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Entrepreneurial orientation in high-tech and low-tech SMEs in Malopolska region**

1. Introduction

There is an ongoing discussion in the literature concerning EO and its measurement in different types and groups of enterprises. It has been discussed and tested under different conditions and in various geographies. However, we identified the relatively low number of such publications pertaining to emerging economies in Central and Eastern Europe (CEE). The results suggest that entrepreneurial orientation has a positive effect on business growth in emerging markets in that region (Reijonen et al., 2015). We want to join the discussion on EO by providing results of research from that region and verifying the extent to which the EO of a company is shaped by its other characteristics. In a similar vein, Yordanova researched the EO of Bulgarian companies and analyzed the impact of the form of ownership (family-owned versus non-family-owned) as well as the CEO's level of education and tenure and the company's learning orientation, growth plans, foreign ownership, environmental dynamism, size, and age on the level of EO (Yordanova, 2011).

We decided to measure the EO in SMEs in Malopolska (a region located in the southern part of Poland, with Krakow serving as the capital). Enterprises from the SME sector have been selected as a sample because they play a dominant role in the development of many economies, including the emerging economies of CEE. We focused on the Malopolska region because it is one of the most entrepreneurial and innovative regions in Poland. We assume that such a social and business environment as represented by Malopolska may be supportive for the entrepreneurial behaviors of enterprises. Additionally, we compare the enterprises

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operating in high-tech and low-tech industries in terms of EO. We have focused on these two groups of enterprises, because the first group starts to play an important role in regional development while the second group is still represented by numerous enterprises proud of their tradition in the region.

The aims of the paper are to measure the EO of a sample population and to confirm the relationship between company characteristics (technological development of the industry in which they operate and the stage of organizational development) and EO. Three hypotheses have been proposed and tested in the paper. The EO measurement scale proposed by Covin and Slevin (1989) was implemented in the survey.

The structure of the paper is as follows. First, the theory of entrepreneurship as related to the organizations is reviewed. Second, the concept of entrepreneurial orientation (EO) is explored, and the related research is analyzed. Third, the entrepreneurship literature on innovation and high-tech industries as well as organizational development are studied, and hypotheses are formulated. Fourth, the research methodology is described. Finally, our results are presented along with their limitations, and recommendations for future research are suggested.

2. Theoretical framework and hypotheses

Entrepreneurship is perceived as one of the main forces driving the development of organizations. Hisrich, Peters, and Sheperd identify entrepreneurship as "behaviours that are related to the creation of value through the exploitation of opportunities in novel and innovative ways" (Hisrich et al., 2005, p. 10). One of the key terms in understanding the phenomenon of entrepreneurship is entrepreneurial opportunity. Casson defined it as "those situations in which new goods, services, raw materials, and organizing methods can be introduced and sold at greater than their cost of production" (Casson, 1982, p. 220). For Stevenson and Jarillo, opportunity is a "future situation which is deemed desirable and feasible" (Stevenson and Jarillo, 1990, p. 23).

Entrepreneurship is identified as a "new entry" (Lumpkin and Dess, 1996, p. 136) as well as creating organization (Gartner, 1989, p. 47). But it is also perceived as a process that "involves all the functions, activities, and actions associated with the perceiving of opportunities and the creation of organizations to pursue them" (Bygrave and Hofer, 1991, p. 14).

Entrepreneurship leads to the creation of new organizations, but it is also an important trait of existing entities. Many organizations strive to become entrepreneurial ones. Miller proposed that the entrepreneurial organization is "one that engages in product-market innovation, undertakes somewhat risky ventures, and is first to come up with proactive innovations" (Miller, 1983, p. 771). The

entrepreneurial attitudes of organizations are a subject of corporate entrepreneurship. It is also perceived as a way of "renewal or innovation within the current organization" (Sharma and Chrisman, 1999, p. 13), and it focuses on "formal or informal activities aimed at creating new business in established companies through product and process innovations and market developments" (Zahra, 1991, p. 261).

Morris noted that "entrepreneurship occurs in varying degrees and amounts". There are several concepts of the measurement of entrepreneurship in organizations. One of them is entrepreneurial orientation (EO), developed by Lumpkin and Dess (1996) on the basis of Miller's (1983) definition of an entrepreneurial firm. EO is characterized by "a propensity to act autonomously, a willingness to innovate and take risks, and a tendency to be aggressive toward competitors and proactive relative to marketplace opportunities" (Lumpkin and Dess, 1996, p. 137). One of the commonly used measurement scales was proposed by Covin and Slevin. It consists of nine items related to three dimensions: risk-taking, innovativeness, and proactiveness (Covin and Slevin, 1989, p. 75). Hughes and Morgan proposed a scale with 18 questions related to 5 dimensions of entrepreneurial orientation (risk-taking, innovativeness, proactiveness, autonomy, and competitive aggressiveness) and 5 questions related to the business performance of the firm (Hughes, Morgan, 2007, pp. 657–658). Anderson et al., have re-conceptualized EO and posited that "(1) EO is a multidimensional construct consisting of two non-interchangeable dimensions – entrepreneurial behaviors and managerial attitude towards risk; (2) there is positive covariance between these two dimensions; and (3) both dimensions are fundamentally necessary for EO to exist" (Anderson et al., 2015, p. 1583).

There are numerous examples of the utilization of EO scales in research and substantial findings both for theory and practice resulting from those surveys. Saeed et al. posited that the relationship between entrepreneurial orientation (EO) and firm performance is among the best-researched topics in entrepreneurship literature (Saeed S. et al., p. 255). EO and its relationship to performance is examined in different types of enterprises, industries, and cultural environments. Most EO research relates to big companies, but there are also studies on EO-performance relationship in SMEs (Mason et al., 2015; Altinay et al., 2016) and microenterprises (Campos et al., 2013). Wei-Loon examined the influence of EO on the performance of government-linked companies (GLCs). He found that all five dimensions in EO recorded significant positive effects on the performance of GLCs and suggested that EO is not only suitable to be applied in privately owned companies but also in GLCs (Wei-Loon, 2013).

The EO–performance relationship is impacted by national cultural and macroeconomic drivers. Saeed, Yousafzai, and Engelen found that national cultural differences impact the EO–performance relationship through the impact on the behavior of buyers in markets, and they lead to differences in the practices of

individuals in firms (Saeed S. et al., 2014, p. 259). They suggest that EO is related to a firm's performance more strongly in national cultures that are characterized by low uncertainty avoidance, low power distance, high in-group collectivism (partly confirmed), high political stability, and when the country is a developing nation. Kreiser et al. have found that "the various dimensions of cultural values and several of the institutions that are representative of national culture impact the willingness of entrepreneurial firms to display risk taking and proactive behaviors" (Kreiser et al., 2010, p. 959). EO is examined also in relation to an organizational culture. Engelen et al. found that an organizational culture that is an adhocracy is most effective in advancing entrepreneurial orientation, especially in national cultures that are characterized by strong individualism and low power distance, whereas a hierarchical organizational culture is generally a barrier to entrepreneurial orientation (Engelen et al., 2014). Brettel et al. have found that "developmental, group, and rational culture has a strong positive impact on EO, whereas the impact of hierarchical culture is negative" (Brettel et al., 2015, p. 868). However, Covin and Miller suggest that "being entrepreneurial" in an international context "may imply the presence of entrepreneurial 'dimensions' not currently acknowledged or emphasized in the EO conversation" (Covin and Miller, 2014, p. 28).

EO can be utilized in various contexts, including different external environments. This is in line with the suggestion of Zahra et al. (1999, p. 55) about corporate entrepreneurship research in different geographies and industries. Miller indicates that "particular insight may also be generated by comparing contexts that are hypothesized in a theoretically informed typology" or "where the institutional environments and institutional logics may vary greatly, while many other aspects of structure and environment are quite similar" (Miller, 2011, p. 886). Following these prompts, the EO in the enterprises of the Malopolska region of Poland will be explored, especially since the available examples of such research are not numerous (Nogalski and Karpacz, 2011; Bratnicki and Kulikowska-Pawlak, 2011; Dyduch, 2008) and their operationalizations of EO vary (which makes any meta-analysis of secondary data difficult).

There is some research on EO in the high-tech context as well as research focused on innovation's influence on EO. Atuahene-Gima and Ko (2001, p. 56) state that entrepreneurial orientation is "akin to technological orientation" (Atuahene-Gima and Ko, 2001). Nasution et al. have found a positive relationship between entrepreneurship and innovation in organizations operating in the hospitality industry (Nasution et al., 2011, p. 341). Some studies indicate that firms representing entrepreneurial orientation are able to introduce new products that are highly unique and/or breakthrough innovations (Renko et al., 2009, p. 338). However, Kollmann and Stöckmann suggest that the constituent dimensions of EO differ in their effects on exploration and exploitation (as well as performance) in the

context of innovation processes (Kollmann and Stöckmann, 2014). Miller posits that innovativeness may be especially important in the high-tech context (Miller, 2011, p. 880). This is in line with the results of the meta-analysis of Saeed et al. (2014, p. 278), who found that the EO–performance relationship has significant moderator effects and larger effect sizes for firms with a high-tech focus than for firms with a non–high-tech focus (which confirms the findings from Rauch et al.'s (2009) meta-analysis). Kressel identified the importance of innovativeness in small high-tech companies (Kressel, 1995), and Arshad et al. found that four dimensions of EO (innovativeness, proactiveness, competitive aggressiveness, and risk-taking) significantly affect the business performance of technology-based SMEs in their survey in Malaysia (Arshad et al., 2014) The learning processes (which are linked with innovations) are also examined in the view of EO. Wang has found that learning orientation (LO) must be in place to maximize the effect of EO on performance and that, along with EO, LO is an important dimension (Wang, 2008). Altinay et al. (2016) identified a positive relationship between organizational learning capability and EO. Some network structures may enhance EO, and high-tech industry clusters are perceived as an environment that promotes an innovative orientation (Miller, 2011, p. 882).

Therefore, we propose the following hypothesis:

H1: There is a differentiation of enterprise EO between high-tech industries and traditional industries.

The theory of organizational development suggests that, in the early stage, entrepreneurship and innovativeness are among the most important sources of development. This is reflected in the concept proposed by Adizes (1988) as well as Quinn and Cameron (1983). Greiner (1972) also points at innovativeness as a key element in the early development of an organization. Stoner and Wankel suggest that organizations in their early stages of development position themselves in the market and pursue many opportunities but do not perceive planning and coordinating as key managerial activity (Stoner and Wankel, 1994, p. 249). Hughes and Morgan examined EO in firms at the embryonic stage of development and found that organizing activities around proactiveness (and to some extent innovativeness) is essential to securing improved performance (Hughes and Morgan, 2007, p. 657–658). Chaston and Sadler-Smith studied small creative industry enterprises, and they have found that "high-growth small firms are characterized by well-developed internal capabilities allied to an entrepreneurial orientation" (Chaston and Sadler-Smith, 2012, p. 415). Based on their meta-analysis, Saeed et al. (2014, p. 278) found that the EO–performance relationship has more significant moderator effects and larger effect sizes for small firms than for large firms, which confirms the findings from Rauch et al.'s (2009) meta-analysis.

Therefore, we hypothesize:

H2: There is an inverse monotonic relationship between EO and the age of a company.

H3: There is an inverse monotonic relationship between EO and the size of a company expressed in the number of employees.

3. Research methods

In accord with the aims of this study and proposed hypotheses, the surveyed population was defined as companies:

- whose primary activity is in the industry defined by PKD (Polska Klasyfikacja Działalności – Polish Classification of Economic Activities): code 26 – manufacture of computer, electronic, and optical products; code 27 – manufacture of electrical equipment; and code 31 – manufacture of furniture;
- that have their place of business in the Malopolska region;
- that are SMEs.

The abovementioned industries have been chosen to represent different levels of technology. Groups 26 and 27 are very modern industries, while Group 31 manufactures more-traditional products. The choice of these two contrasting groups of companies (PKD 26 and 27 combined as a high-tech group, and 31 as a low-tech group) will facilitate the verification of the hypothesis that there is some inter-industry differentiation of entrepreneurial orientation. Moreover, these groups represent approximately 10% of the whole manufacturing industry in total (section C of PKD) in the region, so their economic significance is substantial.

The whole sample consists of companies from one region – Malopolska (which is an important region of Poland due to its economic, scientific, and educational significance). The entrepreneurial potential of Malopolska has also been recognized by the European Committee of Regions, which awarded this region as European Entrepreneurial Region 2016 (European Union Committee of Regions, 2016).

The survey was carried out in September 2015. The sampling frame preparation, sample drawing, and collection of data was carried out by the Central Statistical Office of Poland (Krakow branch). A professional staff was hired to administer the survey during visits to company facilities. The questionnaire consisted of sample demographic questions and the main item (which was a nine-question entrepreneurial orientation measurement tool developed by Miller (1983) and Covin and Slevin (1989) and presented by Covin and Wales (2012, p. 692), translated to Polish).

The sample size was 100 companies. Since 50 companies refused to take part, a further 47 companies were drawn to take their place. Two companies

were discarded from the sample because they identified their primary activity as something other than PKD 26, 27, or 31. The final sample size is, therefore, 95 companies. The structure of the sample is described in Table 1.

Table 1

Structure of the sample

PKD class	Sample (n)		
	total	small enterprises	medium-sized enterprises
26	17	14	3
27	18	13	5
31	60	52	8
total	95	79	16

Source: own elaboration, based on data delivered by Statistical Office of Poland (Krakow branch)

Entrepreneurial orientation was measured using a tool developed by Miller (1983) and Covin and Slevin (1989). Each of the nine questions measures the respondent's agreement with a pair of opposite statements in a five-point scale, where 1 means "I completely agree with the first statement" and 5 – "I completely agree with the second statement". Three of the questions pertain to the innovativeness of the company, three to its proactiveness, and three to its risk propensity. The indices of innovativeness, proactiveness, and risk-taking were calculated, and the general index of entrepreneurial orientation was been calculated by the summation of the responses.

4. Analysis and results

The choice of the statistical tools is a result of the nature of the data (categorical or ordinal level of measurement) and the postulated relationships between variables (monotonic, but not necessarily linear). Therefore, the Kruskal-Wallis H test was chosen to confirm the existence of statistically significant differences in the medians between groups (Hypothesis 1) and the Spearman correlation of ranks to confirm monotonic relationships between variables (Hypotheses 2 and 3).

Reliability analysis was performed using the Cronbach method. The value of the alpha coefficients for each of the indices presented in Table 2 is greater than 0.7. Hair et al. (2011, p. 255) qualify alpha coefficients between 0.7 and 0.8 as

having good strength of association and those between 0.8 and 0.9 being very good. Therefore, the reliability analysis suggests that the items in the measurement tool used in this study are, in fact, consistent and do measure the same construct.

Table 2

Cronbach alpha coefficients of the index and subindices of entrepreneurial orientation

Index	Cronbach alpha coefficient
innovativeness	0.73
proactivity	0.72
propensity to risk	0.86
entrepreneurial orientation	0.88

Source: own research

The median of entrepreneurial orientation index is 13.5 on a scale of 0 to 36. The midpoint of the frequency distribution is below the midpoint of the scale (which denotes neutral answers). In the subindices, the medians were as follows: 5 for innovativeness; 4 for proactiveness; and 3 for risk propensity (on a scale of 0 to 12). So, the decision-makers assess their companies as prone to well-proven solutions rather than to innovations; they are clearly more risk-averse and reactive than risk-prone and proactive. Therefore, the subject companies are entrepreneurial to a fairly low extent.

