
PILLAR 3: MARKET DISCIPLINE OF THE KEY STAKEHOLDERS IN CEE COMMERCIAL BANK AND TURBULENT TIMES

Michal MUNK¹, Anna PILKOVA², Lubomir BENKO³,
Petra BLAŽEKOVÁ⁴

¹*Department of Informatics, Faculty of Natural Sciences, Constantine the Philosopher
University in Nitra, Tr. A. Hlinku 1, SK 949 74, Nitra, Slovakia*

^{2,4}*Department of Strategy and Entrepreneurship, Faculty of Management, Comenius University
in Bratislava, Odbojárov 10, SK 820 05, Bratislava, Slovakia*

³*Institute of System Engineering and Informatics, Faculty of Economics and Administration,
University of Pardubice, Studentská 95, CZ 532 10, Pardubice, Czech Republic
E-mail: lubomir.benko@gmail.com (corresponding author)*

Received 19 February 2017; accepted 24 July 2017

Abstract. The study presented in the paper contributes to covering the gap in the area of sufficient information disclosure that also increases the interests of relevant stakeholders in contributing to depository market discipline and in being relevant to their interest within Pillar 3 framework. This paper is focused on an analysis of website data dedicated to Pillar 3 disclosures of commercial banks and on studying the behaviour of stakeholders in relation to the timing of serious market turbulence. The examined data consists of log files that were pre-processed using web mining techniques and from which were extracted frequent itemsets by quarters and evaluated in terms of quantity. The authors have proposed a methodology to evaluate frequent itemsets of web parts over a dedicated time period. The results show that stakeholders' interest in disclosures is lower after turbulent times in 2009, higher in the first quarter, also higher together with annual reports (lower for Pillar 3 solo information). The paper's results suggest that further changes in commercial banks' information disclosure are inevitable in order to achieve an effective market discipline mechanism and meaningful disclosures according to the regulator's expectations.

Keywords: risk management, market discipline, financial regulation, Pillar 3, data pre-processing, web usage mining.

JEL Classification: C8, G01, G28, G32.

Introduction

The globalization, conglomeration, innovation and development of capital markets have significantly accelerated. However, the ability of supervisors to adequately monitor and regulate financial institutions has been limited and remove the market discipline has acquired a significantly greater role in remove the financial markets' regulatory matters. Remove the Market discipline in its broader terms can be understood as a mechanism

via which market participants monitor, assesses and discipline risk taking by financial institutions. Its significance has become very important during and just after the last financial crises that, among others, spotted a decrease of collective respect towards the financial system's supervision and regulation. Reactions to that are focusing on Basel regulatory documents and are related to the EU legal capital requirements directives. Basel III documents have been significantly changed and extended in all aspects, including the Pillar 3 – Disclosure and Market Discipline.

During recent years all these regulatory documents have been the subject of extensive review and scrutiny by all stakeholders that have been impacted remove by them. The revised version of the Pillar 3 framework has been launched by the BIS Committee in December 2015 (Basel 2015) which has completed the first phase of Pillar 3 review, and it is in process of implementation by national jurisdictions. The second phase of Pillar 3 review has started with the launch of the Pillar 3-disclosure requirements Consultative Document in March 2016 (Basel 2016), which was in the consultative phase, opened for comments until June 2016. This phase serves as a feedback mechanism to design remove of updated disclosure requirements and it also includes their consolidation, in order to achieve a single coherent Pillar 3 framework. According to the Consultative document (Basel 2016), the final version to revised Pillar 3 framework will introduce nine new disclosure requirements and its implementation dates will be also published. Nevertheless, all these approved changes and improvements have not reflected all the significant specifics and requirements of the affected market participants. Among them are the banking sectors which are dominated by foreign-owned entities, and uninsured depositors' discipline is a key source of market discipline. The importance of this group of stakeholders is shown by the fact that more than 40% of the amount deposits are uninsured deposits which are kept on the banks accounts in Slovakia. In our previous studies (Drlik *et al.* 2013; Munk *et al.* 2013; Pilkova *et al.* 2015) we have found out very low interests of stakeholders of the bank operating in this environment on mandatory required and presented information by commercial banks. However, we have also found out that in this weak interest time there has been the highest interest in Pillar 3 information in the particular time period (the first quarter). In this paper we present the results of our study focusing on the frequency and type of information in which stakeholders are interested in these specific conditions in the first quarter. Our main goal is twofold: a/ based on analysis of websites dedicated to Pillar 3 of commercial banks that operate in CEE countries to identify key types of information which are in the prevailing interests of the stakeholders; b/ to study the behaviour of stakeholders in relation to the timing of serious market turbulences. Our findings contribute to the coverage gap in CEE countries research on depositors market discipline from a theoretical point of view, for regulators and commercial banks management in CEE countries particularly now when a revised version of Pillar 3 allows the use and flexible presentation of information.

The structure of the paper is as follows. Current status of the research is contained in the second section. The third section includes applied research methodology and the fourth section describes the research results based on annual and quarter time frameworks. The last section is a discussion.

1. Related work

Market discipline and its importance is tightly related to remove the corporate governance theories when modern corporations separate ownership from control of the governing of the allocation of available resources. However, there is evidence on serious conflicts between shareholder value maximization and the other stakeholder interests including how governance mechanisms can solve these agency and information problems (see more in Bliss 2000). Because of increasing complexity of organizations within the banking systems and their significant role in economies the government oversights and regulations are not sufficient to monitor and control them efficiently. Even sometimes some of their traditional instruments like deposit insurances can create adverse effects on the bank management behaviours as far as their risk taking activities. It is due to that the idea that private investors (depositors) can help regulators to identify and control excessive risk appetite of the banks through market discipline has been developed (Berger 1991; Flannery 2001). This idea has also been materialised in the Basel committee on banking supervision on capital adequacy (Basel (1999), codified as regulatory requirement in 2004) in which market discipline has been designated as one of the Three Pillars of the future financial regulation as “market discipline imposes strong incentives on banks to conduct their business in a safe, sound and efficient manner” (Basel 1999: 17). In literature there are different definitions and explanations of market discipline terms. Bliss and Flannery (2002) strength two distinct components of market discipline as: a/ market monitoring which refers to the hypothesis that investors accurately evaluate changes in a firm’s conditions and incorporate the firm security prices. Monitoring generates market signals that may convey useful information to supervisors. b/ market influence that is the process by which outside claimants influence firm’s actions. Flannery (2001) states that the optimal method for analysis and forecasting bank risk should be found because of the distinction between “market monitoring” and “market influence”, which clarifies the potential uses of “market discipline” in bank supervision and both system’s mistakes. On the other side, according to Stephanou (2010), market discipline can be viewed from the perspective of four interrelated building blocks: 1. Information and disclosure – the public availability of adequate, timely, consistent and reliable information about the financial institution’s financial performance and risk exposure; 2. Market participants – the existence of independent market participants with the incentive to monitor the financial institution and the ability to accurately process the information that it discloses; 3. Discipline mechanism – the various instruments, whether financial, legal or regulatory that market participants can use to exercise discipline; 4. Internal governance – the organizational and compensation structures that determine whether insiders (senior management and Board of Directors) understand and control the risks that the financial institution is taking, and are incentivized to change their behaviour in response to market signals.

