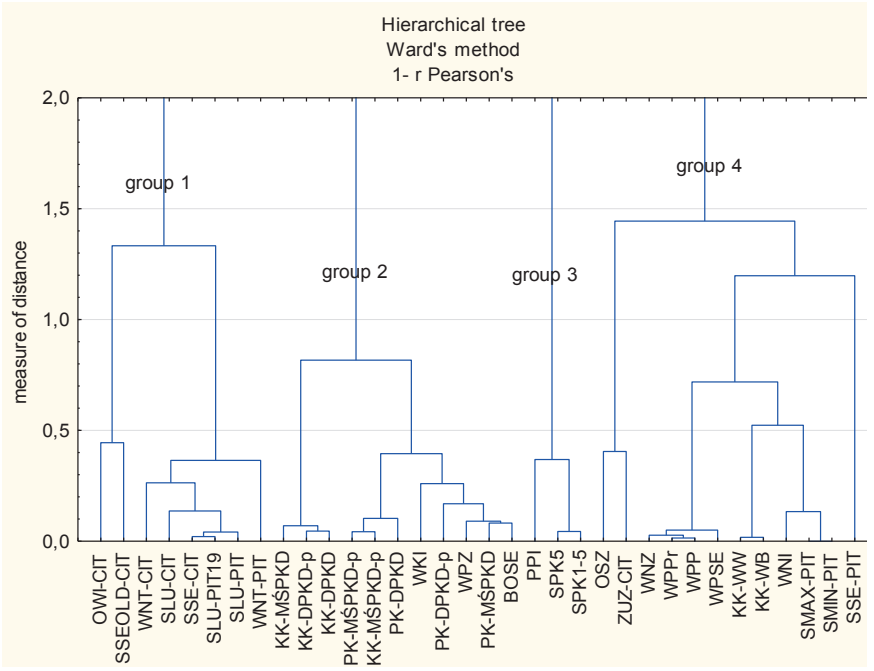

Figure 1. Cluster analysis – graph of hierarchical grouping variables

Four groups of variables are shown in Figure 1. There was no variable associated with the investments of MSEs, MEs, or LEs in either the second or third group. On the other hand, in the first group as well as in the fourth, most variables are related to the investments of MSEs, MEs, or LEs. Tax incentives were mainly in the first group. Moreover, almost all variables are significantly correlated with each other.

The next step of the analysis was a multidimensional scaling. It is used in order to reveal important hidden dimensions that allow us to explain the observed similarities or differences (distance) between variables (StatSoft 2014). All variables, including variables describing the level of investment spending, were selected for analysis. The standard configuration of Guttman–Lingoes was adopted as the initial configuration, and the process of estimating achieved convergence after 16 iterations. Figure 2 shows the result of the final configuration in two dimensions.

Based on the estimation results such as the **stress factor (0.142), the coefficient of alienation (0.157)**, and **the Shepard diagram,** the obtained projection can be considered as an average. The average distance was to match the reconstituted final configuration to the actual distance (resulting from the distance matrix).

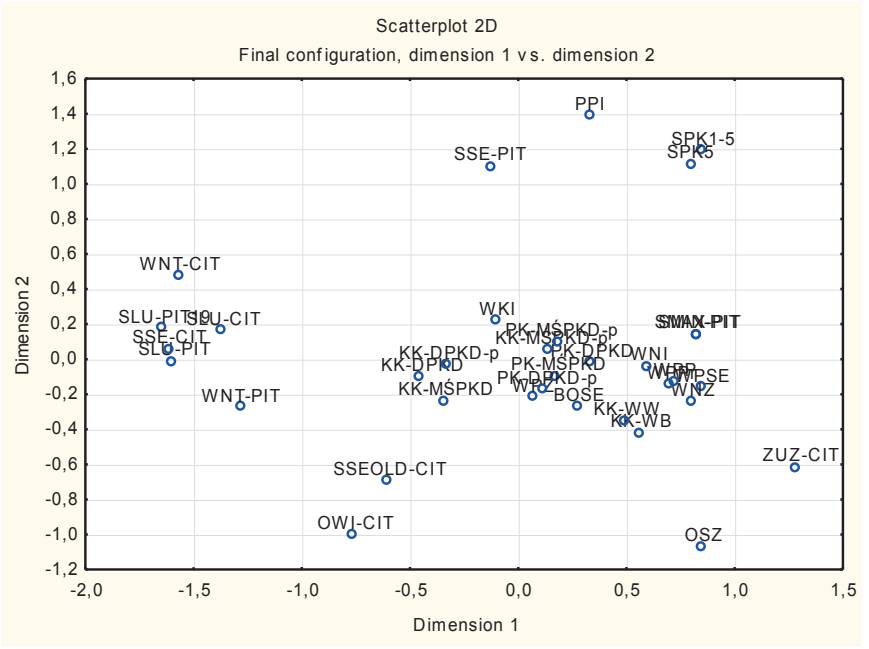

Figure 2. Multidimensional scaling – final configuration

However, Figure 2 shows that the variables form a number of groups similar to the cluster analysis. One group consists of some tax instruments. The other two groups include variables related to consumer confidence, business prosperity in the industry, and surveys conducted by the NBP on the situation of the credit market. The outliers are, for example, PPI, interest rates of loans (SPK1–5, SPK5), gross household savings (OSZ), and one of the fiscal incentives (ZUZ–CIT).