In an attempt to test the hypothesis concerning the differentiation of entrepreneurial orientation indices between high-tech and low-tech industries, the sample has been split into two categories: high-tech (PKD 26 [manufacture of computer, electronic, and optical products] and PKD 27 [manufacture of electrical equipment]) and low-tech (PKD 31 [manufacture of furniture]). The sizes of the defined classes are 35 firms in the hi-tech class and 60 firms in the low-tech class.

Table 3

Medians of entrepreneurial orientation index and its subindices (innovativeness, proactivity, and risk-taking) in high-tech and low-tech company classes

The level of technological development	Innovativeness subindex [0–12]	Proactivity subindex [0–12]	Risk-taking subindex [0–12]	Entrepreneurial orientation index [0–36]
Low-tech	5	4	3	10
High-tech	8	5	3	17.5

Data source: own research

The data in Table 3 illustrates a higher level of entrepreneurial orientation index in high-tech companies (median of 17.5 versus 10 for low-tech companies, on a scale of 0 to 36). This is mainly due to the fact that the high-tech companies' innovativeness subindex is considerably higher than that of low-tech companies – the median is 8 as compared to 5, on a scale of 0 to 12. There is also a difference in the proactivity subindex – the median is 5 compared to 4, on a scale of 0 to 12. The median of the risk-taking index is equal for both groups. The statistical significance of the abovementioned differences in medians has been tested using the Kruskal-Wallis *H* test. It can be concluded that high-tech and low-tech companies are significantly different in their innovativeness ($H\,[1, N = 93] = 5.5, p = 0.02$) and proactivity ($H\,[1, N = 92] = 4.54, p = 0.03$) but are not statistically different in their risk-taking ($H\,[1, N = 93] = 0.92, p = 0.34$). Also, the entrepreneurial orientation index displays a statistically significant difference ($H\,[1, N = 90] = 5.55, p = 0.02$).

The correlation of EO indices to the development stage of a company was also tested. The development stage variables were the age of the organization and the number of employees. The Spearman rank correlation coefficient for the pair of variables (age of organization and EO) is –0.32 ($p = 0.002$). For EO subindices and age of the organization, the rho coefficient is $rho = -0.32$ ($p = 0.0016$) for proactivity, $rho = -0.21$ ($p = 0.04$) for risk-taking, and $rho = -0.25$ ($p = 0.015$) for innovativeness. Therefore, the monotonic relationship between variables is significant (albeit low) (Ostasiewicz et al., 1995, s. 311), and it is negative (as hypothesized).

The Spearman rank correlation coefficient for the pair of variables: number of employees and EO is 0.2 ($p = 0.06$). For the EO subindices and number of employees, the rho coefficient is $rho = 0.23$ ($p = 0.03$) for proactivity, $rho = 0.24$ ($p = 0.02$) for risk-taking, and $rho = 0.086$ ($p = 0.41$) for innovativeness. Therefore, the monotonic relationship between variables is low or statistically insignificant (Ostasiewicz et al., 1995, s. 311). Furthermore, it is positive, not negative monotonic (as we hypothesized). Table 4 summarises the veryfication of the hypotheses.

Table 4

Hypotheses verification summary

H1: There is a differentiation of enterprise EO between high-tech industries and traditional industries.	supported
H2: There is an inverse monotonic relationship between EO and the age of a company.	supported
H3: There is an inverse monotonic relationship between EO and the size of a company expressed in the number of employees.	not supported

Source: own research

5. Discussion and implications

This study addressed three research questions. The first question was related to the differentiation of enterprise EO between high-tech and low-tech industries. The next two questions applied to the relationship between EO and organizational development (particularly, EO and the age of a company as well as EO and the number of employees).

With respect to the first question, our results show the existence of a differentiation of EO between enterprises operating in high-tech and traditional industries; i.e., EO is stronger in high-tech enterprises than in low-tech. The findings support our previous assumption and Hypothesis H1 as well as theories presented in the literature. The findings are in line with the results of the meta-analysis of Rauch et al. (2009) and Saeed et al. (2014). This suggests that relationships observed by other researchers in other areas are also relevant to enterprises operating in the emerging economy of the Malopolska region.

Analyzing the medians of the sub-inices of EO, we can observe that the difference between enterprises operating in high-tech and low-tech industries is mainly caused by the innovativeness index. In the case of the proactiveness index, the difference is less pronounced, and it is statistically insignificant in the risk-taking index. This leads to the conclusion that innovativeness is the dominant dimension of EO in enterprises operating in the high-tech industry.

Our results show an inverse relationship between EO and the age of an organization. This relationship is especially strong in the case of proactiveness and significantly lower in the cases of innovativeness and risk-taking. This means that the tendency to behave actively and in an innovative way is stronger in young enterprises, and their attitude toward risk is less conservative than with older companies. These results are in line with theory of organizational development and support Hypothesis H2.

Our results show a correlation between the number of employees and EO. However, the Spearman rho is low in the case of proactiveness and risk-taking (and not statistically significant in the case of innovativeness). What is important, the relationship between EO and the size of an enterprise is positive. Hypothesis H3 is not supported by the results of our study. This finding is somewhat in line with the results obtained by Mickiewicz et al. (2010) in Lithuanian SMEs (where a positive correlation between EO and the number of employees was reported) and also with Yordanova's research into Bulgarian companies (Yordanova, 2011). This suggests that the nature of the connection between EO and company size is not as straightforward as we have hypothesised. Whereas age is obviously an independent variable, a company's size might be a result of its performance (which, in turn, is dependent on EO to a certain degree).

The study here has some limitations. First, the findings are within the context of the Polish economy in the Malopolska region, which calls for caution when generalizing the outcomes globally. Second, the sample was relatively small; it represents only three sub-industries, so this also limits the generalizability of the findings. Third, even though it is widely used in similar research, the methodology of measuring EO used in this study is based on subjective assessments by respondents and not hard metrics. Fourth, statistical analyses in the case of some indicators show relatively low levels of statistical significance.

The abovementioned limitations offer possibilities for future research on EO with bigger samples and in other geographical and industrial contexts. Another track of future research is connected with the development of the EO-measurement methodology; in particular, those based on comparing declarations gathered through traditional EO scales with hard metrics (e.g., in innovative activity) achieved by a company, which are reflected in relevant documentation and registers. Another area that requires more research is the dynamics of EO in connection with organizational development (e.g., how EO and its dimensions change through an organization's life cycle). Additionally, we recommend more detailed EO research into emerging economies, including the environmental and culture factors that influence EO. Among the most promising research problems we see is determining the influence that unstable economic and legal environments have on entrepreneurial behavior and EO.

6. Conclusions

The aim of this paper was to measure the EO of SMEs operating in the Malopolska region of Poland. For our results to be comparable with those from other studies, we used the scale we deemed as the most standard based on a literature review; that is, the EO measurement scale proposed by Covin and Slevin (Covin and Slevin, 1989). The results suggest that the subject companies are entrepreneurial to a fairly low extent.

The second aim was to confirm the relationship between company characteristics (the technological development of the industry in which they operate and their stage of organizational development) and EO. Three hypotheses concerning these relationships were proposed and tested in the paper. The hypothesis concerning the differentiation between high-tech and low-tech companies was supported by the data. The hypothesis stating an inverse correlation between a company's age and EO was also supported by the data. The nature of the relationship postulated by the third hypothesis concerning the inverse correlation between company size and EO is not as straightforward. We have found a positive

correlation, although below a level of statistical significance (which is opposite of the inverse correlation we hypothesised).

This paper is one of the first attempts to utilize EO in the context of Polish SMEs, but we see such research as a promising field of future research.

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Spatial contagion between stock markets in Central Europe**

1. Introduction

The process of globalization has enabled investors to invest in financial markets all over the world. However, the appearance of global investors has tightened relationships between financial markets in different parts of the world. This, in turns, has made international portfolio diversification a very difficult task. Hence, a deeper analysis of the existence and strength of relationships between markets for risk management and optimal portfolio allocation has become important as never before.

In recent years, a large amount of financial and econometric literature has been devoted to analyze various kinds of short- and long-term linkages between stock markets. Their aim has been to give a better description of information flow. Initially, the largest part of the literature about co-movement and interdependencies has concentrated on developed markets (e.g., Hamao et al., 1990; Cappielo et al., 2006). Subsequently, the linkages between developed and emerging markets have also been examined (see, for example, Chen et al., 2002; Kim et al., 2005; Syllignakis and Kouretas, 2011). Only a small part of the literature describes such relationships between stock markets in Europe. Moreover, the conclusions from empirical research are not always consistent.

Long-range dependencies between European markets have been analyzed by Voronkova (2004), Černy and Koblas (2005), Égert and Kočenda (2007), Syriopoulos (2007), Wójtowicz (2015), among others. The majority of these indicate the existence of long-term relationships (cointegration, fractional conitegration) between daily data of European stock markets (both developed

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and emerging). On the other hand, analogous intraday relationships have not been confirmed.

More common results can be observed when short-term relations are investigated. Hanousek et al. (2009) showed significant spillover effects on the stock markets in Prague, Budapest, and Warsaw. Moreover, the situation in CEE markets is significantly influenced by the situation of the stock market in Frankfurt. This impact is even stronger than the impact of CEE markets themselves. Similar results were obtained by Černý and Koblas (2005). The important impact of developed European markets on CEE emerging markets was also indicated by Égert and Kočenda (2007), who showed significant intraday causalities between returns of CEE markets and causal relationsships from developed to emerging markets. On the other hand, Égert and Kočenda (2011) found very few positive time-varying correlations between the intraday returns of BUX, PX50, and WIG20.

The existence of a high or very low correlation between stock markets is not the only factor that should be taken into account in a portfolio-diversification strategy. Changes in the strengths of linkages between markets during calm and turbulent periods seem to be even more important. The existence of a low correlation during a calm period encourages diversification; however, when correlation between markets increases during a crisis, then a loss on one of them is accompanied by a loss on the others. This leads to the issue of contagion between stock markets that also should be taken into account when building a well-diversified portfolio. However, the literature lacks the one common formal definition of contagion for financial markets; thus, there is no common measure of contagion. There are several different approaches to this issue. In general, we can say that contagion occurs when interdependencies between markets are higher during turbulent times than in tranquil times (see, for example, Forbes and Rigobon, 2002). Thus, there is a difference between "strong interdependency between markets" and "contagion". Contagion does not exist when two markets are highly correlated during both calm and turbulent times. It occurs when markets are more-tightly connected in turbulent times than they are during calm periods. Hence, in this paper, we say that there is contagion between two markets when a significant shift in correlation is observed during a turbulent period.

The majority of empirical studies on contagion is based on data concerning periods around financial crises. A natural approach is to compare correlations between markets before and after a crisis. Such comparisons have also been done by applying conditional correlation (CC) models. Using Constant Conditional Correlation (CCC) and Smooth Transition Conditional Correlation (STCC) models, Savva and Aslanidis (2010) showed that markets in the Czech Republic, Hungary, and Poland revealed stronger correlations with the Euro area than

smaller CEE markets like Slovenia and Slovakia. Using the Dynamic Conditional Correlation (DCC) GARCH models, Syllignakis and Kouretas (2011) showed that the 2007–2009 global financial crisis significantly shifted conditional correlation between the developed markets (Germany and US) and emerging CEE markets. On the other hand, Baruník and Vácha (2013) studied contagion between CEE markets using the wavelet approach and confirmed contagion only between the stock markets in the Czech Republic and Germany.

The analysis of contagion based on a comparison of correlation before and after a crisis has a considerable drawback associated with the significance test for the shift in correlation during these two periods. This is caused by different properties of financial time series during tranquil and turbulent times. Hence, Durante and Jaworski (2010) (see also Durante et al., 2013; Durante and Foscolo, 2013) considered an alternative approach to analyze changes in stock market co-movements. They introduced the notion of spatial contagion based on the copula approach. Instead of comparing correlation before and after a given crisis, they proposed a comparison of correlation for very low returns (in the left tail of returns distribution) with correlation around the median (in the central part of the distribution). This definition of contagion does not depend on the choice of a particular crisis, but all cases of severe losses on both markets are taken into account. Such an approach is in line with the results of Longin and Solnik (2001), who applied the extreme value theory to show an increased correlation of large negative returns.

In this paper, we study contagion among three European stock markets; namely, the stock exchanges in Frankfurt (FSE), Vienna (VSE), and Warsaw (WSE). They are specially selected stock markets because they differ considerably but also share some similarities. The Frankfurt Stock Exchange is an example of a large developed market. It is one of the largest and the most-important stock markets in Europe. Its capitalization is about eighteen times greater than that of the Vienna Stock Exchange (VSE) and about eleven times greater than that of the Warsaw Stock Exchange (WSE)[1]. The Vienna Stock Exchange (somehow smaller than the FSE) is also a developed market. On the other hand, the stock exchange in Warsaw is still seen as an emerging market. Despite these differences, both the VSE and WSE are among the largest stock markets in Central and Eastern Europe. Moreover, both the VSE and WSE ensure enough liquidity to be taken into account in a global diversification issue. Hence, in this paper, we analyze contagion between stock markets by taking into account their sizes as well as their degrees of development. This

[1] At the end of July 2015, capitalization of the FSE was at the level of €1.65 trillion compared to €147 billion of capitalization of the WSE and €90 billion capitalization of the VSE [source: Federation of European Securities Exchanges; www.fese.eu].

will show how the similarities and differences between markets under study are reflected in contagion effects.

The main part of the analysis of contagion between the abovementioned stock markets is performed on the basis of the daily returns of their main indices. However, due to the very fast and significant reaction of stock markets to important publicly available information[2], we also perform an analysis on the basis of intraday data. The application of data sampled with different frequency will show how the speed of information flow influences the strength of the relationships between the markets. To study the relationships among the stock markets, we apply the spatial contagion measure of Durante and Jaworski (2010). We also propose its modification (called the conditional contagion measure) that takes into account the impact of the state of a third market on a contagion measure between two given markets. This enables us to verify whether contagion between markets is induced by external factors such as other stock markets.

The rest of the paper is organized as follows. In the next section, we provide a short description of the spatial contagion measure applied in the paper. We also propose a conditional contagion measure to analyze the impact of one stock market to the contagion between the other markets. In Section 3, we present and analyze in detail the data that we use in the empirical study in Section 4. A brief summary concludes the paper.

2. Spatial contagion measure

2.1. Contagion measure between two markets

According to the description presented in the introduction, we say that there is contagion between two markets if the correlation between returns of their indices during a turbulent time is stronger than during a tranquil time. In turbulent times or during crises, large decreases of stock prices are observed, and negative returns dominate. On the other hand, returns vary around zero in tranquil times. Hence, contagion may be understood as the difference between the correlation of very low negative index returns (in the lower tail of the bivariate distribution of returns) and that of returns from around their medians (in the central part of the return distribution). This is the basic idea of the spatial contagion measure proposed by Durante and Jaworski (2010) (see also Durante et al., 2014).