One of the aims of market discipline is to be efficient. According to literature reviews, efficiency of market discipline is studied either from the perspective of pricing of the banks securities, mainly subordinated debt or discipline effect of depositors.

There are many more empirical studies related to the pricing of bank securities than those that are related to depositor market discipline. Beyer *et al.* (2010) find that the main causes of quarterly stock price variations are financial announcements (28.4%) and financial forecasts (15.7%), what proves that investors do adjust their behaviour in response to disclosed information and confirms the existence of Stephanou's second block. According to Jordan *et al.* (2000), market participants react substantially to public announcements of formal supervisory action with 5% decline in stock prices on average, especially in the case of disclosure of new significant information. However, according to many authors, subordinated debt plays an important position in market discipline. The main reason is that if banks want to issue subordinated debt they have to reveal additional information about their financial conditions and the market expresses its readiness to buy this instrument through accepted prices (spreads) (Jagtiani *et al.* 1999; Evanoff, Wall 2000; Sironi 2003). Distinguin (2008) suggests that requiring banks to hold subordinated debt should reduce bank risk via direct market discipline, but two criteria must be fulfilled: subordinated debt holders should have access to sufficient information about bank riskiness, but they should not benefit from any kind of insurance.

In theory it has been argued that depositor discipline in banking is insufficient. According to Birchler and Maechler (2001), deposit insurance may further weaken the monitoring incentives of small depositors, but large and uninsured depositors still find monitoring worthwhile. In their research Berger and Turk (2015) discovered stronger depositor discipline in the US than in Europe due to the considered bailout of larger organizations in Europe. Berger and Turk (2010) have discovered that significant depositors' discipline did exist in the 11-year period prior to recent financial crisis and depositors' reactions are more consistent to equity-asset ratios than to measures of loan portfolio performance. Depositors' discipline is stronger at unlisted large institutions than at small unlisted than vice versa. In this respect Hadad *et al.* (2011) research analysis presence of market discipline of 104 commercial banks shows that higher deposit rates are associated with higher deposit and liquidity risk and highlights that integration of market discipline and regulatory discipline is crucial. Furthermore, Nier (2005) in his research finds that transparency improves bank stability and reduces its probability of falling into crisis. On the other hand, Moreno and Takalo (2016) conclude that only an intermediate level of transparency is socially optimal in order to balance its opposing effects: more transparency decreases efficient liquidity and increases rollover risk, given the level of asset risk, which banks may compensate by taking more risk. However, Freixas and Laux (2011) in their research are questioning the transparency of Pillar 3 reports, due to events which occurred during the financial crisis.

The market discipline framework can represent a functional system that might provide a meaningful complement to regulatory oversight of financial institutions and play a central role in modern banking regulation (Bartlett 2012) only in case, when all four of Stephanou's blocks are in perfect coherence. Cubillas *et al.* (2012) find that market discipline is weakened by banking crises and its reduction is larger in environments where it was enhanced before the crises. Moreover, based on their research, policy implica-

tions, regulations and interventions strengthen market discipline. Negative effects on market discipline have recapitalization and forbearance. On the other hand, less supervisory power and more private ownership and supervision of banks have opposite effects. Nier and Baumann (2006) also conclude that in times when countries undergo crises risk-taking incentives are stronger and market discipline can restrict them. Results are supportive to the improvement of market discipline by policy initiatives, such as Pillar 3. However, effective market discipline, as Jagtiani and Lemieux (2001) suggest, asks for the enhancement of accurate and timely financial disclosures which is in conjunction with Berger and Davies (1998) who conclude that effective market discipline depends on market disclosure of private valuable information that reaches the market. On the other hand, Calomiris (2009) focuses on negative aspects of financial regulation and points out desirable changes in regulation highlighted by crises, which, among others, contains disclosure standards and market-based risk measures in order to achieve an accurate reaction to turbulent times. Although Distinguin *et al.* (2006) indicate that the use of market-related indicators can predict banks' financial problems, but market discipline is also lower for banks that benefit from implicit government guarantees such as insured deposits and is weakened by stronger regulatory discipline (Distinguin *et al.* 2012).

As our research is focused on the depository market discipline in CEE countries we specifically reviewed studies on market discipline and Pillar 3 related to this region. We have to just agree with Berger and Bouwman (2013) that research particularly on depository discipline in Europe is scant. And above all the situation in CEE research in this field is even worse. According to the interesting study of Distinguin *et al.* (2012), explicit deposit insurance (implemented in 1990's in CEE countries) contributed to effective market discipline in CEE. They also discovered that interbank deposits play a disciplining role in these markets and the banks with higher proportion of these deposits have lower levels of risk in this region. In Russia, Karas *et al.* (2013) found out after the introduction of deposit insurance for households that deposits inflows and outflows are less sensitive for insured deposits than for uninsured ones which is in line with the other reviewed studies. Therefore, they conclude that the uninsured depositors impose stronger market discipline than insured ones. Also Hasan *et al.* (2013) studied new aspects of market discipline by exercising non-financial depositors on banks operating in CEE countries. But they questioned indirect support Pillar 3 transparency and its efficiency. In the research it is proved that the depositors are reacting in positive correlation much more significantly to rumours concerning the banks' parent companies (especially to negative ones) than to banks own fundamentals (financial reports). Moreover, the research results suggest that CEE depositors had the ability to differentiate between founded and unfounded rumours.

Literature review confirmed that to achieve market discipline efficiency is a complex issue which is influenced by many factors. Among them three very often appear in research studies: a/ government support (safety net) which means explicit or implicit guarantee; b/ level of financing banks by insured and uninsured funds; c/ sufficient information disclosure to relevant market participants, their incentives and ability to assess bank risk.

Our study should contribute to cover the gap in the area of sufficient information disclosure that would also increase interests of relevant stakeholders to contribute to depository market discipline and be relevant to their interests within Pillar 3 framework. To study stakeholders behaviour we used web usage mining methods. For this purpose we proposed a methodology to evaluate frequent itemsets of web parts in time (Munk *et al.* 2015).