One of the essential elements of multidimensional scaling is to interpret the received final configuration dimensions. One can assume that Dimension 1 is a measure of the similarity of variables, like the correlation coefficient. It is more difficult to interpret Dimension 2. After some additional studies, it appears that the dimension shows a measure that is similar to the sum of the correlation coefficients of the variable with the others.

Both of these types of analysis were used to widen the possibilities of statistical inference. Analyses showed a relationship between the dependent variables and potential independent variables that allow us to group the potential independent variables, which makes it possible to attempt to build an econometric model.

Analyses were made with the Statistica program.

4.3. Building the econometric model

The final stage of the statistical analysis was an attempt to build the econometric model with one equitation based on multiple regression. The potential independent variables were divided into groups using the previous analysis. The selection of variables that represent each group was made by the **method of unweighted pair-group centroid**. This method involves (for groups of more than two-elements) selection of the variable in which the sum of distances to the other variables in the group is the lowest. Based on Figure 1, it was found that:

- SLU–PIT from Group 1 was selected as an explanatory variable;
- WNZ from Group 4 was selected as an explanatory variable;
- there is no variable significantly correlated with the investments of MEs, MSEs, or LEs in Groups 2 and 3;
- variables SLU–PIT and WNZ are associated with both the investments of MSEs, MEs, and LEs.

Using multiple regression analysis, three econometric models with one equitation for each dependent variable was built. In the best model, the investments of MSEs were the dependent variable. The multiple correlation coefficient was $R = 0.923$ ($R^2 = 0.852$). The condition of coincidence was met (Hellwig 1976):

$$\text{sign}\,(y\,(xj, y)) = \text{sign}\,(\beta j) \tag{1}$$

where:

sign (r (xj, y)) – a sign of the correlation coefficient between the dependent and the explanatory variable

sign (βj) – a sign of a beta coefficient in the econometric model for the explanatory variable.

Unfortunately, the beta coefficient of the variable WNZ was statistically insignificant – the significance level was $p \leq 0.05$. Under these circumstances, to create an econometric model seems pointless. Otherwise, the model with one dependent variable lead to almost the same conclusion as the calculation of the linear correlation between the investments of MSEs and the SLU–PIT (which, moreover, is almost identical [0.920] to the coefficient of multiple regression).

The other two models were characterized by both a lower coefficient R2 and the irrelevance of beta coefficients for both variables.

5. Conclusions

The relationship between fiscal instruments and the investments of both small– and medium–sized enterprises as well as large companies in Poland has not been the main subject of research. Although some studies have been taken so far, no conclusive answers exist as of yet. In connection to this, the authors decided to analyze this area of research.

The statistical analysis revealed that there is a significant relationship between the level of investment in micro, small, and medium–sized enterprises and the majority of tax instruments. This supports hypothesis H1 in some part. However, the results suggest that the smaller the enterprise, the more stronger relationship with fiscal incentives exists. There are tax instruments that are correlated with all size of enterprises. This includes settlement of losses from previous years according to both the flat tax and general, progressive tax scale under PIT and special economic zones under CIT. Moreover, the relationship between these instruments and the investments of MSEs is stronger than for MEs and LEs. This supports hypothesis H2.

The authors also make a comparison with other factors that should influence the investments of enterprises. It turns out that there is a negative relationship between the instruments and the indicators of consumer confidence and business prosperity, particularly for medium– and large–sized companies. Moreover, there are outliers that include PPI, interest rates of loans, and gross households savings. In connection to this, hypothesis H3 should be rejected.

The authors also tried to build an econometric model, but it was impossible. Nevertheless, the area of research undertaken by the authors needs more studies. It should be connected with (among others) an attempt to estimate the deadweight effect of fiscal incentives.