Let X and Y be the random variables that represent the returns of two stock market indices, and let the dependence between them be described by means of

[2] For example, Gurgul and Wójtowicz (2014, 2015) showed that the stock markets in Vienna and Warsaw react to US macroeconomic news in just the first minutes after news announcements.

copula C. For α_1, α_2, β_1, $\beta_2 \in [0,1]$, consider the two following sets of R^2: *tail* set $\boldsymbol{T}_{\alpha_1,\alpha_2}$ and *central* set $\boldsymbol{M}_{\beta_1,\beta_2}$, given by formulas:

$$T_{\alpha_1,\alpha_2} = \left[-\infty, q_X(\alpha_1)\right] \times \left[-\infty, q_Y(\alpha_2)\right] \tag{1}$$

$$M_{\beta_1,\beta_2} = \left[q_X(\beta_1), q_X(1-\beta_1)\right] \times \left[q_Y(\beta_2), q_Y(1-\beta_2)\right] \tag{2}$$

Where q_X and q_Y are the quintile functions associated with random variables X and Y, respectively.

Tail set represents negative returns during a turbulent time on both markets. These returns are smaller than the given thresholds $q_X(\alpha_1)$ or $qY(\alpha_2)$. On the other hand, set corresponds to a tranquil time and describes returns in the central part of their joint distribution.

Following Durante and Jaworski (2010) and Durante et al. (2014), we say that there is *symmetric contagion* between X and Y at given threshold level $\alpha \in (0, 0.5)$ if the Spearman correlation in the tail is significantly greater than that in the central part of the distribution; i.e.,

$$\rho(T_\alpha) > \rho(M_\alpha) \tag{3}$$

where $\rho(T_\alpha) = \rho(X,Y \mid (X,Y) \in T_{\alpha,\alpha})$ is the Spearman correlation between X and Y on tail set $T_{\alpha,\alpha}$ and $\rho(M_\alpha) = \rho(X,Y \mid (X,Y) \in M_{\alpha,\alpha})$ is the Spearman correlation between X and Y on central set $M_{\alpha,\alpha}$, and the inequality (3) is statistically significant.

In the above definition of contagion, however, the choice of threshold α may influence the final result. To avoid the problem caused by an arbitrary choice of threshold α, Durante et al. (2014) defined the *symmetric contagion measure* between X and Y by the following formula:

$$\gamma(X,Y) = \frac{1}{\lambda(L)} \lambda\left(\left\{\alpha \in L \mid \rho_{T,\alpha} > \rho_{M,\alpha}\right\}\right) \tag{4}$$

where $L \subset [0, 0.5]$ is a connected set of possible values of thresholds α, λ is the Lebesgue measure on [0, 1]. The above contagion measure simply counts how many times correlation $\rho_{T,\alpha}$ between X and Y in tail set $T_{\alpha,\alpha}$ is significantly greater than correlation computed in central sett $M_{\alpha,\alpha}$.

In order to determine the estimates of coefficients $\rho_{T,\alpha}$ and $\rho_{M,\alpha}$, the threshold copula approach could be applied. However, to overcome difficulty with assumption about a proper copula function, an empirical copula can be taken into consideration. The correctness of such an approach follows from the properties of empirical copulas discussed by Schmid and Schmidt (2007).

Hence, the procedure of spatial contagion measure calculation is as follows (for details, see Durante et al., 2014):

1. Univariate return series are filtered via the appropriate AR-GARCH models.
2. The empirical cumulative distribution function of residuals is computed.
3. Interval is equally divided into a finite number of equidistant points α_i.
4. For each threshold $\alpha = \alpha_i$ ($i = 1, \ldots, n$), tail set $T_{\alpha,\alpha}$ and central set $M_{\alpha,\alpha}$ are determined and Spearman correlations $\rho_{T,\alpha}$ and are computed.
5. For each α_i, the null hypothesis that $\rho(T_\alpha) = \rho(M_\alpha)$ against $\rho(T_\alpha) > \rho(M_\alpha)$ is tested[3].
6. The contagion measure is then computed as the percentage of significant inequalities $\rho(T_\alpha) > \rho(M_\alpha)$; that is:

$$\hat{\gamma}(X,Y) = \frac{\#\left\{i : \rho\left(T_{\alpha_i}\right) > \rho\left(M_{\alpha i}\right)\right\}}{n}$$

2.2. Conditional contagion measure

It is well-known that relationships between two stock markets are also influenced by their relationships with other markets. To take this fact into account, bivariate relations are frequently studied by means of multivariate models with additional exogenous variables. Hence, we propose a generalization of the definition of the contagion measure above between two return series X and Y to the case when information about third return series Z is also taken into account. To do this, we consider a copula describing the joint distribution of trivairate return series (X, Y, Z). Let:

$$\rho\left(T_\alpha, T_{\alpha_0}\right) = \rho\left(X,Y \middle| (X,Y) \in T_{\alpha,\alpha}, Z \in T_{\alpha_0}\right) \tag{5}$$

$$\rho\left(M_\alpha, T_{\alpha_0}\right) = \rho\left(X,Y \middle| (X,Y) \in M_{\alpha,\alpha}, Z \in T_{\alpha_0}\right) \tag{6}$$

be the Spearman correlations between return series X and Y when $(X,Y,Z) \in T_{\alpha,\alpha} \times T_{\alpha_0}$ or when $(X,Y,Z) \in M_{\alpha,\alpha} \times T_{\alpha_0}$, respectively.

There is contagion between X and Y conditional on $Z \in T_{\alpha_0}$ when

$$\rho\left(T_\alpha, T_{\alpha_0}\right) > \rho\left(M_\alpha, T_{\alpha_0}\right) \tag{7}$$

and the inequality is significant.

[3] This hypothesis (or 'these hypotheses') can be verified by bootstrap methods (see Durante et al., 2014).

Analogously, we define contagion between X and Y if Z is in central set M_{α_0} as:

$$\rho\left(T_{\alpha}, M_{\alpha_0}\right) > \rho\left(M_{\alpha}, M_{\alpha_0}\right) \tag{8}$$

and the inequality is significant.

Formulas (7) and (8) describe contagion between X and Y on given level α when Z is in lower tail T_{α_0} (and negative returns of Z are observed) or when Z is in central set M_{α_0} (and returns around the median are observed), respectively. Conditional contagion between X and Y exists when the change in strength of the relationship between X and Y is significant during a turbulent time for (Formula [7]) or during a tranquil time for (Formula [8]). Let us note that, in the above definitions, we allow for different values of thresholds α and α_0 for (X, Y) and Z.

The algorithm of the computation of the conditional contagion measure is similar to the algorithm for the contagion measure described in the previous subsection; however, it is based on a three-dimensional empirical copula, and the classification to the tail and central sets is performed conditionally on the values of Z.

In Step 5 of the algorithm, the existence of conditional contagion can be examined by testing the significance of inequality (7) (or [8]). Additionally, we can test the significance of the impact of variable Z on contagion between X and Y; i.e., whether restriction of Z to tail set strengthens contagion between X and Y. It is equivalent to test:

$$H_0 : \rho\left(T_{\alpha}\right) - \rho\left(M_{\alpha}\right) = \rho\left(T_{\alpha}, T_{\alpha_0}\right) - \rho\left(M_{\alpha}, T_{\alpha_0}\right) \tag{9}$$

against

$$H_1 : \rho\left(T_{\alpha}\right) - \rho\left(M_{\alpha}\right) < \rho\left(T_{\alpha}, T_{\alpha_0}\right) - \rho\left(M_{\alpha}, T_{\alpha_0}\right) \tag{10}$$

Alternative hypothesis (10) means that the difference between the correlations of X and Y in their tail and central sets is larger when we take into account information about the values of Z. An analogous test can be defined for $Z \in M_{\alpha_0}$ to verify whether restriction to a calm period for significantly impacts contagion between X and Y[4].

[4] All of these tests can be performed by the bootstrap method.

3. Data

The analysis presented in this paper is based mainly on the daily log-returns of the main indices of stock exchanges in Frankfurt, Vienna, and Warsaw; namely, DAX, ATX, and WIG20[5]. Daily index returns cover the period from January 4, 2000, to December 31, 2014. This 15-year period contains phases of bull as well as bear markets; in particular, it includes the period of the recent global financial crisis (2007–2009). This allows us to study contagion not only when stock prices increase but also when they fall. Thus, we will be able to not only describe the impact of the financial crisis, but it will also ensure the robustness of the contagion measures. To model the daily data, we will apply AR(1)-GARCH(1,1) models with skewed Student's *t*-distribution.

Additionally, we study the contagion effect on the basis of 5-minute log-returns. The intraday data covers the rather-stable market period between March 22, 2013, and July 31, 2014. During this period, DAX increased by about 17% while ATX and WIG20 decreased by about 5% and 2%, respectively. Application of the intraday data from this quite calm period will show how the relationships between the stock markets under study changed in response to local and short-lived negative impulses that could not be recorded in the daily data.

In an analysis of the intraday data, the trading hours of the stock markets must be taken into account, because they were open at different hours of the day in the period under study[6]. Due to the differences in trading hours on the markets and to the fact that first 5-minute intraday return is observed at 9:05, intraday relations are analyzed only during the common periods between 9:05 and 16:50. When modeling intraday data, it is a well-known fact that intraday volatility usually increases at the beginnings and ends of trading sessions; this should be taken into account. Restricting the analysis to the period of 9:05–16:50 does not completely remove the periodic pattern from volatility series. Figure 1 shows a U-shaped pattern observed in intraday return volatility[7]. Additionally, in 5-minute return volatility, we can observe the very strong impact of US macroeconomic news (usually announced at 14:30). This strong impact of various US macroeconomic news announcements on the European stock market is widely confirmed by empirical works (see; e.g., Harju and Hussain, 2011; Gurgul and Wójtowicz, 2015).

[5] Data comes from Bloomberg, the Vienna Stock Exchange, and Warsaw Stock Exchange, respectively.

[6] In 2013 and 2014, continuous trading started at 8:55 on the VSE and at 9:00 on the FSE and WSE. It ended at 16:50 (WSE), 17:30 (FSE), and at 17:35 (VSE). Moreover, on the FSE and VSE, there were intraday auctions at 13:00 and 12:00, respectively.

[7] Because we trim the period under study at 16:50, the increase of returns volatility at the end of the trading session is not visible in Figure 1.

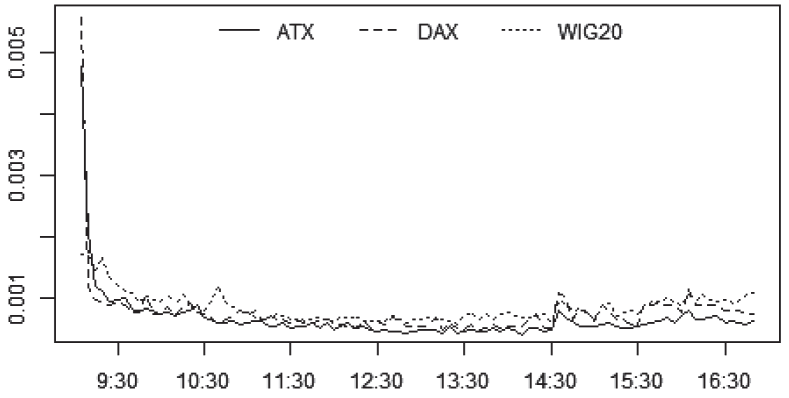


Figure 1. Cross-sectional standard deviations of 5-minute returns of ATX, DAX, and WIG20 during period of March 22, 2013 – July 31, 2014

Source: Authors' calculation

To deal with the periodic pattern in volatility and with the impact of US news announcements, we apply a method of Flexible Fourier Form (FFF) adopted to intraday data by Andersen and Bollerslev (1997). Specifically, we decompose 5-min returns $R_{t,n}$ at time n on day as:

$$R_{t,n} - E\left(R_{t,n}\right) = s_{t,n}\sigma_{t,n}Z_{t,n} \tag{11}$$

where $Z_{t,n}$ is i.i.d(0, 1) and $\sigma_{t,n}$ is the daily volatility factor that can be approximated by volatility forecasts from the appropriate GARCH model with skewed Student's t-distribution constructed for daily returns. $s_{t,n}$ is an intraday (diurnal) seasonal component such that $\ln\left(s_{t,n}^2\right)$ can be estimated from the following FFF regression:

$$\begin{aligned} 2ln\frac{\left|R_{t,n}-\bar{R}\right|}{\left(\bar{\sigma}_t N^{0.5}\right)} &= c + \sum_{k=1}^{D}\lambda_k I_k\left(t,n\right) + \delta_1\frac{n}{N_1} + \delta_2\frac{n^2}{N_2} + \\ &+ \sum_{p=1}^{P}\left(\delta_{c,p}\cos\left(\frac{2\pi p}{N}n\right) + \delta_{s,p}\sin\left(\frac{2\pi p}{N}n\right)\right) + \varepsilon_{t,n} \end{aligned} \tag{12}$$

where N refers to the number of returns per day (here, N = 94), $N_1 = \frac{N+1}{2}$, $N_2 = \frac{(N+1)(N+2)}{6}$, $I_k(t, n)$ is a dummy variable related to weekdays as well as US macroeconomic news announcements. On the basis of the literature (see; e.g., Nikkinen et al., 2006; Harju and Hussain, 2011; Gurgul and Wójtowicz, 2014, 2015), we include regression dummy variables in the FFF describing the impact

of announcements of the following US macroeconomic indicators: Consumer Price Index (CPI), Producer Price Index (PPI), Industrial Production (IP), Retail Sales (RS), Durable Goods Orders (DGO), Nonfarm Payrolls (NFP), Existing Home Sales (EHS), Housing Starts (HS), and New Home Sales (NHS).

Application of FFF confirms the conclusions from Figure 1 regarding the very-high variance of returns at the beginning of the trading session. It also indicates the strong and significant impact of US macroeconomic news announcements on intraday volatility. This is clearly visible in Figure 2, where we present examples of intraday volatility components for the days with US announcements at 14:30. After removing the daily and intraday seasonality components of volatility, we filter the 5-min returns out with AR(10)-GARCH(1,1) models with conditional skewed Student's *t*-distribution.

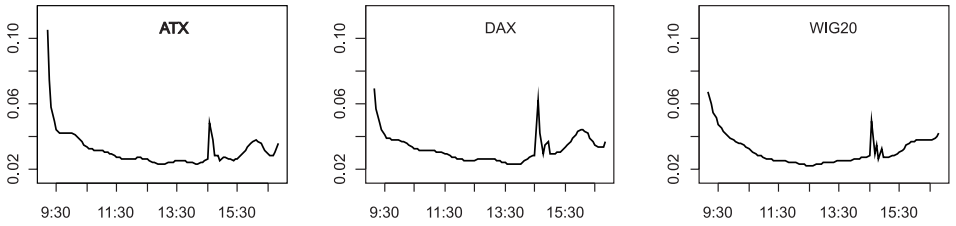


Figure 2. Intraday seasonal component of ATX, DAX, and WIG20 on days with US macroeconomic news announcements at 14:30

Source: Authors' calculation

4. Contagion – empirical results

4.1. Correlations

We start the analysis by describing the correlations between index returns. This will give us our very-first insight into the relationships between the stock markets. To compare the results for the data sampled with a different frequency, we first analyze the correlations between the daily returns and then between the 5-min returns. Table 1 contains Spearman correlations computed for daily returns during the whole period of 2000–2014 and also for two sub-periods of equal length: from January 4, 2000, to July 2, 2007, and from July 3, 2007, to December 31, 2014. Partition of the data and the analysis in these sub-periods allows us to compare the strength of the relationships between the markets before and after the global financial crisis of 2007–2009. All of the correlations reported in Table 1 are significant at the 1% level; hence, we can simply conclude that the relationships observed between the stock markets under study are significantly positive. The strongest correlations are between both of the developed markets

in Frankfurt and Vienna, while the weakest relation is between the VSE and WSE. These results are observed in each of the periods; however, the higher values of correlations in the second sub-period indicate a positive impact of the global crisis on the relationships between the markets. This is in line with the empirical literature that correlation between returns is not constant but varies over time.