The majority of the time spent on a data mining project is usually oriented on data pre-processing. The importance of data pre-processing is indisputable and many authors attempt to come up with novel approaches to minimize time and resource the cost of this phase. The paper written by Gullo (2015) provides a technical overview of methods and tasks of data mining and also describes the importance of data pre-processing. Losarwar and Joshi (2012) discuss the importance of data pre-processing in Web Usage Mining and introduce a complete pre-processing technique. The results showed that the process is time consuming and often requires usage of special algorithms. Studies such as Munk *et al.* (2015), Munk, Benko (2016), focusing on log file processing, deeply described each of the pre-processing phases. Authors focused on methods of session identification and their impact on the extracted sequence rules. Abdullah *et al.* (2014) propose a sequential pre-processing model and sequential pre-processing tool in effort of sequential dataset generation. They worked with a log file and MySQL database to extract a sequential dataset which can be used by other data mining tools. A Partition Enhanced Mining Algorithm was introduced by Ogunde *et al.* (2015) to enhance the mining of distributed databases using partitioning in the field of Distributed Association Rule Mining.

2. Research methodology

In our paper, data related to Pillar 3 were gathered from the bank webserver log files (Munk *et al.* 2012). The webserver log files keep information about visitors, which can be used for the analysis of visitor's behaviour. Data pre-processing of their usage consists of data cleaning, integration, transformation, session identification, path completion and data reduction (Kapusta *et al.* 2013, 2014).

Data preparation was done based on Kapusta *et al.* (2013, 2014) where it was needed to pre-process log files from multiple servers that are used as load balancers. Research methodology was inspired by Munk *et al.* (2010a), Munk *et al.* (2010b), Munk *et al.* (2015) and applied to the evaluation of the frequent itemsets in terms of quantity. In this experiment the itemsets were evaluated based on time- quarters during the years 2009–2015. The source of data for our experiment is web server log file of domestic significant commercial banks operating in Slovakia. The experiment was conducted on a sample of 10 378 751 log accesses which were obtained after the data pre-processing included data cleaning, session identification and path completion. The applied methodology is as follows:

1. Obtaining log files from multiple servers.
2. Data preparation consisting of multiple tasks:
 - a. Data cleaning – the most important step is to clean data from the unnecessary

- data (requests on styles, pictures or scripts). This step leads to obtain the raw data containing only the accesses to the web portal. Data cleaning involves also the removal the accesses of robots of search engines.
- b. User/session identification – there are multiple techniques used to identify users/sessions which were described in Munk *et al.* (2015). For this research the visitors were identified based on the user agent and sessions were identified using the Reference Length method.
 - c. Reconstruction of activities of web visitors – focused on a retrograde completion of records on the path the user went through by means of a Back button of the web browser (Munk *et al.* 2015).
3. Data analysis consisting of searching of behaviour patterns of web users during quarters in the examined period. The results were processed by association rule analysis using STATISTICA Sequence, Association, & Link Analysis, which is an implementation of algorithm using a-priori algorithm together with a tree structured procedure that requires only one pass through data (Statsoft Inc. 2013). The support for an itemset is given by a proportion of records in the transactions data set that have the itemset. That means that for an itemset (A) the support can be calculated

$$Support(A) = \frac{frequency\ of\ (A)}{number\ of\ transactions\ in\ the\ dataset} * 100. \quad (1)$$

Lift of rules can be similarly calculated. Based on support and confidence a lift for a rule can be defined and computed

$$Lift(if\ Athen\ C) = \frac{confidence(if\ Athen\ C)}{support(C)}, \quad (2)$$

where

$$Confidence(if\ Athen\ C) = \frac{support(if\ Athen\ C)}{support(A)} * 100. \quad (3)$$

We focused on frequent itemsets extracted with the minimum support of 1% (Pilkova *et al.* 2015).

4. Understanding the output data from output of analysis and defining assumptions.
5. Comparison of results of data analysis based on quarters in the examined years.

3. Results

The graphs (Figs 1–7) depict the found frequent itemsets where the size of each node represents the *support* of the web part- 1-itemset (set of only one item). Thickness of the line between two web parts represents the level of *support* of the 2-itemset or the combination of two web parts. Brightness of the line represents the *lift* of pair of the web parts.

In the first quarter of 2009 (Fig. 1), the web part */Group/* belonged to the most visited part with almost 60% of the *support*. The web parts */Pillar3 Q-terly Info/* and */Rating/*

were occurred in the identified sessions with probability more than 30%, similarly /*Annual Reports*/ and /*Information for Banks*/ with the probability more than 20%. The web parts /*Pillar3 Semiannual Info*/ and /*Emitent Prospects*/, with the probability about 15% belonged to the less popular. The web parts /*General Shareholder Meeting*/ and /*Financial Reports*/ did not meet the minimum *support*, i.e. the likelihood of occurrence in the identified sessions (transactions) is less than 1%.

In the first quarter of 2009 (Fig. 1), the pairs (/Group/, /Pillar3 Q-terly Info/) and (/Annual Reports/, /Pillar3 Q-terly Info/) with almost 19% of the *support* belonged among the most visited pairs of the web parts. The pairs (/Rating/, /Group/), (/Pillar3 Q-terly Info/, /Pillar3 Semiannual Info/), (/Rating/, /Information for Banks/), (/Rating/, /Annual Reports/), (/Group/, /Information for Banks/) and (/Rating/, /Pillar3 Q-terly Info/) were occurred in the identified sessions with the probability about 16%. Remaining pairs achieved the probabilities in the range of 13–15%.

The web parts (Fig. 1) are independent (*lift* = 1) in the case of pairs (/Group/, /Pillar 3 Q-Tel Info/), (/Rating/, /Group/), (/Annual Reports/, /Group/) and (/Group/, /Information for Banks/). Unlike remaining pairs, positive correlation (*lift*> 1) was identified and the web parts are seen more often together than separately in the identified sessions. The high degree of positive correlation (*lift* = 5.02) was obtained for the pair (/Emitent Prospects/, /Pillar3 Semiannual Info/), i.e. if the web part /Emitent Prospects/ is occurred in the session, it is 5.02 times more likely that there also exists the web part /Pillar3 Semiannual Info/, as in the sessions selected randomly. The same also applies vice versa, regardless of the orientation of the pair-rule. Similarly, the high degree of positive correlations (*lift*: 2.5 to 3.5) were reached for the following pairs (/Information for Banks/, /Emitent Prospects/), (/Annual Reports/, /Emitent Prospects/), (/Information for Banks/, /Pillar3 Semiannual Info/), (/Annual Reports/, /Pillar3 Semiannual Info/), (/Rating/, /Emitent Prospects/), (/Pillar3 Q-terly Info/, /Emitent Prospects/), (/Rating/, /Pillar3 Semiannual Info/), (/Pillar3 Q-terly Info/, /Pillar3 Semiannual Info/), (/Annual Reports/, /Information for Banks/) and (/Rating/, /Information for Banks/). The remaining pairs achieved the *lift* degree in the range of 1.5 to 2.