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Summaries

Anna Blajer-Gołębiewska, Arkadiusz Kozłowski: **Financial determinants of corporate reputation: a short-term approach** ▪ Managerial Economics 2016, vol. 17, no. 2

JEL Classification: G11, D46, D53, L14, C23

Keywords: *corporate reputation, investment decisions, value of firms, financial markets, panel data models*

The aim of this study was to verify the short-term impact of financial variables on the corporate reputation perceived by investors. In the study we applied an approach from the field of business valuation assuming that corporate reputation perceived by investors is reflected in the difference between the valuation of a company by investors and its book value. Using panel data methodology, we analysed impacts of selected financial variables, representing company's profitability, stability and its level of risk, on these differences in valuations of selected companies listed on the Warsaw Stock Exchange. Particularly, we chose companies operating in Construction and IT sectors to represent different types of activities (industry vs. services), which impacts also the diversity in the structure of their financial statements. In the study we used multiple regression models and analysis of contingency tables (chi-squared tests of independence and Yule's coefficient of colligation). Our data suggest that there is a lack of strong short-term relations between analysed financial variables and corporate reputation. Nevertheless, we found different determinants of corporate reputation in the Construction sector (stability and profitability as well as their changes) and in the IT sector (stability, changes in profitability and the level of financial risk).

Beata Detyna, Jerzy Detyna, Anna Dudek-Kajewska: **Evaluation of training programs by medical employees in a chosen hospital in Poland** ▪ Managerial Economics 2016, vol. 17, no. 2

JEL Classification: M00, M53, M54

Keywords: *training, training programs, quality management, quality improvement, training support*

This article contains the results of research on the evaluation of the training offer addressed to the medical staff of one of the largest Polish specialist hospitals. The authors have used surveys addressed to employees: doctors and nurses. On the basis of numeral data received from the respondents, two "quality maps" have been drawn that show the opinion of "white coat"

workers (doctors and nurses) about the hospital training offer. This work presents similarities and differences between assessments of doctors and nurses. A short description of the hospital as well as its weaknesses and strengths has been presented. A direction of possible changes has been indicated by the employees. The authors indicate the significance of training programs in order to gain work satisfaction, and the role of the personnel strategy to achieve the objectives. They emphasize the significance of aimed professional development in a health-care-providing institution where knowledge and skills have an influence on the health and lives of patients. Research results showed the validity of the practical use of the quality map in the process of hospital management. This tool allows us to get answers about which areas (according to respondents) carrying out corrective actions are recommended.

Henryk Gurgul, Łukasz Lach, Tomasz Wójtowicz: **Linear and nonlinear intraday causalities in response to U.S. macroeconomic news announcements: Evidence from Central Europe** ▪ Managerial Economics 2016, vol. 17, no. 2

JEL Classification: G12, G14

Keywords: *trading volume, return volatility, public news, sequential information arrival, Granger causality*

This paper deals with an analysis of the information flow on and between three European stock markets operating in Frankfurt, Vienna, and Warsaw. We examine causal links between returns, volatility, and trading volume as well as the time of reaction to a news release and changes in the duration of causal interference. To model the conditional variance, we use the ARMA(1,1)-EGARCH-M(1,1) model. We investigate linear and nonlinear Granger causalities on the three stock exchanges using Bayesian large sample correction of the critical values in significance tests. The results of our study confirm the dominant role of the Frankfurt Stock Exchange, since the most significant linear relationship is the causality running from DAX30 returns to the returns of the ATX20 and WIG20 (which exists irrespective of the time of the day, presence of important public news, and lag length of the underlying VAR models). Moreover, the empirical results of this paper confirm the strong impact of announcements of macroeconomic news from the U.S. economy on the structure of both linear and nonlinear causal links on the three markets under study.

Henryk Gurgul, Robert Syrek, Christoph Mitterer: **Price duration versus trading volume in high-frequency data for selected DAX companies** ▪ Managerial Economics 2016, vol. 17, no. 2

JEL Classification: G15, G19

Keywords: *Frankfurt Stock Exchange, intraday data, duration models, copulas*

The main goal of this paper is to gain insights into the dependence structure between the duration and trading volume of selected stocks listed on the Frankfurt Stock Exchange. We demonstrate the usefulness of the copula function to describe the dependence of specific unevenly spaced time series. The properties of the time series of price durations and trading volumes under study are in line with common observations from other empirical studies. We observe clustering, overdispersion, and diurnality. For most of the stocks, the seminal model (linear parametrization with exponential or Weibull distribution) can be replaced by a logarithmic specification

with more-flexible conditional distributions. The price duration and trading volume associated with this duration exhibit dependence in the tails of distribution. We may conclude that high cumulative trading volumes are associated with long duration. However, changes of price over short times are related to low cumulative volume.

Maciej Woźniak, Robert Lisowski: **Relationship between fiscal instruments and investments of industrial SMEs and LEs in Poland** ▪ Managerial Economics 2016, vol. 17, no. 2

JEL Classification: E62, H2, H3, C0

Keywords: *fiscal instruments, investments, small and medium-sized enterprises, large enterprises*

The authors used statistical tools to analyze the relationship of fiscal support instruments and the level of the investment of industrial micro, small, and medium–sized enterprises in comparison to large companies in Poland in the years 2006–2014. The results revealed that there is a significant relationship between the level of investment in micro–, small–, and medium–sized enterprises and the majority of tax instruments. There is a negative relationship between the instruments and some of other factors that should influence on the investments of enterprises.

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