Table 1

Spearman correlations between daily returns of ATX, DAX, and WIG20

Period	ATX-DAX	ATX-WIG20	DAX-WIG20
Jan 4, 2000 – Dec 31, 2014	0.592	0.446	0.489
Jan 4, 2000 – Jul 2, 2007	0.403	0.301	0.376
Jul 3, 2007 – Dec 31, 2014	0.758	0.576	0.610

Source: Authors' calculation

To illustrate time-variation in the correlations between the markets, we apply the trivariate DCC-GARCH model of Engle (2002) with multivariate normal distribution. To model the conditional variance of the univariate returns, we apply AR(1)--GARCH(1,1) models with skewed Student's *t*-distribution. These models adequately capture the autocorrelation and heteroscedasticity of daily returns. The time-varying conditional correlations presented in Figure 3 confirm the strong impact of the 2007–2009 crisis on the relationships between the stock markets. During the period before the crisis, the correlations between the index returns varied at around 0.4. After 2008, a shift in correlations to about 0.6–0.8 is observed. At this level, the correlations remained until 2012–2013, when they started to decrease; but even after that, they still remain above the pre-crisis level. As shown in Table 1, the strongest correlations are observed between ATX and DAX for nearly the entire period.

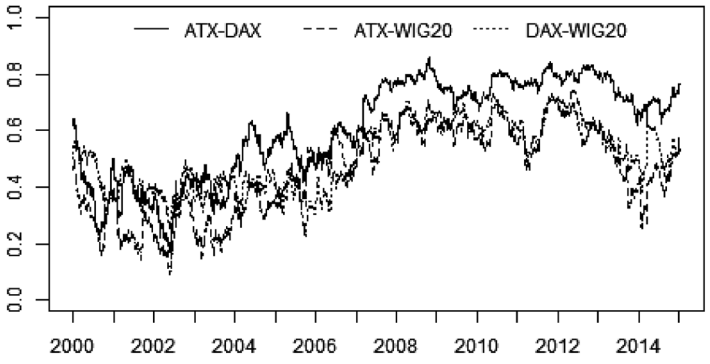


Figure 3. Conditional correlations between ATX, DAX, and WIG20 returns

Source: Authors' calculation

The time-varying correlations presented above between the daily returns of ATX, DAX, and WIG20 give very general information about the strength of the relationships between the indices. The values of both conditional and unconditional correlations indicate rather-strong interdependencies, particularly between the stock markets in Frankfurt and Vienna. As we mentioned in the introduction, there is a fine line between interdependence and the contagion effect, and even a very-strong correlation does not indicate contagion. However, an increase in the correlations induced by the financial crisis may be regarded as an argument in favor of contagion on the daily level.

Analysis of the intraday data leads to similar conclusions about the relationships between the markets. All of the rank correlations of the 5-minute returns reported in Table 2 are significant, varying from 0.173 for ATX-WIG20 to 0.421 for ATX-DAX. Correlations computed on the basis of the intraday data are lower than the correlations of the daily returns. This is once again in line with the literature. As in the case of the daily data, the strongest co-movement is observed between both developed markets while the weakest intraday interrelationships are between them and the WSE. Comparing the results in Table 1 and 2 suggests the similar nature of relationships between the markets irrespective of the frequency of data applied.

Table 2

Spearman correlations between intraday returns of ATX, DAX, and WIG20

ATX-DAX	ATX-WIG20	DAX-WIG20
0.421	0.173	0.292

Source: Authors' calculation

4.2. Spatial contagion

For each pairing of the indices under study, we compute the spatial contagion measure described in Section 2 on the basis of daily data. We restrict the analysis to interval $L = [0.05, 0.3]$. By dividing L equally into 50 subintervals of length 0.005, we consider 51 thresholds $\alpha = 0.05, 0.055, ..., 0.3$. We do not consider lower α to ensure that tail set T_α is non-empty. Analysis of the contagion is performed on the basis of standardized residuals from AR(1)-GARCH(1,1) models with conditional skewed Student's t-distribution computed for daily returns.

The results presented in Table 3 indicate a very-strong contagion between ATX and WIG20, a moderate contagion between ATX and DAX, and a very weak contagion between DAX and WIG20 during the whole period of 2000–2014. To help interpret the values of the contagion measures in Figure 4, we present correlations in tail sets T_α (solid lines) and in central sets M_α (dashed lines) for different α from interval L. For the lowest threshold $\alpha = 0.05$, central set M_α covers almost all of the

data except the most-extreme cases. Thus, the first correlation coefficient on M_α is usually close to the value of the respective Spearman correlation reported in Table 1.

Table 3

Spatial contagion measures between daily returns

Period	ATX-DAX	ATX-WIG20	DAX-WIG20
Jan 4, 2000 – Dec 31, 2014	0.510	0.804	0.294
Jan 4, 2000 – Jul 2, 2007	0.808	0.962	0.385
Jul 3, 2007 – Dec 31, 2014	0.385	0.462	0.269

Source: Authors' calculation

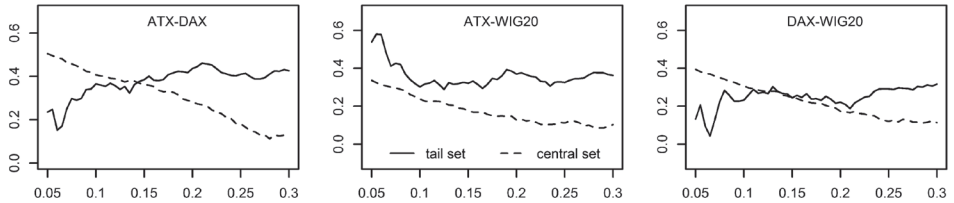
Value 0.804 of the spatial contagion measure for the ATX-WIG20 pair during the whole period means that correlation $\rho(T_\alpha)$ in tail set T_α is significantly greater than correlation $\rho(M_\alpha)$ in central set M_α in about 80% (i.e., 41 out of 51) of threshold values from interval L. These differences between $\rho(T_\alpha)$ and $\rho(M_\alpha)$ are visible in the central graph of Panel A in Figure 3 for very-small α and $\alpha > 0.15$.

For the data from the whole period, the behavior of the correlations between each pairing of indices in the central sets is similar. For each pair of indices, $\rho(M_\alpha)$ decreases from 0.4–0.5 to about 0.1–0.2 as α increases, and sets M_α concentrate around the medians. Differences occur when analyzing the correlations in tail sets T_α. Only in the case of ATX-WIG20 correlations are $\rho(T_\alpha)$ greater than $\rho(M_\alpha)$ for the smallest thresholds α, while the largest drops in ATX or WIG20 are only weakly correlated with very-negative changes in DAX; thus, for these pairs, $\rho(M_\alpha)$ is greater than $\rho(T_\alpha)$ for very small α. This means that only between ATX and WIG20 are correlations for the extreme negative returns (correlations in the left tails) significantly greater than the correlations of the returns around zero. Hence, ATX and WIG20 are more-strongly tied during turbulent times than during calm periods.

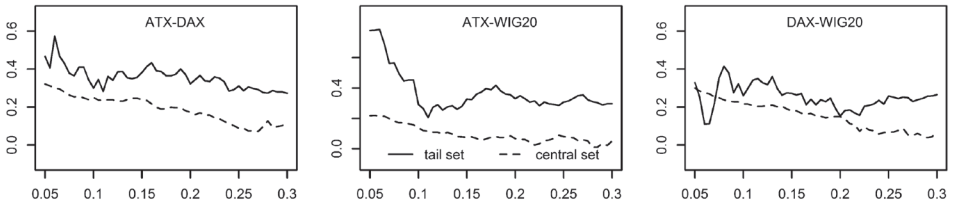
From Table 1 and Figure 3, it follows that interrelations between the markets have strengthened since 2007. To analyze the impact of the financial crisis on contagion, we repeat the above computations in the sub-periods before and after July 2007. When we restrict our attention to the period before the crisis (January 2000 – July 2007; Panel B in Figure 4), we can notice that contagion measures are higher than in the whole period for each pairing of indices. These differences are mainly due to smaller correlations in the central parts of the bivariate distributions of the returns. This is particularly visible when we compare correlations in the central sets on the graphs in Panels A and B in Figure 4. However, in the cases of ATX-DAX and ATX-WIG20, changes in $\rho(M_\alpha)$ are also accompanied by much-higher correlation in the tails, particularly for very-small α. Hence, we can conclude that, before the crisis, there was a contagion effect between ATX and DAX as well as between ATX and WIG20.

The bankruptcy of Lehmann Brothers and the global financial crisis raised correlations between the indices by about 0.1–0.2 (see Table 1). From Panels B and C in Figure 4, it follows that these changes were caused by increased correlations in the central sets and decreased correlations in the tails of return distributions. The change in the dependency between extremely negative returns after 2007 is most-pronounced for ATX-DAX, where the correlation $\rho(T_\alpha)$ for $\alpha = 0.05$ decreases from 0.47 (before 2007) to 0.13 (after 2007). As a result of these shifts in correlations, we observe rather-low values of contagion measures in the period of July 2007 to December 2014. A detailed analysis of the graphs in Panel C in Figure 4 indicates that, for α smaller than 0.15–0.2, correlations in left tail T_α are not significantly greater than correlations in the central sets. Actually, they are even smaller than the respective $\rho(M_\alpha)$, and the values of the contagion measures after the crisis are mainly due to the significance of $\rho(T_\alpha) - \rho(M_\alpha)$ for the largest α from the right-hand side of interval L. Hence, we can conclude that there has been no significant contagion between the markets since the crisis.

Panel A: January 4, 2000 – December 31, 2014



Panel B: January 4, 2000 – July 2, 2007



Panel C: July 3, 2007 – December 31, 2014

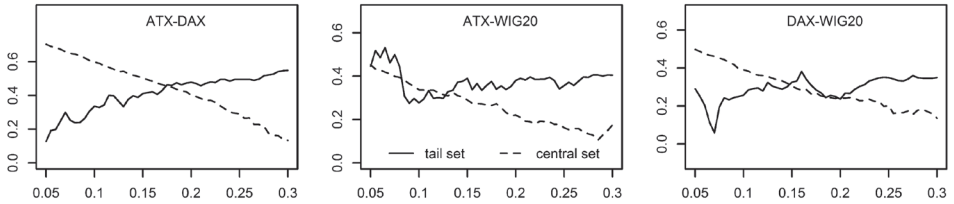


Figure 4. Correlations between ATX, DAX, and WIG20 in tails and central parts of their distributions

Source: Authors' calculation

From the above description, it also follows that the observed differences between the correlations before and after the crisis in the whole sample (and also in large central sets) explain the changes in contagion measures between these two periods. When returns are highly correlated (as in the period after the crisis), there is not enough space for further significant increases in correlation when bad news reaches the markets. This shows that the high correlation of returns and contagion are two distinct notions; in fact, the presence of high correlation actually hinders contagion.

The results from the analysis of changes in intraday co-movement of the markets are reported in Table 4. The values of the spatial contagion measures indicate the existence of strong contagion, particularly between DAX and the other indices. However, a comparison of the graphs in Figure 5 indicates differences in these relations. Values of the correlations between the returns of ATX and DAX in the left tails of their distributions are stable regardless of the value of threshold α, while the correlations between extreme changes of DAX and WIG20 are very low. They are even smaller than the respective correlations in the central sets. In the case of both pairings with DAX, difference $\rho(T_\alpha) - \rho(M_\alpha)$ is insignificant for the smallest thresholds α; i.e., for the most-extreme price declines. These differences become significant for larger mainly due to decreasing $\rho(M_\alpha)$. Hence, the quite-high values of the contagion measures in Table 4 are somehow virtual, because shift in correlation is not observed for the very-extreme changes in the indices but rather for moderate drops.

Table 4

Spatial contagion measures between intraday returns

ATX-DAX	ATX-WIG20	DAX-WIG20
0.902	0.649	0.745

Source: Authors' calculation

A comparison of Table 4 with the results for daily data after the crisis (in Table 3) reveals further differences between contagion measured on the daily and intraday horizon. For example, in the case of ATX-WIG20, the strongest contagion on the daily level is accompanied by the weakest contagion on the intraday level. On the other hand, the strongest contagion between 5-minute data is observed between ATX and DAX, but they show only a moderate contagion on the daily level. This phenomenon is due to the aggregation of information during a trading session. Daily returns are the sum of intraday returns; thus, extreme changes in a very short horizon (caused, for example, by important news) do not necessarily lead to equally strong changes in the daily data. On one market, such an impulse can lead to permanent change in prices (and impact the daily returns) while it may simply disappear on the other

market and leave daily returns unaffected. This shows the difference between the analysis of contagion on the basis of data recorded with different frequency and explains why there is no contagion in the daily data but there is in the intraday returns. The analysis of contagion strongly depends on the investment horizon.

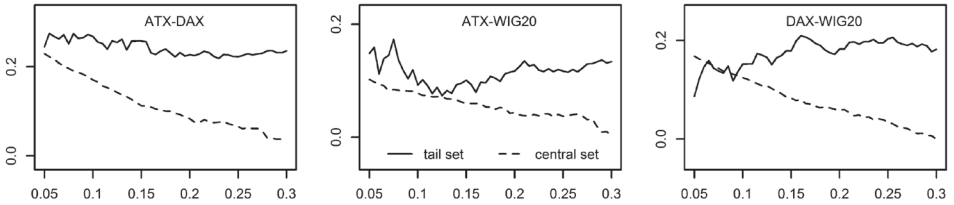


Figure 5. Correlations between 5-min returns in tails and central parts of bivariate distributions

Source: Authors' calculation

4.3. Conditional contagion

To illustrate how linkages between stock markets impact the contagion measure for each pairing, we estimate conditional contagion measures that take into account the situation in the third market. Estimation results for the same set of α as in the previous subsection and for $\alpha_0 = 0.25$ are reported in Table 5[8]. In Panel A, we present the conditional contagion measures between each pairing when the returns of the third market are in tail set T_{α_0}. This corresponds to Formula (7). In Panel B, we report conditional contagion measures when returns of the third market are in their central set M_{α_0}. This corresponds to Formula (8). Additionally, we report (in parentheses) the percentage of rejection of the null hypothesis in tests (9)–(10) that conditional contagion is stronger than the unconditional contagion in Table 3. This allows us to evaluate the impact of the restriction of the data according to the third variable.