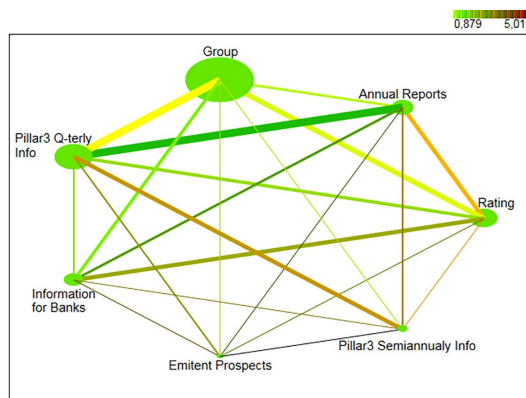


Fig. 1. Visualization of the first quarter of the year 2009

In the first quarter of 2010 (Fig. 2), the web parts */Group/*, */Pillar3 Q-terly Info/* belonged to the most visited parts with almost 40% of the *support*. The web parts */Annual Reports/* and */Rating/* were occurred with the probability more than 20%, and similarly the web part */Information for Banks/* was occurred with the probability around 10%. The less popular web parts */Pillar3 Semiannually Info/*, */General Shareholder Meeting/*, */Emitent Prospects/* and */Financial Reports/* had the likelihood of occurrence around or less than 1%.

In the first quarter of 2010 (Fig. 2), the most visited pair of the web parts was (*/Pillar3 Q-terly Info/*, */Annual Reports/*) with the *support* more than 20%. The pairs (*/Group/*, */Rating/*) and (*/Pillar3 Q-terly Info/*, */Rating/*) were occurred in the identified transaction with the *support* of around 6%. The remaining pairs achieved probability less than 3%.

The high degree of positive correlation ($lift = 2.7$) was found for the pairs (*/General Shareholder Meeting/*, */Pillar3 Q-terly Info/*) and (*/Pillar3 Semiannually Info/*, */Pillar3 Q-terly Info/*) (Fig. 2). For the pairs (*/Annual Reports/*, */Pillar3 Q-terly Info/*) and (*/Pillar3 Semiannually Info/*, */Annual Reports/*) were also found positive correlations ($lift: 1.5$ to 2). In the case of pair (*/Rating/*, */Group/*) the web parts are considered independent. The remaining web parts achieved the degree of negative correlations ($lift: 0.2$ to 0.5) which means that they were more separately found in the identified sessions.

In the first quarter of the year 2011 (Fig. 3), the web part */Group/* with probability of 50% was the most interesting. Web parts */Pillar3 Q-terly Info/*, */Annual Report/* and */Ratings/* belonged to less interesting, compared to web part */Group/*, with *support* around 20%. Web part */Information for Banks/* had less *support* than 10% and web parts */Pillar3 Semiannually Info/*, */Emitent Prospects/*, */General Shareholder Meeting/* and */Financial Reports/* had the probabilities of visit less than 1%.

The pair (*/Pillar3 Q-terly Info/*, */Annual Reports/*) was the most visited during the first quarter of 2011 with 20% of the *support* (Fig. 3). The probability of occurrence of identified pairs (*/Group/*, */Rating/*) and (*/Information for Bank/*, */Group/*) was achieved only around 5%. The remaining pairs have been accessed with the probability of less than 3%.

Independence was found (Fig. 3) for the web parts pair (*/Group/*, */Information for Banks/*) ($lift = 1$). The highest degree of interestingness was found for the pair (*/Pillar3 Q-terly Info/*, */Annual Reports/*) with $lift = 2.9$. On the other hand, pair (*/Group/*, */Rating/*) has a negative correlation ($lift = 0.4$).

The first quarter of 2012 (Fig. 4) showed the same behaviour as previous years, where the web part */Group/* had the highest *support* of 45%. Web parts */Pillar3 Q-terly Info/*, */Rating/* and */Annual Reports/* were interested for the visitors with the probability of almost 20%. *Support* of around 10% was showed for the web parts */General Shareholder Meeting/* and */Pillar3 Semiannually Info/*. Minimum *support* of 1% was not achieved for web parts */Information for Banks/*, */Emitent Prospects/* and */Financial Reports/*.

The probability of access to the pairs of web parts was lower during the first quarter of 2012 (Fig. 4), where the pairs (*/Group/*, */Pillar3 Q-terly Info/*) and (*/Pillar3 Q-terly Info/*, */Annual Reports/*) were achieved the highest probability of nearly 10%. Other pairs were visited with the *support* of less than 5%.

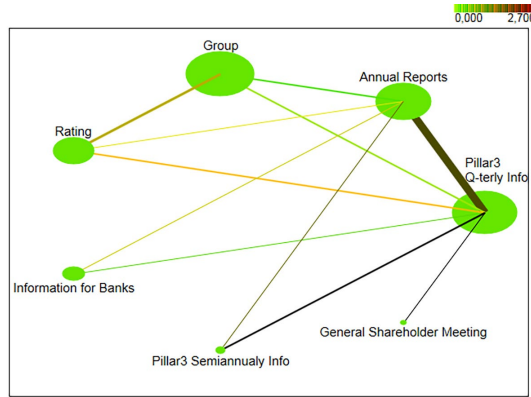


Fig. 2. Visualization of the first quarter of the year 2010

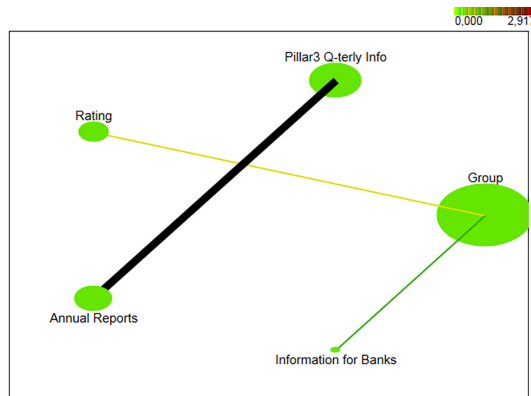


Fig. 3. Visualization of the first quarter of the year 2011

The highest positive correlation ($lift = 3$) was found (Fig. 4) for the rule (*/Annual Reports/, /Pillar3 Semiannually Info/*). Similarly, the higher degree ($lift = 2.4$) was found for pairs (*/Pillar3 Q-terly Info/, /Annual Reports/*) and (*/Pillar3 Semiannually Info/, /Pillar3 Q-terly Info/*). Web part pairs (*/Pillar3 Semiannually Info/, /Group/*) and (*/Pillar3 Q-terly Info/, /Group/*) showed signs of independence ($lift = 1$). Negative correlation ($lift = 0.5$) was found for the pair (*/Group/, /Annual Reports/*).

In the first quarter of 2013 (Fig. 5), the web part */Group/* belonged to the most visited web parts with the *support* of 50%. Other popular web parts were */Pillar3 Q-terly Info/*, */Annual Reports/* and */Rating/* with the *support* of around 20%. The web parts */General Shareholder Meeting/*, */Information for Banks/*, */Pillar3 Semiannually Info/* with the *support* of less than 5% were recorded as less popular. Probability of visits of web parts */Emittent Prospects/* and */Financial Reports/* did not meet the required *support* of 1%.