First of all, the very-strong impact of DAX on the contagion between ATX and WIG20 should be noted. When we intersect M_α and T_α with the extremely negative returns of DAX, then for the all α form the interval L the correlation between the extremely negative returns of ATX and WIG20 is larger than that of the central set of their distribution. Moreover, in about 63% of the cases, the shift in these correlations in the presence of the extreme values of DAX is significantly greater than without such restrictions. This means that, during a turbulent time on the FSE, the strength of relationships between the extremely low returns of ATX and WIG20 increases more than usual.

[8] We chose this because it is small enough to treat as a tail set. On the other hand, it ensures a sufficient amount of data in the majority of cases.

Table 5

Conditional contagion measures between daily returns

Panel A: Conditional contagion measures when third variable is in tail		
ATX-DAX	**ATX-WIG20**	**DAX-WIG20**
0.510 (0.529)	1 (0.627)	0.078 (0.078)
Panel B: Conditional contagion measures when third variable is in center		
ATX-DAX	**ATX-WIG20**	**DAX-WIG20**
0.274 (0.059)	0.667 (0.235)	0.549 (0.314)

Source: Authors' calculation

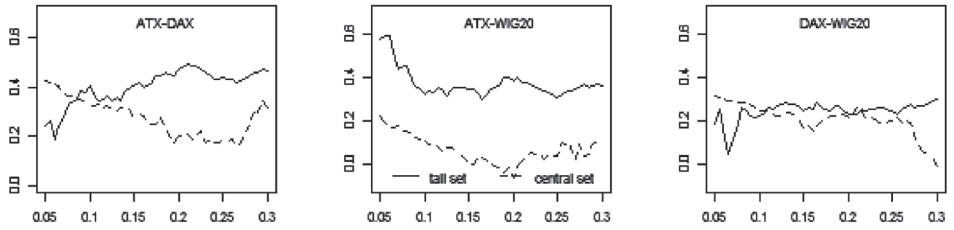
It seems that restricting the analysis to the left tail of WIG20 return distribution has no impact on the contagion measure between ATX and DAX. It is close to the value in Table 3 for the whole sample without restrictions. Also, there is a visible similarity between the left upper graphs in Figures 4 and 6. However, restricting the analysis to very-low WIG20 returns significantly increases the differences between ATX-DAX correlations $\rho(T_\alpha)$ and $\rho(M_\alpha)$ for about 53% of the threshold values; however, as in the case of the whole period, the correlations between the very-extreme loses of ATX and DAX are smaller than the correlations in the respective central sets. This means that the relationssships between the two markets weaken during very-turbulent trading sessions.

Very low conditional contagion between DAX and WIG20 indicates that the relationships of returns in the tail and central part of their bivariate distribution are similar when restricted to the very-low ATX returns. There are no visible differences between the correlations of very-negative returns and returns close to the medians. Thus, big losses on the VSE do not affect the relationships between DAX and WIG20.

Panel B of Table 3 reports conditional contagion measures when returns of the third index are in their central set. These results are heavily biased by the very-small number of observations in the tail sets for very low α (Panel B of Figure 6).

For each pairing, the size of T_α is less than 50 observations for $\alpha < 0.13$. When we consider only those thresholds for which the number of elements inf T_α is greater than 50, the conditional contagion measures are equal to 0.324, 0.358, and 0.429, respectively, and the impact of the third variable on $\rho(T_\alpha) - \rho(M_\alpha)$ becomes insignificant – the null hypothesis in tests analogous to (9)–(10) is not rejected for each α from L.

Panel A: Third variable is in tail set



Panel B: Third variable is in central set

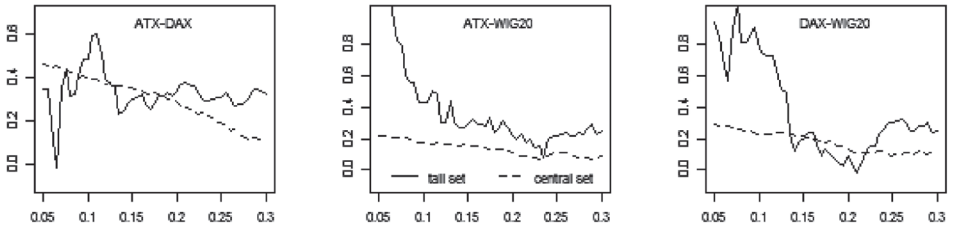


Figure 6. Correlations between daily returns in tails and central parts of their distributions when third variable is also restricted

Source: Authors' calculation

Table 6

Conditional contagion measures between intraday returns

Panel A: Conditional contagion measures when third variable is in tail		
ATX-DAX	**ATX-WIG20**	**DAX-WIG20**
0.823 (0.745)	0.765 (0.137)	0.843 (0.745)
Panel B: Conditional contagion measures when third variable is in central set		
ATX-DAX	**ATX-WIG20**	**DAX-WIG20**
0.235 (0)	0.157 (0)	0.601 (0)

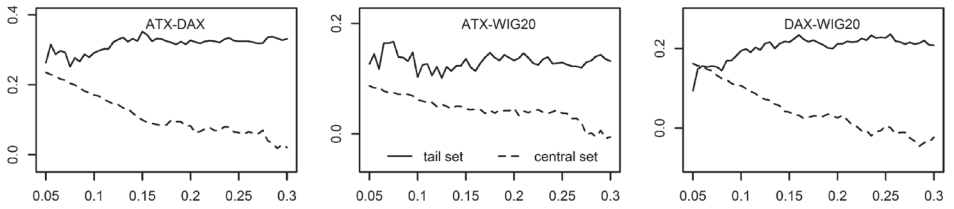
Source: Authors' calculation

Now, let us turn to the conditional measure calculation based on the intraday data. From Table 6, it follows that the intersections of T_α and M_α with the lower tail of the third index rather do not influence the contagion measures. The conditional contagion measures in Panel A of Table 6 are quite close to the spatial contagion measures in Table 4. Also, the graphs in Figures 5 and 7 look very similar. It follows that changes in correlations between each pairing when the analysis

is restricted to the very-low returns of the third index are similar to the changes when the whole sample of the data is taken into account. However, as indicated by the numbers in parentheses in Panel A of Table 6, information about the value of the third index impacts correlations $\rho(T_\alpha)$ and $\rho(M_\alpha)$. The restrictions affect the size of the shifts in the correlations. For example, in the case of ATX and DAX, the null hypothesis in Test (9)–(10) is rejected for about of the thresholds. This means that, for these thresholds when ATX and DAX switch from calm to turbulent times, changes in their correlations are larger when this shift is accompanied by drops in WIG20. A similar result is observed when we consider changes in DAX and WIG20 during a turbulent time on the VSE. In contrast to the results above, information about DAX returns has only a little additional impact on the nature of relationships between the ATX and WIG20 returns. The null hypothesis in Test (9)–(10) is rejected only in about 14% cases for this pair.

In contrast to the results above, restricting the analysis of correlations between each pairing of indices to the central part of the third index leads to weaker dependencies in the tail sets. As a result, there is no visible contagion between the restricted data despite the moderate values of the conditional contagion measures in Panel B. For each pairing, shifts in correlations do not increase significantly when we take into account only data from the third market during calm periods. The null hypothesis in the tests analogous to (9)–(10) is not rejected for any threshold.

Panel A: Third variable is in tail set



Panel B: Third variable is in central set

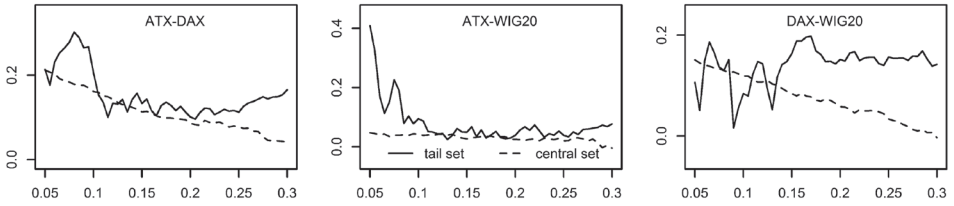


Figure 7. Correlations between 5-min returns in tails and central parts of their distributions

Source: Authors' calculation

5. Conclusions

In this paper, we analyze and compare the relationships between stock markets in Frankfurt, Vienna, and Warsaw. The analysis is performed on the basis of daily data from the period of January 2000 – December 2014 as well as on the basis of 5-minute returns from the period of March 22, 2013 – July 31, 2014. Contagion between these stock markets is examined by means of a spatial contagion measure (Durante and Jaworski, 2010). To describe the impact of each stock market on the relationships between the other two markets, we propose a conditional contagion measure.

Results of the empirical study on the daily basis show a strong correlation (both conditional and unconditional) between the indices under study. When the intraday data from the post-crisis period are considered, correlations are weaker but still significant. The strongest correlation is observed between the indices of the both developed markets in Frankfurt and Vienna irrespective of data frequency.

A further analysis of daily returns indicates strong contagion between both of the smaller markets; namely, VSE and WSE. There is a significant difference in correlations in the left tail and central part of the bivariate distribution of ATX and WIG20 returns. Contagion between the stock markets in Vienna and Warsaw is even more pronounced during turbulent times on the stock exchange in Frankfurt. In the case of contagion with the FSE, no shift in correlations between the central part of the return distribution and its tail is observed for very-extreme loses. This is only significant for larger values of thresholds . The analysis also reveals the significant impact that the 2007–2009 crisis had on contagion. Increased correlations after the crisis reduced contagion between the markets and hindered international diversification.

Contagion between intraday data differs considerable from the contagion for daily returns. For 5 min returns, the difference between correlations in the tails and central parts of the index returns is significant for larger sets of admissible threshold values. Stronger contagion is observed between the ATX and DAX returns. This means that (on the intraday investment horizon) very-bad news implies contemporaneous reactions of a similar strength on both of the developed markets. Additionally, applying the conditional contagion measure shows that the interrelations between each pairing depend on the state of the third market. During a turbulent time on one of the markets, shifts in correlations between the other two are significantly higher than in the whole sample.

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Agricultural income and prices. The interdependence of selected phenomena in Poland compared to EU-15 member states

1. Introduction

In the 1950s and 1960s, Europe entered a period of dynamic development as well as a demographic explosion. High food demand oriented the farming policy of forming the European Economic Community (EEC) toward the increase of agricultural production in order to satisfy the growing demand and achieve food self-sufficiency. This objective was accomplished relatively quickly; therefore, farming incomes became a basic problem for a common agricultural policy (CAP); more precisely, a problem concerning the necessity to increase and stabilize incomes in order to make farming profitable. Thus, the decrease in the significance of agriculture (concerning its share in GDP creation) and, above all, the properties of land (cf. Czyżewski, 2007) and the phenomenon of the outflow of economic surplus from agriculture make farming incomes lower than in other sectors. Furthermore, the process of creating incomes does not always tie in with surplus (Woś, 2004). One should note that, in some highly-developed countries, farming incomes exceed incomes from other businesses. However, this is not caused by the internal efficiency of farming but mainly by intensive support policies. Despite the relative loss of its significance and lively debates concerning its effectiveness and validity (cf. Gąsowski, 2015), agricultural policy still constitutes approximately 40% of the EU budget. The level of farming support in the EU amounts to about 20% (as measured by the Producer Support Estimate (PSE) index), while in Japan, South Korea, and Norway (for instance), it is more than 50% (OECD 2014). However, agricultural incomes remain lower than in the non-agricultural environment in some countries; for example, in the new member states of the EU – like Poland (Baer-Nawrocka, 2013). Therefore, farmers can be considered to be in an underprivileged position.

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Yet, the concept of farming incomes may not be accurate enough. Particular characteristics must be taken into account, including; e.g., farmers seeking employment in other economy sectors and having difficulty keeping the functions of one's household separate (as a place of residence and consumption as well as an agricultural holding as a place of work and source of income). Hence, a single universal measure of farming incomes does not exist. Additionally, the subject matter is further complicated by the fact that farming incomes are influenced by a number of factors, including those connected directly with agricultural production as well as those of an external character. As Polish farming has been included in the CAP mechanisms since 2004, the revenues of agricultural holdings should be expected to improve. According to the convergence hypothesis, one can suppose that such changes in Poland should arise relatively faster than in the member states of the so-called "old EU"; that is, in the EU-15. Hence, the main objectives of the paper are as follows: (1) examination of the level of changes in various types of farming incomes, including the role of payments from the Common Agricultural Policy (CAP) in Poland as compared to the member states of the EU-15; and (2) an analysis of the relationship between price changes (as one of the factors that shapes farming incomes) and agricultural incomes in Poland after 2004. The period of research covers the years 2004 through 2013. The Farm Accountancy Data Network (FADN) is the main source of data. The first part of the paper presents information on the specific nature of the FADN database. The subsequent parts show the data on farming incomes and its relationship to prices with the use of panel regression models. In the case of data concerning incomes (which is used to compare Poland with other countries), the differences in current prices were taken into consideration. It was assumed that the price level for the EU-27 is 1; then, original data was subsequently divided by a coefficient determining the level of prices in an individual country in comparison to the EU average. For instance, that coefficient in the analyzed years was about 0.6 for Poland, while for Denmark, it was 1.35.

2. Propaedeutics of the FADN database

Much significant data on the economic situation of agricultural holdings is provided by the FADN database. It is publicly accessible and contains nearly 150 variables concerning agricultural holdings, including production, revenues, costs, subsidies, and taxes. The collected data widely presents the economic conditions of agricultural holdings. Thanks to the managerial accounting used instead of the financial approach, the data describes the results of agricultural holdings more adequately, since using financial accounting is substantially conditioned by legal regulations that vary in individual member states (IERIGŻ 2015). Furthermore,

the FADN presents data in various sections; i.e., geographical, sectorial, and structural (Goraj, 2000). Therefore, it is possible to check the net income of an average agricultural holding located in Burgundy involved in winemaking, for example. It must be emphasised that the presented data concerns an average agricultural holding and not all agricultural holdings in a given category. However, it is crucial to note the FADN scope of observation only includes economically active farms. The potential of a farm is measured by its economic size. Since 2009, the economic size of an agricultural holding is measured by the total SO coefficient (expressed in Euros). The Standard Output (SO) is the average monetary value of the agricultural output at farm-gate price of each agricultural product (crop or livestock), with some exceptions. Prior to 2009, the economic value was measured by the Standard Gross Margin (SGM). The concept of that measure was similar; however, its formula was slightly more-complicated. Nevertheless, all of the data in the FADN database since 2000 has been recalculated according to the new methodology.

The aim of the FADN research is to study at least 90% of all standard output in the EU member states' agriculture. The highly diverse farming structure of individual member states results in a different threshold of economic size required for an agricultural holding to be included into the FADN research for each country. In countries such as Belgium, France, Germany, or the Netherlands, this threshold is fi25,000. However, in countries that are characterized by a low concentration of arable land and where most of the production is provided by small and very-small farms, the threshold for being included in the research is much lower (out of necessity). This is, for instance, fi4000 for Poland, while for Bulgaria and Romania, it is only fi2000 (European Commission http://ec.europa.eu/agriculture/rica/methodology1_en.cfm). A large number of small farms are not only characteristic of the new member states but also of Mediterranean countries. For Italy, Spain, Greece, or Portugal, the aforementioned threshold is as low as Poland's (fi4000).

The nature of the farm structure in individual countries determines not only their varied thresholds of the FADN field of observation but also the extent of research in the farming area, labor input, or even number of agricultural holdings. For instance, nearly half of the farms are being studied in Poland compared to only 37% in Portugal. In turn, in countries dominated by big farms, this number rises to 60% or even 70% (e.g., Belgium, the Netherlands, and Ireland). Noticeable differences among the analyzed countries are also outlined including the labor input covered by the research. In Portugal, only 53% of the AWU labor force input (Annual Work Unit – means a person employed full-time; in Poland, this amounts to 2120 hours per annum) fell under the scope of FADN observation (in Poland and Finland, this was 68% and 90%, respectively. This shows that not only are there many small farms in Poland and Eastern European countries but also that the labor force input is significantly high. However, lesser differences are

noticeable as far as the field of observation of arable land is concerned. In Poland, this is 85%, while in Denmark (for example), this amounts to 96% (source: European Commission http://ec.europa.eu/agriculture/rica/methodology2_en.cfm). Therefore, a valid conclusion is that there are many small farms in Poland, and the total area on which they operate is also small. Among the agricultural holdings included in the FADN observation, a representative sample has been chosen. Importantly, the method of sampling is stratified (multidimensional). This means that the representative sample must include farms representing all kinds of production within a specified region and an economic size category (if possible).

3. Agricultural incomes in Poland compared to EU-15

As mentioned in the introduction, the specific nature of agricultural incomes allows us to present them using several categories. The FADN database presents many measures of agricultural incomes, among which we can list gross income (gross added value), net value added, and the income of a family-run agricultural holding. The most-basic category (as well as the simplest) is gross income, which is calculated by subtracting the amount of indirect use from the total level of production. The difference is then adjusted by the balance of subsidies and taxes relevant to the current business operations. Data concerning the shape of gross income in an average FADN agricultural holding in Poland and in the member states of the EU-15 is presented in Table 1.

Despite the fact that the differences of prices (see Table 1) were taken into consideration, agricultural incomes (gross incomes) in Poland remain much lower when compared to countries such as Belgium, Denmark, the Netherlands, or the United Kingdom. Gross income in an average Polish FADN farm reaches fi29,100, while in the above-mentioned member states, this exceeds fi100,000. The highest is in the Netherlands – it reaches fi182,700. However, the income of a farm in Poland was higher than in Portugal and Greece and only slightly lower than in Italy (fi33,300). One must remember, however, that the data in Table 1 concerns an average agricultural holding within the field of an FADN observation, and as it is widely known that the average size of such farms is much lower in Poland and eastern Europe than in Western Europe. If big farms were included (e.g., an economic size of fi100,000 to 500,000), the gross income of Polish farms would not deviate from the average (Czyżewski and Kryszak, 2015a). Taking these constraints into consideration, more-significant questions concerns the tendency of changes in incomes in Poland compared to the member states of the EU-15 as well as the issue of whether the rate of these changes in Poland is higher. In 2013, gross income (nominal approach) was higher by 42% than it was in 2004. A higher increase was noted only in Denmark (104%), Germany (51%), and the Netherlands (57%). However, this information

must be approached with caution. Agricultural incomes are unstable by nature, and they do not grow linearly. For instance, in the case of Poland, the lowest income in the analyzed period was fi19,000, and that value was noted in 2005; however, the highest income was found in 2012 (fi29,600). Comparing two particular years is not fully justified, especially in the case of Poland, Denmark, Sweden, and the United Kingdom (where changes of exchange rate are an additional factor). Nevertheless, an increasing tendency in gross incomes can be observed in the analyzed period of ten years. These incomes grew on average by 4.7% year-to-year while the average value of the HCPI (Harmonised Consumer Price Index) was 2.8% per year during the same period. An average rate of gross income growth in Poland was higher by approximately 1 percentage point than the average for the examined member states. On the other hand, one must remember that incomes grew even more rapidly in Denmark, Germany and the Netherlands, for example – countries where incomes were high already at the beginning of the research period.

Another important category concerning agricultural incomes is net income, which is regarded as the income of a family-run agricultural holding as it represents the payment for privately owned resources involved in the production of and for the risk connected with farming. This income is calculated by subtracting depreciation from gross income (the result is the net added value) and the cost of external factors. Next, the balance of subsidies and taxes concerning investment activity is added. Thus, this category is similar to disposable income (Czyżewski and Kryszak, 2015a). Table 2 includes the data in this category.

The income of a family-run farm in an average Polish agricultural holding was fi17,200 in 2013; although this was relatively low, it must be stressed that it was higher than in Greece and Portugal as well as in Sweden and Finland. The level of net income of agricultural holdings in individual countries differed significantly.

In Sweden, this type of incomes barely reached fi12,000, and in the Netherlands, it was up to fi61,200. Again, these rate of change must be closely studied, because the differences in income levels depend on the size of the farms. In 2013, the net income in Poland was 37% higher than it was in 2004. The fluctuations of incomes of family-run farms must be regarded as stronger than in the case of the gross income. During the entire period of research, the income of family-run agricultural holdings in Poland grew annually by 6% on average; however, in other analyzed countries, the situation was highly diverse. It is worth remarking that net income grew rapidly in Germany and the Netherlands (each with a high original level of income per farm) but also in Sweden where incomes were highly unstable. Such important changes in income in this latter country can be explained to some extent by the fluctuations of currency exchange rates (Swedish Krona to EUR). However, we must remember that instability of income also concerns many other countries where the Euro is the official currency.

Table 1

Gross income and its changes over time, including differences in prices in FADN agricultural holdings in Poland and member states of EU-15 (in thousands of Euros) in 2004–2013

Country	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2013/ 2004	Average year-to-year change
Belgium	83.2	83.9	89.8	96.7	83.9	85.0	109.8	100.3	111.9	108.6	31%	3.6%
Denmark	74.8	83.6	92.9	103.3	94.5	85.0	122.2	138.1	154.6	152.6	104%	9.2%
Germany	80.6	81.6	87.5	101.0	85.1	83.4	101.3	104.1	118.2	121.4	51%	5.2%
Greece	20.5	22.6	22.2	22.4	21.1	20.4	21.1	19.8	19.9	19.7	-4%	-0.3%
Spain	38.2	31.8	35.7	42.4	39.6	32.8	34.7	34.3	34.9	35.1	-8%	-0.3%
France	70.6	71.2	75.5	87.4	79.2	67.5	91.0	95.7	96.8	86.6	23%	3.2%
Ireland	24.4	24.1	25.5	29.4	26.8	18.8	26.3	31.6	34.5	33.6	38%	5.3%
Italy	29.8	30.6	31.7	36.4	34.4	35.2	35.0	35.4	35.6	33.3	12%	1.4%
Luxemburg	80.7	79.3	82.8	96.3	92.6	73.8	79.1	102.9	103.7	99.7	24%	3.2%
Netherlands	116.3	122.6	138.0	148.0	140.8	138.6	178.5	164.9	187.0	182.7	57%	5.7%
Austria	41.0	40.6	41.9	47.3	47.2	39.2	39.5	44.3	44.2	43.8	7%	1.1%
Poland	20.5	19.0	21.3	26.0	22.5	21.1	26.7	29.0	29.6	29.1	42%	4.7%
Portugal	17.4	17.7	19.7	20.6	21.4	20.7	22.7	22.5	23.6	24.7	42%	4.0%
Finland	40.7	40.4	40.9	51.3	47.2	42.0	50.4	48.9	48.9	44.9	10%	1.8%
Sweden	43.9	47.6	47.1	60.1	59.0	40.5	52.8	56.5	60.7	58.4	33%	4.8%
United Kingdom	74.2	79.6	81.8	97.2	93.0	95.3	104.2	114.4	107.0	105.5	42%	4.3%

Source: Authors' calculations on the basis of FADN and Eurostat (prices levels) databases from 2004 to 2013

Table 2

Incomes of family-run agricultural holding (net) and changes in them over time, including differences of prices in FADN farms in Poland and member states of EU-15 (in thousands of Euros) from 2004 to 2013

Country	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2013/2004	Average year-to-year change
Belgium	43.0	44.5	49.7	52.9	39.2	36.9	59.1	46.8	58.1	52.3	22%	5%
Denmark	4.7	11.3	15.0	1.9	–38.4	–33.7	6.8	23.2	46.1	43.8	832%	–201%
Germany	28.2	28.6	31.8	42.6	26.3	21.6	35.1	36.7	46.5	47.5	69%	10%
Greece	14.8	16.5	16.4	16.7	15.2	14.1	15.1	13.2	12.9	12.6	–15%	–2%
Spain	28.5	22.5	27.0	31.9	27.7	21.3	23.6	23.5	23.3	24.2	–15%	–1%
France	26.9	26.8	30.4	39.5	30.8	16.0	39.0	42.3	42.3	28.5	6%	10%
Ireland	14.7	15.1	14.9	18.2	15.5	13.6	15.7	21.8	20.6	20.0	36%	5%
Italy	19.3	20.2	21.0	24.8	21.5	22.1	22.5	22.3	22.4	20.6	7%	1%
Luxemburg	33.7	32.9	34.8	44.2	36.4	21.4	22.1	42.7	31.6	37.2	10%	7%
Netherlands	28.6	37.3	45.1	44.1	28.9	20.6	54.0	36.9	60.5	61.2	114%	20%
Austria	22.6	22.2	23.7	28.1	28.2	20.0	21.2	27.2	25.1	23.4	4%	2%
Poland	**12.5**	**10.5**	**12.8**	**16.7**	**12.1**	**11.3**	**16.8**	**18.5**	**18.6**	**17.2**	**37%**	6%
Portugal	9.6	10.2	12.3	12.7	13.7	13.5	15.4	15.3	16.1	17.0	77%	7%
Finland	17.7	17.1	15.5	22.5	17.1	12.7	20.2	18.1	18.2	14.5	–18%	1%
Sweden	4.4	9.8	7.1	20.9	22.4	4.9	13.6	13.1	12.4	12.0	173%	43%
United Kingdom	25.1	29.4	30.6	43.6	43.2	41.4	49.9	57.9	45.9	42.2	68%	7%

Source: Authors' calculations on the basis of FADN and Eurostat (prices levels) databases from 2004 to 2013

Quick changes in income going in different directions cause problems in carrying out long-term analyses; as a result, the cognitive value is limited. A question arises: why do agricultural incomes (regardless of the adopted measurement category) vary so widely despite a common agricultural policy? If this policy is supposed to be of a pro-income and stabilizing character (cf. Deluga, 2014), one should think that, in times of decreased farm incomes, the role of union payments and the institutional framework for agriculture in general should be greater. Hence, we should examine which part of the net income comes from the balance of subsidies and taxes connected to a farm's current operations (Table 3).

In Poland, the balance of subsidies and taxes connected with the current operations represented 31% and 75% of the income of family-run farms in 2004 and 2009, respectively. During the whole analyzed period, this represented 50% on average. The scale of dependence on subsidies in Poland can be considered moderate compared to the other EU-15 member states. The relatively low level of dependence of Belgian and Dutch agricultural holdings (42% and 33% on average, respectively) is worthy of attention, since the high efficiency of farms in these countries is evident considering their high incomes. On the other hand, the fact that the balance of subsidies and taxes of current business in countries like Germany, Finland, and Sweden exceeds 100%, which means that farming production in these regions would become unprofitable without agricultural subsidies.

Based on the data from Tables 3 and 4, the claim concerning the stabilizing role of union payments can be confirmed. In most of the countries, the year with the lowest farm income was the year in which the balance of subsidies and taxes related to their current activity was the highest. This was particularly true in 2009 when the financial crisis developed; the agricultural sector suffered greatly then. It can be stated that, if not for the payment system, the fluctuation of agricultural incomes would have been even greater. On the other hand, the fact that there is such a strong correlation between farming production and subsidies is alarming. It is also an argument against the industrial model of farming development. It can be noticed that even big and very-modern French or German agricultural holdings are not able to function independently[1].

Finally, one more question remains considering agricultural incomes: is the relative weakness of Polish and Mediterranean farming caused only by their less-efficient economic structure or is it conditioned by the smaller average area? To answer this question, it is reasonable to present the data concerning the income of family-run farms in Poland and the member states of the EU-15 per hectare of arable land – again, taking into consideration the differences in prices (Table 4).

[1] It is worth mentioning that, nowadays, the problem of risk and instability in the farming business has become significant and was included among the problems covered by the CAP reform after 2013. Mutual funds can be mechanisms used to limit the risk, and they often do not operate for profit. They operate successfully in the Netherlands (Sulewski et al., 2014).

Table 3

Balance of subsidies and taxes connected with current operations as percentage of income of family-run agricultural holding (including differences in prices level) from 2004 to 2013 (%)

Country	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Average
Belgium	36	35	37	39	53	57	38	46	37	40	42
Denmark	391	166	140	1225	−61	−70	332	104	52	54	233
Germany	97	98	100	76	120	156	102	97	76	73	100
Greece	40	38	48	44	52	54	51	54	52	56	49
Spain	28	36	31	25	36	47	49	49	48	46	39
France	87	91	84	65	82	157	67	62	61	88	84
Ireland	96	99	105	92	107	115	109	78	92	89	98
Italy	27	28	29	22	22	23	23	23	22	25	24
Luxemburg	105	108	111	90	110	186	187	120	167	122	131
Netherlands	22	23	27	28	45	68	27	43	25	20	33
Austria	87	91	85	68	68	98	86	61	65	71	78
Poland	31	35	47	38	60	75	55	52	49	57	50
Portugal	63	62	53	52	49	54	50	49	50	51	53
Finland	201	218	230	176	238	311	209	226	228	277	232
Sweden	547	254	388	139	131	617	220	234	236	247	301
United Kingdom	141	129	126	89	90	106	80	66	80	89	100

Source: Authors' calculations on basis of FADN and Eurostat (prices levels) databases from 2004 to 2013

Table 4

Income of a family-run farm (net income) per hectare of arable land in FADN agricultural holdings in Poland and EU-15, including differences of prices

Country	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2013/2004	Average change year to year
Belgium	1.05	1.08	1.20	1.22	0.89	0.78	1.22	0.97	1.18	1.06	1%	3%
Denmark	0.06	0.14	0.18	0.02	-0.42	-0.36	0.07	0.24	0.48	0.45	650%	–203%
Germany	0.38	0.37	0.41	0.54	0.34	0.25	0.41	0.43	0.54	0.55	45%	8%
Greece	1.98	2.07	2.09	2.20	2.02	1.72	1.78	1.46	1.39	1.35	–32%	–4%
Spain	0.84	0.67	0.76	0.88	0.74	0.59	0.65	0.64	0.61	0.62	–26%	–2%
France	0.34	0.33	0.37	0.47	0.36	0.19	0.45	0.48	0.50	0.33	–1%	9%
Ireland	0.35	0.36	0.33	0.40	0.34	0.31	0.36	0.50	0.41	0.39	11%	3%
Italy	1.27	1.29	1.30	1.68	1.45	1.33	1.42	1.40	1.46	1.32	5%	1%
Luxemburg	0.50	0.46	0.46	0.58	0.48	0.27	0.28	0.54	0.37	0.47	–5%	6%
Netherlands	0.94	1.23	1.44	1.30	0.86	0.58	1.49	1.01	1.70	1.77	87%	19%
Austria	0.74	0.70	0.77	0.91	0.90	0.62	0.68	0.89	0.80	0.72	–2%	1%
Poland	0.80	0.61	0.74	0.91	0.62	0.61	0.91	1.00	0.99	0.90	13%	4%
Portugal	0.40	0.43	0.50	0.50	0.54	0.52	0.63	0.61	0.67	0.67	66%	6%
Finland	0.38	0.35	0.31	0.44	0.33	0.24	0.37	0.33	0.33	0.26	–32%	–1%
Sweden	0.05	0.11	0.08	0.23	0.25	0.05	0.14	0.13	0.12	0.12	134%	41%
United Kingdom	0.18	0.20	0.21	0.28	0.29	0.26	0.32	0.37	0.28	0.25	45%	6%

Source: Authors' calculations on basis of FADN and Eurostat (level of prices) databases from 2004 to 2013

In 2013, the income of a family-run farm per hectare of arable land on Polish farms reached fi90 on average. During the whole analyzed period, this was the highest in 2011 – reaching fi1000. Interestingly, net incomes per hectare were higher only in four EU-15 countries; these were Belgium and the Netherlands (countries with modern agriculture and relatively big farms) and also Italy and Greece (where the income per agricultural holding was relatively low). It appears that the income efficiency per hectare is relatively high in these countries (as well as in Poland).