Only two pairs of web parts were occurred in the identified sessions during the first quarter of 2013 (Fig. 5) – (*/Pillar3 Q-terly Info/, /Annual Reports/*) with the *support* of almost 15% and (*/Group/, /Pillar3 Q-terly Info/*) with the *support* less than 5%.

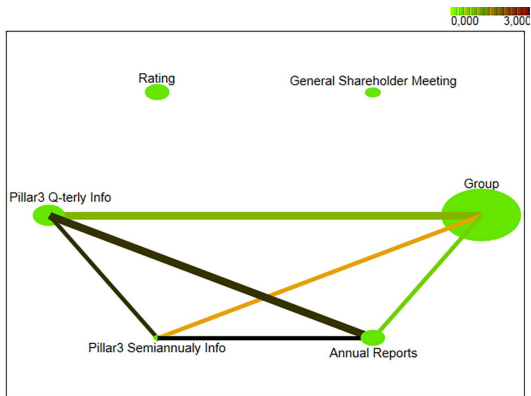


Fig. 4. Visualization of the first quarter of the year 2012

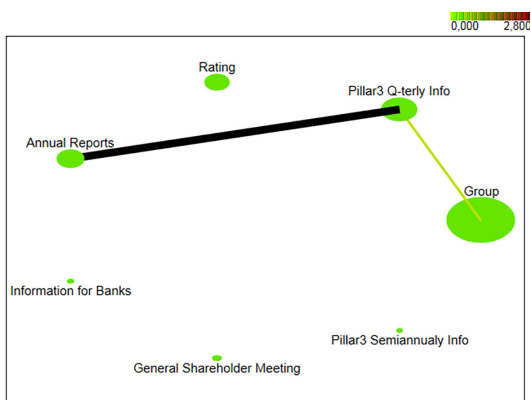


Fig. 5. Visualization of the first quarter of the year 2013

The highest degree of interestingness ($lift = 2.8$) was found (Fig. 5) for the rule (*/Annual Reports/, /Pillar3 Q-terly Info/*). On the other hand, the web parts (*/Group/, /Pillar3 Q-terly Info/*) were more separately found in the identified sessions ($lift = 0.3$).

For the first quarter of years 2014 (Fig. 6) and 2015 (Fig. 7), the web visitors behaved almost likewise. In this first quarter, web part */Group/* was the most visited web part with the *support* of 50%. Web parts */Pillar3 Q-terly Info/*, */Annual Reports/* and */Rating/* were also frequently visited with the probability of around 20%. The only difference was in the web part */General Shareholder Meeting/* visited with the *support* of 5% in the first quarter of 2014, but in the first quarter of 2015 it did not meet the minimum *support* of 1%. The rest web parts */Information for Banks/*, */Pillar3 Semiannually Info/*, */Emitent Prospects/* and */Financial Reports/* did not meet the limit of 1% during the first quarter of 2014 and also during the first quarter of 2015.

During the first quarter of years 2014 (Fig. 6) and 2015 (Fig. 7), only one web pair (*/Pillar3 Q-terly Info/, /Annual Reports/*) was occurred in the identified sessions with

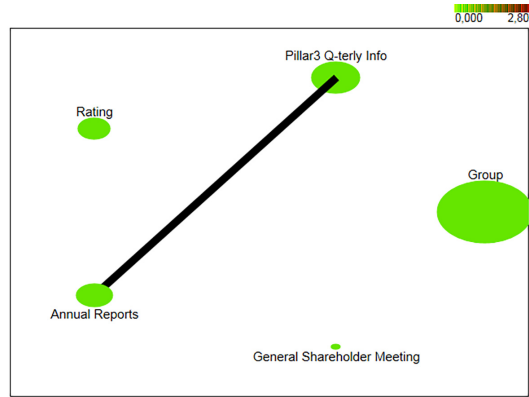


Fig. 6. Visualization of the first quarter of the year 2014

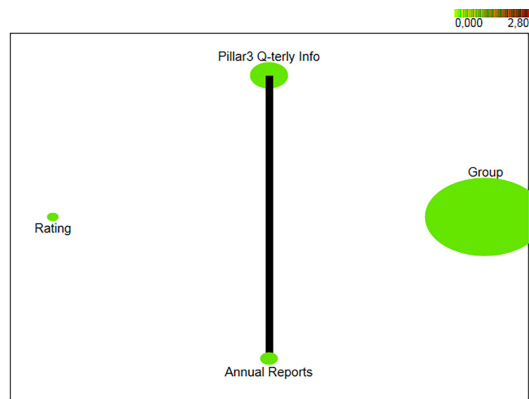


Fig. 7. Visualization of the first quarter of the year 2015

the probability of almost 15%. Moreover, this web pair showed the highest positive correlation ($lift = 2.8$).

Based on the Cochran Q, test results for the first quarter ($Q = 65.8594$, $df = 6$, $p < 0.0000$) the zero hypothesis reasoning that the incidence of frequent itemsets of the web parts does not depend on time, is rejected at the 0.1% significance level. The most frequent itemsets in the first quarter (Table 1) were identified in 2009 (almost 64%), the lowest in 2014 and 2015 (approximately 11% to 14%).

From the multiple comparisons (Table 1) three homogenous groups (15Q1, 14Q1, 11Q1, 13Q1, 12Q1), (13Q1, 12Q1, 10Q1) and (09Q1) were identified in terms of the average incidence of found frequent itemsets of the web parts. Statistically significant differences were proved at the 5% significance level, in the average incidence of found frequent itemsets between quarter 09Q1 and others as well as between quarter 10Q1/12Q1/13Q1 and quarters (11Q1, 14Q1, 15Q1).

Table 1. Homogeneous groups for incidence of frequent itemsets of the web parts in examined years for the first quarter

Year	Per.	1	2	3
15Q1	11.36%	****		
14Q1	13.64%	****		
11Q1	18.18%	****		
13Q1	20.45%	****	****	
12Q1	27.27%	****	****	
10Q1	40.91%		****	
09Q1	63.64%			****

In the case of the second quarter ($Q = 27.51515$, $df = 6$, $p < 0.000116$) the zero hypothesis is rejected at the 0.1% significance level and the most frequent itemsets (Table 2) were identified in year 2009 (more than 45%), the lowest in 2014 and 2015 (approximately 18–20%).

Table 2. Homogeneous groups for incidence of frequent itemsets of the web parts in examined years for the second quarter

Year	Per.	1	2	3
15Q2	18.18%		****	
14Q2	20.45%	****	****	
12Q2	22.73%	****	****	
13Q2	29.55%	****	****	****
11Q2	38.64%	****		****
10Q2	38.64%	****		****
09Q2	45.45%			****

From the multiple comparisons (Table 2) three homogenous groups (15Q2, 14Q2, 12Q2, 13Q2), (14Q2, 12Q2, 13Q2, 11Q2, 10Q2) and (13Q2, 11Q2, 10Q2, 09Q2) were identified based on the average incidence of found frequent itemsets of the web parts. Statistically significant differences were proved at the 5% significance level, in the average incidence of found frequent itemsets between quarter 09Q2 and (12Q2, 14Q2, 15Q2) as well as between quarter 10Q2/11Q2 and quarter 15Q2.