Denmark is also an interesting example of where the gross income of farms is high while net income (family-run farm) (including per hectare) is low. This is caused by the very high costs of external production factors (e.g., rent, interest, non-family member employees). These costs in Denmark are so high that the net income in this country was negative in 2008 and 2009.

On the basis of the data above, one should not jump to the conclusion that enlarging the farming area of farms in Poland, Greece, or Italy would automatically cause proportional (and significant) growth of income per farm. It should be noted that the growth of area of farms can contribute to increased external costs (e.g., the need to employ workers). Then, the gross income of a farm can grow significantly while the income of a family-run farm grows to a lesser extent or remains stable.

4. Relationship between prices, subsidies, and agricultural incomes in Poland

On the basis of the thoughts above, a follow-up question arises: why are agricultural incomes subject to significant fluctuations despite the existing policy? There are a number of factors that shape the level of income, both on the micro and macro levels. In the long term, one may indicate the role of productivity growth. Otherwise, we can list determinants such as interest rates, wages, and salaries in economy, global trade distortions, etc. However, when it comes to yearly fluctuations, prices are the factor shaping this situation; therefore, the relationship between the changes in price and income of farms are worth tracking in the example of Poland. To do so, net agricultural income (translated into Family Work Unit – FWU, which means the number of family members employed full-time) was compiled with the price gap index in the panel regression model. The price gap refers to an index representing the relationship between the prices of goods sold by farmers and the prices of goods that they buy. These are expressed in the form of indexes, so a level above (or below) 100 shows that the price rate has changed in favor of (or against) farmers as compared to the previous period. To check the robustness of our model, an extra variable is added in the second step:

the balance of subsidies and taxes per hectare (also in index form). Therefore, we may check how the sensitivity of changes in income is shaped as compared to the changes in the price gap and subsidies. Firstly, a panel regression model for 16 countries is computed (EU15 and Poland). Then, the whole group is divided into two smaller groups: countries with higher-than-average agricultural net income per farm (for 16 countries) and the second with lower-than-average values. The equations is as follows:

$$NI_{it} + PG_{it} + \beta' x_i + \lambda' x_t + u \tag{1}$$

where:

– i denotes the country,
– t denotes the year,
– NI denotes net farm income per Family Work Unit (index, previous year =100),
– PG denotes price gap (index),
– β' is a vector of dummy variables for countries,
– λ' is a vector of dummy variables for years,
– u is a random error

and in the second step:

$$NI_{it} + BS_{it} + \beta' x_i + \lambda' x_t + u$$

where BS denotes the balance of subsidies and taxes per hectare (index, previous year =100).

Ordinary least squares (OLS) basic models were computed. Then, we computed panel models with fixed and random effects (FE and RE, respectively). The evaluation regarding the suitability of the models was examined by the Breusch-Pagan (BP) and Hausman tests. The BP is useful when comparing OLS and panel models. The Hausman test indicated which panel model was more appropriate (FE or RE). The final models were computed taking into account of the Beck–Katz robust standard errors (PCSE) (Table 5).

In nearly all the cases, the OLS model proved to be valid (however, we decided to include also of the appropriate panel models). This means that, among the countries studied, there was no significant individual effect, and the data used could be interpreted as cross-sectional. As for the models with price gap as the only variable, it can be said that the changes in price relations influence changes in agricultural income in a statistically significant way, but the marginal effect is stronger for those countries with relatively lower income per farm.

Table 5

Effect of changes in balance of subsidies and taxes and price gaps in changes in Farm Net Income/FWU[a]

Group of countries	UE15	UE15	8 countries	8 countries	7 countries	7 countries
Model type	OLS	RE	OLS	RE	OLS	RE
Changes in net income/FWU vs. price gap						
Number of observations	135	135	**72**	72	**63**	63
Constant	**−211.801***** (69.930)	−211.801*** (69.930)	**−175.619**** **(57.540)**	−175.619*** (57.540)	**-284.439*** **(137.697)**	−280.957** (138.361)
Price gap	**3.222***** (0.6923)	3.222*** (0.693)	**2.841***** **(0.571)**	2.841*** (0.571)	**3.976**** **(1.392)**	3.945*** (1.398)
Breusch-Pagan or Hausman test p value	0.57	0.95	**0.15**	0.64	**0.84**	0.57
Changes in net income/FWU vs. price gap and balance of subsidies and taxes per hectare index						
Number of observations	**135**	135	72	**72**	**63**	63
Constant	**−250.586***** **(68.0474)**	−250.586*** (68.0474)	−231.583*** (69.1912)	**−231.583**** **(0.0008)**	**−308.352*** **(136.677)**	−306.682*** (137.670)
Price gap	**3.168***** **(0.698)**	3.168*** (0.698)	2.731** (0.564)	**2.731***** **(0.564)**	**3.964**** **(1.391)**	3.913** (1.398)
Balance of subsidies and taxes per hectare index	**0.432 (0.285)**	0.432 (0.285)	0.656 (0.518)	**0.656 (0.518)**	**0.245 (0.214)**	0.277881 (0.219)
Breusch-Pagan or Hausman test p value	**0.54**	0.99	0.07	**0.82**	**0.80**	0.58

Source: Authors' calculations on basis of FADN and Eurostat databases

[a] As an outlier, Denmark was excluded from the models. The group of 8 countries consists of Belgium, Germany, Spain, France, Luxembourg, the Netherlands, Austria, and the United Kingdom. They have a net income higher than average in the whole group. The group of 7 countries consists of Greece, Ireland, Italy, Poland, Portugal, Finland, and Sweden. *, **, and *** denote 10%, 5%, and 1% significance levels, respectively; standard deviations in parenthesis.

One should remember that these are usually countries with more-fragmented (and thus, economically weaker) agriculture. The models indicate that this structure is conducive to instability in the agricultural sector, which, in turn, is one of the basic risks in agriculture. The inclusion of a further variable (which is the index of change in the balance of subsidies and taxes in agriculture) makes that marginal effect of price gap on incomes decrease only slightly, and its statistical significance is preserved.

This confirms the existence of the relationship between fluctuations in incomes and volatility of price relations. The index of the balance of subsidies and taxes was statistically insignificant in all models; however, when comparing OLS models, the marginal effect was stronger for countries where income per farm is relatively high. This corresponds with the earlier conclusions concerning high dependence of farm incomes on the payment system in the developed countries.

When analyzing these models, one should be cautious. Their ability to explain changes in the income index is relatively small. It is known that agricultural incomes depend on a number of other factors that were not included, such as productivity, interest rates, the level of unemployment in other sectors of the economy, etc. However, our main goal was to highlight the relationship between price gap and income changes. The set of potential factors influencing farm income also depends on the adopted research perspective: micro- or macro-economic. In this first approach, one could go as far as to completely ignore the impact of price relations when looking for a pattern of growth of single-farm income. This requires the assumptions of perfect competition in which a single farm is a price-taker and, therefore, has no effect on the market price level. In the macro perspective, one can turn to studying the reactions of agriculture in changing fiscal policy or monetary policy options (Czyżewski and Kułyk, 2010). However, if the changes in income (indexes) are tested, the price gap remains one of the most important factors influencing this variability. The purpose of the construction of the abovementioned models was, thus, to verify the occurrence of this dependence.

5. Conclusions

This paper analyzes various phenomena concerning agricultural incomes and the correlation between them and price relations. On the basis of the information presented above, the following conclusions can be made:

– agricultural incomes per farm in Poland (gross as well as net) remain significantly lower compared to most member states of the EU-15; in all countries, the characteristic feature of farming incomes is their instability, especially in the net approach; attention should also be paid to the fact that agricultural

incomes in Poland demonstrate an upward trend (higher than the average in the examined group), though agricultural income increases relatively quickly in countries with highly efficient farming;
– the instability of agricultural incomes is connected, among other things, with the change of the price relations; these relations strongly influence the changes in farm net income; however, the marginal effect is stronger in countries with smaller farms and, thus, smaller income per farm;
– during times of lower agricultural incomes due to the deterioration of price relations, for example, the subsidies of CAP have a stabilizing role. In these times, their share in incomes tends to be higher; however, the share of subsidies in the incomes of Polish farms remains relatively low;
– the efficiency of Polish farms conceived as their ability to create net income (per hectare) is one of the highest among the studied countries; hence, it seems that the best way to strengthen the economic potential of Polish farms and partly to become more independent from price fluctuations is to enlarge their area; however, enlarging farms can lead to the growth of costs of external factors and to the emergence of negative effects concerning the natural environment.

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Multi-criteria decision methods for CSR management – literature review

1. Introduction

Contemporaneously, a company's overall aspirations are comprised of a wide set of financial and non-financial goals. Managers striving for a firm's value creation face the challenge of aligning the conflicting goals of multiple stakeholders to maintain the firm's legitimacy to operate. Corporate Social Responsibility (CSR) is a concept that underlies a multi-pillar strategy where many quantitative and qualitative objectives of multiple stakeholders lever a company's success. CSR refers to the totality of a corporation's financial, social, and environmental performance in conducting its business. In the last decade, much has been done to make CSR practices accountable and transparent. However, even though numerous standards had been developed to support Corporate Social Responsibility, the need for tools and techniques necessary in improving managerial decision-making is urgent. Research into operations provides many interesting insights into multiple-criteria decision-making (MCDM) and multi-attribute decision tools, which then enhance decision rationality under circumstances where a number of heterogenic objectives must be achieved. The most-popular multi-criteria decision tools include AHP, PROMETHEE, ELECTRE, TOPSIS, and their families. The purpose of this article is to investigate if and how MCDM tools can be harnessed to operationalize CSR. Consequently, the financial and non-financial goals of enterprises are deliberated with respect to how goal-setting affects management practices. The method applied in the article is a systematic international literature review. The paper aims at detecting the main strands of the literature and their findings, which should inspire further research.

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2. Financial goals and value creation

The purpose of this section of the paper is to demonstrate a variety of approaches towards corporate financial performance in the context of value creation being a business goal. Advantages and limitations of value-based management (VBM) are presented, and the main approaches to VBM are briefly discussed.

Many believe that the sole responsibility of a business is to make a profit. The maximization of financial efficiency is considered to be the primary goal of an enterprise within the theory of corporate finance (Venanzi, 2012). In this case, financial goals constitute a common denominator for the evaluation of a firm's outcomes; by this, the integrity and purposefulness of a firm's management are safeguarded. Financial-goal orientation determines the related decision-making. However, as to how the financial goal is expressed and organized is of no importance from the perspective of a firm's financial and non-financial outcomes.

It is recognized that Economic Value Added (EVA) is the best available metric for measuring a firm's value. The basic formula for EVA is:

Formula 1.

$$EVA = (ROIC - WACC) \cdot IC$$

where:

ROIC – return on invested capital (EBIT/IC),
WACC – weighted average cost of capital,
IC – invested capital (total assets – current liabilities).

The important advantages of EVA are:

- the focus is on the value created for residual stakeholders (namely shareholders), which additionally brings in the ethical perspective;
- it incorporates the complexity of maximizing the net present value of the firm into a measure that can be used to evaluate current-year performance;
- it illuminates the causes for changes;
- it takes the level of risk into account (by referring to WACC);
- it eschews market inefficiency influence;
- it is a result of interrelated models of investment decisions: shareholders' decisions on investing in a company's stock with the expected risk-return profile of investment and a manager's decision to invest accumulated capital in tangible and intangible assets.

Other financial measures (for example, traditional income measures and earnings per share) are known from their significant drawbacks and offer an

unreliable guide to 'shareholder value creation.' Therefore, they will not be discussed in this paper.

Value Based Management (VBM), where the focus is on a firm's value maximization, is widely believed to be the most-matured managerial approach within financial management (however, it should be stressed that, in any case, metrics are the means and not the goal of a VBM). Informative definitions of VAB are presented in Table 1.

The provided definitions of VBM highlight the following facets of VBM: the objective of management (creating value for shareholders), means (measuring, controlling), time scope (long-term, where short-term and medium-term goals are taken into consideration), transparency (measures), and finally the objective of VBM (reducing agency costs).

Table 1

VBM definitions

No.	Definition	Authors
1	Value-based management is a management control system that measures, encourages, and supports the creation of net worth	Ameels et al., 2002
2	The value-based management approach builds on the preceding practices to provide an integrated framework for measuring and managing businesses, with the explicit objective of creating superior long-term value for shareholders	Ittner and Larcker, 2001
3	Value-based management systems (VBM) provide an integrated management strategy and financial control system intended to increase shareholder value by mitigating agency conflicts.	Ryan and Trahan, 2007

Source: Author's own elaboration

VBM frameworks generally include six basic steps (Ittner and Larcker 2001):

– choosing specific internal objectives that lead to the shareholder's value enhancement;
– selecting strategies and organizational designs consistent with the achievement of the chosen objectives;
– identifying the specific performance variables, or "value drivers," that actually create value in the business given the organization's strategies and organizational design;

– developing action plans, selecting performance measures, and setting targets based on the priorities identified in the value-driver analysis;
– evaluating the success of action plans and conducting organizational and managerial performance evaluations;
– assessing the ongoing validity of the organization's internal objectives, strategies, plans, and control systems in light of current results, and modifying them as required.

The framework of VBM presented above eventually sheds light on both tangibles and intangibles being "value-drivers." The set of value-drivers as well as their importance is usually recognized under strategic planning. Harnessing value drivers requires the development of action plans and selection of performance measures appropriate for each value driver. A balanced scorecard is a popular and useful method for mapping interrelated quantitative and qualitative factors affecting a firm's value. It allows for mixing and linking financial and non-financial data items.