For the third ($Q = 18.54545$, $df = 6$, $p < 0.005005$) and fourth ($Q = 32.04706$, $df = 6$, $p < 0.000016$) quarter in the examined time period, the zero hypothesis is rejected at the 1% significance level. The most frequent itemsets were identified in year 2009 (more than 38% for the third quarter (Table 3) and more than 45% for the fourth quarter (Table 4)). On the other hand, the lowest identified frequent itemsets were found in year 2012 and 2015 (approximately 16% for both quarters).

Table 3. Homogeneous groups for incidence of frequent itemsets of the web parts in examined years for third quarter

Year	Per.	1	2
12Q3	15.91%	****	
15Q3	15.91%	****	
11Q3	20.45%	****	
13Q3	22.73%	****	****
14Q3	22.73%	****	****
10Q3	22.73%	****	****
09Q3	38.64%		****

Based on the multiple comparisons (Table 3), statistically significant differences were identified at the 5% significance level, in the average incidence of found frequent itemsets between quarter 09Q3 and quarters (11Q3, 12Q3, 15Q3).

Table 4. Homogeneous groups for incidence of frequent itemsets of the web parts in examined years for fourth quarter

Year	Per.	1	2
12Q4	15.91%	****	
15Q4	15.91%	****	
14Q4	18.18%	****	
10Q4	20.45%	****	
11Q4	22.73%	****	
13Q4	29.55%	****	****
09Q4	45.45%		****

Statistically significant differences were proved at the 5% significance level, in the average incidence of found frequent itemsets (Table 4) between quarter 09Q4 and others apart from quarter 13Q4.

The event- global downturn (2009) has a significant impact on the quantity of extracted frequent itemsets of the web parts.

In the case of quarters during the year 2009 ($Q = 8.257732$, $df = 3$, $p < 0.040977$) the zero hypothesis is rejected at the 5% significance level. Most frequent itemsets in the year 2009 (Table 5) were identified in the first quarter (more than 63%), the lowest in the third quarter (approximately 39%).

In year 2009 two homogenous groups (09Q3, 09Q4, 09Q2) and (09Q4, 09Q2, 09Q1) were identified (Table 5) based on the average incidence of found frequent itemsets of the web parts.

For the examined years (2010: $Q = 12.58065$, $df = 3$, $p < 0.005638$; 2011: $Q = 11.53846$, $df = 3$, $p < 0.009144$) the zero hypothesis is rejected at the 1% significance level. In the year 2010 (Table 6) the most frequent itemsets were identified in the first quarter (around 41%), the lowest in the fourth and third quarter (approximately 20%–21%). On the other hand, in the year 2011 (Table 7) the most frequent itemsets were identified in the second quarter (around 39%), the lowest in the first and third quarter (approximately 18–21%).

Three homogenous groups (10Q4, 10Q3), (10Q3, 10Q2) and (10Q2, 10Q1) were found for the year 2010 (Table 6) based on the average incidence of found frequent itemsets of the web parts. On the other hand, two homogenous groups (11Q1, 11Q3, 11Q4) and (11Q4, 11Q2) were identified for the quarters in the year 2011 (Table 7).

For the remaining years (2012: $Q = 4.153846$, $df = 3$, $p < 0.245326$; 2013: $Q = 3.255319$, $df = 3$, $p < 0.353912$; 2014: $Q = 4.565217$, $df = 3$, $p < 0.206549$; 2015: $Q = 3.000000$, $df = 3$, $p < 0.391627$) statistically significant differences were not found.

Table 5. Homogeneous groups for incidence of frequent itemsets of the web parts for year 2009

Quarter	Per.	1	2
09Q3	38.64%	****	
09Q4	45.45%	****	****
09Q2	45.45%	****	****
09Q1	63.64%		****

Table 6. Homogeneous groups for incidence of frequent itemsets of the web parts for year 2010

Quarter	Per.	1	2	3
10Q4	20.45%	****		
10Q3	22.73%	****	****	
10Q2	38.64%		****	****
10Q1	40.91%			****

Table 7. Homogeneous groups for incidence of frequent itemsets of the web parts for year 2011

Quarter	Per.	1	2
11Q1	18.18%	****	
11Q3	20.45%	****	
11Q4	22.73%	****	****
11Q2	38.64%		****

The first quarters in years 2009–2010 in the event- global downturn have a significant impact on the quantity of extracted frequent itemsets of the web parts. Results also suggest that stakeholders of the bank are mainly interested in group status, which is in conjunction with Hasan *et al.* (2013).

Conclusions

Market discipline has been recognized as a key objective of the Basel II and III regulations. This mechanism is operationalized through Pillar 3 information disclosure. The Guidelines for this disclosure have been revised a few times with the aim of reacting to comments from stakeholders. The last revision to the Pillar 3 standard has been made in 2015. This process continued with the second phase of the Pillar 3 review through the Consultative document issued in March 2016, which was opened for comments until June 2016. The document includes a new dashboard of key metrics to enable comparisons in measures across banks and over time in order to achieve more meaningful and relevant disclosures. Moreover, the second phase aims also to consolidate all existing and prospective disclosure requirements to the revised Pillar 3. The newly published revised version of Pillar 3 introduced a “hierarchy” of disclosure through prescribed fixed forms for disclosure of quantitative information and forms with more flexible structure intended for meaningful information. In connection with that the flexibility of disclosure creates a space for the design of such content and structure of Pillar 3 information which would contribute to effective deposit market discipline. This effective deposit market discipline can be introduced in the environment of commercial banks owned by foreign financial holdings and operate as closely held companies with a significant portion of uninsured deposits. However, taking into consideration also factors of sufficient information disclosure to relevant market participants, their incentives and ability to assess bank risk should be based on the practical usage of information by users. In our research we identified a few key findings: a/ stakeholders of commercial banks operating under foreign banking groups ownership in CEE countries are interested in regulatory and accounting disclosures mainly in the first quarter. Moreover, in this quarter annual results of the banking groups and annual reports are published altogether with the Pillar 3 risk disclosure; b/ it looks like the Pillar 3 solo information is not of particular interest to those stakeholders, only together with annual reports and information on group. They may assume that group stability is sufficient enough for their confidence in local banks; c/ interest in disclosed information decreased with longer time period after the turbulent 2009 year. This finding suggests that market discipline mechanisms should start to be ready and to operate efficiently particularly during turbulent times. If the banking institution is not ready to disclose information satisfactorily and in a timely manner then losses related to reputational risk can occur.

Our results suggest that further changes in commercial banks information disclosure are inevitable if market discipline mechanisms are to be effective and used according to regulator’s expectations and requirements. According to BIS Committee, in December 2015 disclosures that do not add value to users’ understanding or do not communicate useful information should be avoided. Furthermore, information which is no longer

meaningful or relevant to users should be removed. But still open issues and challenges are what should be relevant disclosure for the numerous groups of key stakeholders—depositors if their interest in officially required information is so low. Our finding and conclusions contributed to it. However, due to some limitations in our research, further in depth study of this topic is inevitable.

Acknowledgements

This work was supported by the project VEGA 1/0776/18 Optimizing the content and structure of the disclosures under Pillar 3 by modelling their use by stakeholders of commercial bank.

Disclosure statement

The authors declare that they have no conflict of interest.

References

- Abdullah, Z.; Herawan, T.; Chiroma, H.; Deris, M. M. 2014. A sequential data preprocessing tool for data mining, in *ICCSA 2014: Computational Science and Its Applications – ICCSA 2014*, 30 June – 3 July 2014, Guimarães, Portugal, 734–746.
- Bartlett, R. 2012. Making banks transparent, *Vanderbilt Law Review* 65(2): 293–386.
- Basel Committee on Banking Supervision. 1999. *A new capital adequacy framework* [online], [cited 20 November 2016]. Consultative paper issued by the Basel Committee on Banking Supervision. Available from Internet: <http://www.bis.org/publ/bcbs50.pdf>
- Basel Committee on Banking Supervision. 2015. *Standards for Revised Pillar 3. Disclosure Requirements* [online], [cited 1 April 2016]. Available from Internet: <http://www.bis.org/bcbs/publ/d309.pdf>
- Basel Committee on Banking Supervision. 2016. *Consultative Document Pillar 3. Disclosure requirements – consolidated and enhanced framework* [online], [cited 20 November 2016]. Available from Internet: <http://www.bis.org/bcbs/publ/d356.pdf>
- Berger, A. N. 1991. Market discipline in banking, in *27th Conference on Bank Structure and Competition*, May 1991, Federal Reserve Bank of Chicago, 419–437.
- Berger, A. N.; Bouwman, C. H. S. 2013. How does capital affect bank performance during financial crises?, *Journal of Financial Economics* 109(1): 146–176. <https://doi.org/10.1016/j.jfineco.2013.02.008>
- Berger, A. N.; Davies, S. M. 1998. The information content of bank examinations, *Journal of Financial Services Research* 14(2): 117–144. <https://doi.org/10.1023/A:1008011312729>
- Berger, A. N.; Turk, R. 2010. *Do depositors discipline banks? An international perspective*. Wharton Financial Institutions Working Papers No 11–25. Wharton Financial Institutions Center.
- Berger, A. N.; Turk, R. 2015. Do depositors discipline banks and did government actions during the recent crisis reduce this discipline? An international perspective, *Journal of Financial Services Research* 48(2): 103–126. <https://doi.org/10.1007/s10693-014-0205-7>
- Beyer, A.; Cohen, D.; Lys, T.; Walther, B. 2010. The financial reporting environment: review of the recent literature, *Journal of Accounting and Economics* 50(2–3): 296–343. <https://doi.org/10.1016/j.jacceco.2010.10.003>
- Birchler, U.; Maechler, A. M. 2001. *Do depositors discipline Swiss Banks?* Working Paper No. 01.06. Study Center Gerzensee, Swiss National Bank.

- Bliss, R. R. 2000. *The pitfalls in inferring risk from financial market data*. Working Paper No. 2000-24. Federal Reserve Bank of Chicago.
- Bliss, R. R.; Flannery, M. J. 2002. Market discipline in the governance of U.S. Bank holding companies: monitoring vs. influencing, *Review of Finance* 6(3): 361–396. <https://doi.org/10.1023/A:1022021430852>
- Calomiris, C. W. 2009. *Bank regulatory reform in the wake of the financial crisis* [online], [cited 25 May 2017]. Available from Internet: https://www.researchgate.net/publication/251309478_Bank_Regulatory_Reform_in_the_Wake_of_the_Financial_Crisis
- Cubillas, E.; Fonseca, R. A.; González, F. 2012. Banking crises and market discipline: international evidence, *Journal of Banking & Finance* 36(8): 2285–2298. <https://doi.org/10.1016/j.jbankfin.2012.04.011>
- Distinguin, I. 2008. *Market discipline and banking supervision: the role of subordinated debt* [online], [cited 25 May 2017]. Available from Internet: <https://ssrn.com/abstract=1098252> <https://doi.org/10.2139/ssrn.1098252>
- Distinguin, I.; Kouassi, T.; Tarazi, A. 2012. Interbank deposits and market discipline: evidence from Central and Eastern Europe, *Journal of Comparative Economics* 41(2): 544–560. <https://doi.org/10.1016/j.jce.2012.07.005>
- Distinguin, I.; Rous, P.; Tarazi, A. 2006. Market discipline and the use of stock market data to predict bank financial distress, *Journal of Financial Services Research* 30(2): 151–176. <https://doi.org/10.1007/s10693-0016-6>
- Drlik, M.; Pilkova, A.; Munk, M.; Svec, P. 2013. Modelling of domestic and foreign visitors' behaviour at commercial bank website during the recent financial crisis, *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis* 61(7): 2065–2070. <https://doi.org/10.11118/actaun201361072065>
- Evanoff, D. D.; Wall, L. D. 2000. *Subordinated debt as bank capital: a proposal for regulatory reform*. FRB Atlanta Working Paper No. 2000-07. Federal Reserve Bank of Chicago.
- Flannery, M. J. 2001. The faces of 'market discipline', *Journal of Financial Services Research* 20(2–3): 107–119. <https://doi.org/10.1023/A:1012455806431>
- Freixas, X.; Laux, C. 2011. *Disclosure, transparency and market discipline* [online], [cited 25 May 2017]. SSRN. Available from Internet: <https://doi.org/10.2139/ssrn.1964321>
- Gullo, F. 2015. From Patterns in data to knowledge discovery: what data mining can do, in *3rd International Conference Frontiers in Diagnostic Technologies, ICFDT3 2013*, 25–27 November 2013, Laboratori Nazionali di FrascatiFrascati, Italy, 18–22.
- Hadad, M. D.; Agusman, A.; Monroe, G. S.; Gasbarro, D.; Zumwalt, J. K. 2011. Market discipline, financial crisis and regulatory changes: evidence from Indonesian banks, *Journal of Banking & Finance* 35(6): 1552–1562. <https://doi.org/10.1016/j.jbankfin.2010.11.003>
- Hasan, I.; Jackowicz, K.; Kowalewski, O.; Kozłowski, Ł. 2013. Market discipline during crisis: Evidence from bank depositors in transition countries, *Journal of Banking & Finance* 37(12): 5436–5451. <https://doi.org/10.1016/j.jbankfin.2013.06.007>
- Jagtiani, J. A.; Kaufman, G.; Lemieux, C. 1999. *Do markets discipline banks and bank holding companies? Evidence from debt pricing*, Emerging Issues Series, S&R-99-3R (June). Federal Reserve Bank of Chicago.
- Jagtiani, J.; Lemieux, C. 2001. Market discipline prior to bank failure, *Journal of Economics and Business* 53(2): 313–324. [https://doi.org/10.1016/S0148-6195\(00\)00046-1](https://doi.org/10.1016/S0148-6195(00)00046-1)
- Jordan, J. S.; Peek, J.; Rosengren, E. S. 2000. The market reaction to the disclosure of supervisory actions: implications for bank transparency, *Journal of Financial Intermediation* 9(3): 298–319. <https://doi.org/10.1006/jfin.2000.0292>

- Kapusta, J.; Munk, M.; Svec, P.; Pilkova, A. 2014. Determining the time window threshold to identify user sessions of stakeholders of a commercial bank portal, in *14th Annual International Conference on Computational Science, ICCS 2014*, 10–12 June 2014, Cairns, Australia, 1779–1790. <https://doi.org/10.1016/j.procs.2014.05.163>
- Kapusta, J.; Pilkova, A.; Munk, M.; Svec, P. 2013. Data pre-processing for web log mining: case study of commercial bank website usage analysis, *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis* 61(4): 973–979. <https://doi.org/10.11118/actaun201361040973>
- Karas, A.; Pyle, W.; Schoors, K. 2013. Deposit insurance, banking crises, and market discipline: evidence from a natural experiment on deposit flows and rates, *Journal of Money, Credit and Banking* 45(1): 179–200. <https://doi.org/10.1111/j.1538-4616.2012.00566.x>
- Losarwar, V.; Joshi, M. 2012. Data preprocessing in web usage mining, in *International Conference on Artificial Intelligence and Embedded Systems, ICAIES 2012*, 15–16 July 2012, Singapore, 1–5.
- Moreno, D.; Takalo, T. 2016. Optimal bank transparency, *Journal of Money, Credit and Banking* 48: 203–231. <https://doi.org/10.1111/jmcb.12295>
- Munk, M.; Benko, L. 2016. Improving the session identification using the ratio of auxiliary pages estimate, in *Mediterranean Conference on Information and Communication Technologies, MedCT*, 7–9 May 2015, Saidia, Morocco, 551–556. https://doi.org/10.1007/978-3-319-30298-0_56
- Munk, M.; Benko, E.; Gangur, M.; Turčáni, M. 2015. Influence of ratio of auxiliary pages on the pre-processing phase of web usage mining, *E+M Ekonomie a Management* 18(3): 144–159. <https://doi.org/10.15240/tul/001/2015-3-013>
- Munk, M.; Kapusta, J.; Švec, P. 2010a. Data preprocessing evaluation for web log mining: Reconstruction of activities of a web visitor, in *10th International Conference on Computational Science 2010, ICCS 2010*, 31 May – 2 June 2010, Amsterdam, Netherlands, 2273–2280.
- Munk, M.; Kapusta, J.; Švec, P.; Turčáni, M. 2010b. Data advance preparation factors affecting results of sequence rule analysis in web log mining, *E+M Ekonomie a Management* 13(4): 143–160.
- Munk, M.; Pilkova, A.; Drlik, M.; Kapusta, J.; Svec, P. 2012. Verification of the fulfilment of the purposes of Basel ii, Pillar 3 through application of the web log mining methods, *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis* 60(2): 217–222. <https://doi.org/10.11118/actaun201260020217>
- Munk, M.; Pilkova, A.; Kapusta, J.; Svec, P.; Drlik, M. 2013. Pillar 3 and modelling of stakeholders' behaviour at the commercial bank website during the recent financial crisis, in *13th Annual International Conference on Computational Science, ICCS*, 5–7 June 2013, Barcelona, Spain, 1747–1756.
- Nier, W. E. 2005. Bank stability and transparency, *Journal of Financial Stability* 1(3): 342–354. <https://doi.org/10.1016/j.jfs.2005.02.007>
- Nier, W. E.; Baumann, U. 2006. Market discipline, disclosure and moral hazard in banking, *Journal of Financial Intermediation* 15(3): 332–361. <https://doi.org/10.1016/j.jfi.2006.03.001>
- Ogunde, A. O.; Folorunso, O.; Sodiya, A. S. 2015. A partition enhanced mining algorithm for distributed association rule mining systems, *Egyptian Informatics Journal* 16(3): 297–307. <https://doi.org/10.1016/j.eij.2015.06.006>
- Pilkova, A.; Munk, M.; Svec, P.; Medo, M. 2015. Assessment of the Pillar 3 financial and risk information disclosures usefulness to the commercial banks users, in *11th International Conference on Intelligent Computing, ICIC 2015*, 20–23 August 2015, Fuzhou, China, 429–440. https://doi.org/10.1007/978-3-319-22053-6_46

Sironi, A. 2003. Testing for market discipline in the European banking industry: evidence from subordinated debt issues, *Journal of Money, Credit and Banking* 35(3): 443–72.
<https://doi.org/10.1353/mcb.2003.0022>

Statsoft Inc. 2013. *Electronic statistics textbook*. Tulsa, OK: StatSoft.

Stephanou, C. 2010. *Rethinking market discipline in banking: lessons learned from the financial crisis*. World Bank Policy Research Working Paper No 5227.

Michal MUNK was appointed as an Associate Professor in System Engineering and Informatics at the Faculty of Informatics and Management, University of Hradec Kralove, Czech Republic, in 2012. Michal Munk is currently an Associate Professor with the Computer Science Department, Constantine the Philosopher University, Nitra, Slovakia. His research interests include the data analysis, web mining and natural language processing. He was a recipient of the Green Group Award of Computational Finance and Business Intelligence (Best paper) of the International Conference on Computational Science 2013, the Workshop on Computational Finance and Business Intelligence (Barcelona, 2013).

Anna PILKOVA is currently a Professor of Management at Faculty of Management at Comenius University in Bratislava, Slovakia. Before she worked at top managerial positions in commercial banks in Slovakia. Her research interests are focused on the banking regulation, risk management and strategic management at commercial banking in developing countries. In addition to that she has conducted research on entrepreneurial activities and entrepreneurship inclusivity as a national team leader for Global Entrepreneurship Monitor. She is a recipient of a few awards among them the Green Group Award of Computational Finance and Business Intelligence (Best paper) of the International Conference on Computational Science 2013, the Workshop on Computational Finance and Business Intelligence (Barcelona, 2013).

Lubomír BENKO is currently pursuing the PhD degree in Applied Informatics at University of Pardubice, Czech Republic. He is currently a Researcher with the Computer Science Department, Constantine the Philosopher University, Nitra, Slovak republic. His research interests are in the field of web usage mining, natural language processing and big data.

Petra BLAŽEKOVÁ is currently an external PhD student at Comenius University in Bratislava, Faculty of Management. She works at commercial bank in Slovakia as a risk management specialist. Her research interests are in the field of risk management, reporting and regulation.