Under VBM, diverse monitoring and incentive mechanisms are used to align divergent interests between shareholders and managers. VBM should be acknowledged not only as a financial control system but also as a corporate governance mechanism as well.

Financial management focused on value-creation benefits from very-well-developed, sophisticated, and goal-oriented tools. The financial toolkit includes planning, evidence, analysis, and controlling within numerous fields: capital structure, asset management, liquidity, profitability, risk management, tax planning, etc. The comprehensive architecture of decision support comprises data-driven and model-driven decision support in VBM (Hahn and Kuhn, 2012). VBM should lead to improved decision-making within the company with respect to decisions made at different levels of an organization.

VBM is not an ideal solution; its shortcomings include (Kasiewicz, 2009):

– difficult forecasting;
– significant difficulties in the accurate estimation of WACC;
– difficult translation of metrics covering intangible value drivers (i.e., customer value) onto financial metrics;
– managerial costs of implementing VBM;
– complicated implementation of VBM and its tools;
– difficulties in balancing short-term objectives and long-term value creation;
– incomplete link to the realm of capital markets;
– managers may be over-incentivized towards value-creation;
– risk-management structure is unformed.

The number of listed disadvantages are related to decision-making when intangibles play a role. The totality of the mentioned disadvantages of VBM to-

gether with the inappropriate approach of managers (lack of corporate-culture development, short-termism, focus on inappropriate measures, neglecting important value-drivers) cause VBM not to be applied as comprehensively as suggested in the normative literature. In practice, VBM is by no means a heterogenic phenomenon. In some organizations, the application of VBM is restricted only to the highest levels of hierarchy, whereas it covers the whole organization in others (Malmi and Ikäheimo, 2003). Institutions (particularly, the intra-organizational process by which the institutionalization of management accounting systems shapes organizational change) play a significant role as contingency factors for VBM's impact on a firm's performance (Firk et al., 2016). External institutions constituting part of the business environment affect VBM adoption and its effects (Lueg and Schäffer, 2010). The cognitive styles of CFOs (educational background in business) have a substantial impact on VBM-sophistication (Burkert and Lueg, 2013). Other VBM contingencies suggested in the literature include agency conflicts (Karlik et al., 2016) and uncertainty or strategy (Chenhall, 2006). Therefore, it is possible to offer a number of classification criteria for VBM.

For the purpose of the study, it is important to focus on how the role of financial performance is approached as a value to be created and distributed by the company. Such approaches may differ; therefore, it is possible to recognize a continuum of VBM models reflecting different status of financial performance compared to the outcomes of other firms.

The first VBM model is a "narrow-view model." In this model, financial performance prevails over any other firm outcome. VBM can be used as an excuse to act unethically or to the detriment of certain stakeholder groups, especially when financial performance metrics are set improperly and when executive compensation schemes enhance risk-taking (Hagendorff and Vallascas, 2011) and/or unethical behavior (Harris and Bromiley, 2007) – both resulting in significant externalities. Consequently, the value created for shareholders may be coupled with the destruction of values created for other stakeholders.

The second VBM model is strongly rooted in the tradition of corporate finance. M. Friedman, who coined the famous phrase "the business of business is business," pointed to the fact that enterprises should always follow ethical norms and legal rules (Friedman, 1970). In this model, managers strive for superior financial performance; however, ethical and legal criteria are always met. The value for shareholders is created without harming values for other stakeholders.

The third model is a "state-of-the-art" VBM where managers use strategic planning tools to discover a full picture of the value drivers, including finding how acting in the interest of stakeholders can enhance a firm's value. The focus is on value-creation, and stakeholders are recognized as important value-driving factors. This approach is called "strategic CSR" (Srisuphaolarn, 2013). The value

created for shareholders is enhanced by creating value for other stakeholders (value co-creation within a complex system of business and its environment).

The fourth model of VBM is referred to as enlightened shareholder maximization. This is a revised, integrated role of a corporation that encompasses the financial and social obligations of firms as its core strategy, a strategy with one emphasis: long-term wealth creation for shareholders (Jensen, 2002). In this model, value creation for shareholders is seen as a prerequisite for creating value for other stakeholders. Managers aim at achieving value for all stakeholders.

Each model may eventually fail to meet its purpose due to VBM disadvantages as well as the contingencies mentioned above. Differences in the use of VBM and EVA may have important implications for shaping the long-term results of VBM or EVA.

Despite the variety of its approaches, VBM is sometimes accused of being a source of financial crisis, as it generates significant externalities. It is claimed that VBM is ultimately a microeconomic concept, where priority is given only to shareholder interest (Kasiewicz, 2009). Such a warning is not surprising in the case of "narrow-view" VBM. In the case of "traditional VBM," it is possible to argue that, as far as legal norms and ethical norms are followed, it is the responsibility of the government to introduce macroeconomic policy to reduce negative externalities by the appropriate legal norm enforcement. Social and cultural institutions create social norms strong enough to complement legal norms. In this case, engaging a firm's resources in managing externalities would result in excessive transaction costs, and the desired Pareto-improvement would be lost.

When the "state-of-the-art" or "enlightened" VBM is blamed to be "only microeconomic concepts," one may ask what the business is ultimately expected to be. In any case, this requires the proper recognition of business, social, and ethical obligations.

3. Corporate social responsibility challenge

Contemporaneously, the business landscape is being re-oriented and faces managerial transition to adapt new decision-making criteria and a course of action; namely, "corporate sustainability." The consciousness-of-business impact on society and the natural environment has evolved rapidly. The following building blocks of the perspective on a firm's non-financial outcomes are most important:

- the contracts with stakeholders are incomplete (Asher et al., 2005);
- governments fail in meeting social needs (due to collective decision-making shortcomings, rent-seeking, inefficient management, etc.);

- enterprises create significant negative externalities (in terms of pollution, risk, poverty, health problems, etc.) (Grinols and Mustard, 2001; Kudełko, 2013) that harm stakeholders;
- social norms evolve, and sanctions are visible (Ostrom, 2014);
- enterprises can efficiently provide public goods (Braat and de Groot, 2012);
- asymmetry of information can be easily used to exploit some groups of business stakeholders (as was the case of the recent financial crisis) (Flannery et al., 2013);
- competition failure undermines welfare;
- humanistic management contributes to enriching the conceptualization of the shareholders' profiles as well as manager's profile (Pirson, 2013);
- value shift towards post-materialistic values and non-anthropocentric values is observable (Callicott, 1984);
- the idea of stakeholders is being extended (not only shareholders, clients, employees, and local communities, but global communities, NGOs, minorities, and even future generations are believed to constitute a group of legitimate stakeholders).

Corporate legitimacy, which is understood as the conformation with social norms, values, and expectations (Oliver, 1996) and constitutes a prerequisite for company's survival (Palazzo and Scherer, 2006) became a pressing problem.

From the perspective briefly described above, companies have started to see their ethical commitments in a wider context. Consequently, the concept of Corporate Social Responsibility [CSR] has gained an unprecedented attention among scholars and practitioners. So, far more than 10,000 scientific papers on corporate social responsibility have been published according to the Scopus database (the yearly number of papers on CSR is on the increase). Contemporaneously, 93% of the biggest world companies publish social responsibility reports (in Europe, 80% of large companies publish these types of reports; in Poland, that number is 56%) (KPMG, 2013). Additionally, the quality of CSR reporting is improving (KPMG 2011, 2013). At the stock exchanges, new indices devoted solely to responsible corporations have been introduced (for example, the Domini 400 Social Index, FTSE4GOOD Index, Dow Jones Sustainability, or WIG Respect).

At the core of the CSR concept is the idea that it reflects both the social imperatives and social consequences of business success and that the responsibility accordingly falls upon the corporation; however, the precise manifestation and direction of the responsibility lies at the discretion of the corporation (Matten and Moon 2008). Many definitions of CSR are based on two fundamental ideas. The first is that companies have responsibilities beyond their profit-making activities and mere legal liability (Carroll, 1999; Crespo et al., 2005). The second is that

these responsibilities apply not only to shareholders but also to a broader group of stakeholders (Freeman, 1984). In their in-depth analysis of CSR definitions, Maon et al. (2010) observed that the nature of CSR commitment can differ from a voluntary practice to a moral obligation for the company and that different CSR definitions reflect different kinds of considered stakeholders (internal stakeholders, external stakeholders, or the overall society).

Generally, under the CSR concept, the role of business today is being extended. It is claimed that business is not only responsible for business but should meet the highest ethical standards. A corporation should be responsible as a social actor and citizen, and it should even re-embed the role of the government by taking responsibility for macroeconomic balance, public goods provisioning, and asymmetry of information reduction. Consequently, business context today revolves around the following (Liyanage and Kumar, 2003):

– economical values that rest on the degree of financial accountabilities displayed;
– social values that rest on the degree of social equity displayed;
– environmental values that rest on the degree of environmental care displayed.

Garriga and Melé (2004) indicate that four basic underlying concepts foster CSR theorizing:

– any supposed social activity is accepted if and only if it is consistent with wealth creation (instrumental theories of CSR);
– special power of corporations leads the corporation to accept social duties and rights or participate in certain social cooperation (political theories);
– business depends on society for its continuity and growth and even for the existence of the business itself (integrative theories);
– the relationship between business and society is embedded with ethical values (ethical theories).

Under the instrumental theories of CSR, the role of the business complies with what traditional VBM prescribes. CSR levered by integrative theories generally overlaps with enlightened VBM. In this context, the decision environment is extremely complex and far-reaching. The most-compelling task is to accurately plan and forecast, including linking financial and non-financial data and items.

When CSR is fuelled by an ethical perspective, it can fit traditional VBM. However, it should be stressed that ethical concerns are nowadays seen in a much-more-complex and comprehensive way than some decades ago. This can result in taking excessive burden by corporations (for example, expanded charity programs or inflated ethical standards for suppliers), resulting in unexcused losses in shareholder wealth. Here, the most-compelling task is finding the right balance.

Political theories of CSR bring about a completely new perspective. Many business firms have started to assume social and political responsibilities that go beyond legal requirements and fill the regulatory vacuum in global governance (Scherer and Palazzo, 2011). Political theories of CSR can be in accordance with the assumption that firms should maximize shareholder utility when the utility function is compound (depending on shareholder financial and non-financial goals). Shareholders may wish to use their "corporate vote" and exploit firm's resources just as their private resources (i.e., giving donations to the poor) – to fight social problems. However, a political approach towards CSR may lead to allowing managers to use a firm's resources for purposes contrary to the shareholders' goals. In this case, the expenditures on CSR as well as the foregone profits are simply agency costs. Consequently, the most-compelling task is the accurate recognition of shareholder preferences and appropriate understanding and fulfilment of fiduciary duties.

Despite the numerous publications, best practices, and standards for CSR, there is still no agreement on what companies should be responsible for and how. A number of new metrics of corporate social performance (CSP) have been proposed and discussed (Epstein and Buhovac, 2014), and a number of CSR strategies have been tested. So far, a large number of standards, codes of conduct, and guidelines have been created in response to the necessity to appraise business impacts on society and the natural environment. By the end of 2009, there were about 300 CSR standards, such as the UN Global Compact, ILO Standards, OECD Guidelines for Multinational Enterprises, ISO 14001, GRI (Global Reporting Initiative, 2006), Global Sullivan Principles, SA 8000, and AA1000 (Koerber, 2009). Most of them are under criticism because they inhibit innovation and enhance conformity (Colle de et al., 2014).

In practice, CSR may be used in an opaque manner. Some companies proclaim a policy of ''caring for the world'' by making small donations or taking very small-scale initiatives (which may cost very little); by doing such things, they effectively put a fig leaf over the serious negative externalities they create. Such practices are called "windowdressing." Based on the growing number of reports of corporate hypocrisy, consumers have become inherently skeptical when evaluating CSR information (Connors et al., 2015).

Since CSR overlaps with corporate finance theory prescriptions towards business goal-setting, the picture of objectives that should be achieved by exploiting a firm's resources is incomplete and unclear. The scientific research is largely concentrated on tracing linkages between the enterprise's engagement in social and/or environmental development and their financial performance (Tang et al., 2012; Flammer, 2015). These studies are mainly in pursuit of evaluating CSR by a neoclassical corporate-finance yardstick. The above-mentioned studies are very

intensive and differ significantly when it comes to choosing proxies for social performance, measures of financial performance, a model of regressing financial performance on the proxy for social performance, a time horizon, control variables, and finally a sample. Their results are inconsistent. This, however, is inevitable since, within a sample, it is not possible to define and unify: a) the intended time horizon of enterprises' CSR projects; b) motives that drove the enterprise's decisions; c) financial market efficiency in valuing the positive effects of CSR retaken by an enterprise; d) type of CSR projects; and e) possible heterogeneity of the effects of CSR projects retaken by enterprises resulting from differentiation in the reactions of the complex business environment to the CSR projects (Benabou and Tirole, 2009, pp. 12–13; Wood, 2010, pp. 60–62). Hence, it is not possible to establish an incontestable business case for CSR. However, although CSR does not always contribute to a firm's value, an increase in the firm's social and environmental activities can be value-enhancing (Malik, 2015). The requirement is as stated above:

– accurate planning and forecasting with a focus on transparency of linking non-financial items to financial items;
– finding the right balance between ethical commitments to diverse groups of stakeholders;
– right recognition of shareholder preferences and appropriate understanding and fulfilment of fiduciary duties.

Ultimately, since there is no single standard for a firm's goal-setting, it is solely up to the managers how to approach determining criteria for decision-making. Imperfect instrumentality in decision-making may lead to two serious undesirable consequences. The first would be the silent but definitive subordination of non-financial outcomes to financial outcomes, which may result in losing chances for the firm's sustainable growth as well as in the increase of negative externalities. The second would be the exploitation of the CSR idea to increase the power of managers over a firm's resources, resulting in an increase in agency costs. Both consequences would result in the erosion of CSR concept and of VBM concept. Therefore, there is an urgent need to improve the rationality of managerial decisions to foster the transparency and accountability of CSR practices.

4. Multi-criteria decision making for CSR – literature review

Multiple-criteria decision making (MCDM) has grown as a part of operations research, engaged with designing computational and mathematical tools for supporting the subjective evaluation of performance criteria by decision

makers (Mardani et al., 2015). Multi-criteria decision-making problems comprise of an underlying space of feasible solutions and several objectives that can be evaluated with regard to the feasible solutions. In general, a generic solution approach and unambiguous concept of optimality do not exist for this kind of problem, but different approaches depending on the viewpoint of the decision maker towards the underlying problem are applied (Buchert et al., 2015). Multi-criteria decision making (MCDM) is concerned with structuring and solving decision and planning problems involving multiple criteria. Both quantitative and qualitative factors can be included. The purpose is to support decision makers facing such problems. The MCDM methods helps to improve the quality of decisions by making them more explicit, rational, and efficient (Pohekar and Ramachandran, 2004).

A large number of approaches and techniques have been introduced in this area of research. Multi-criteria decision methods (MCDM) are a family of methods that includes several methods based on weighted averages, priority setting, outranking, fuzzy principles, and their combinations. The methods can also be classified as deterministic, stochastic, and fuzzy methods. The most-popular MCDM tools include a technique for order of preference by similarity to ideal solution (TOPSIS), elimination and choice expressing reality (ELECTRE), analytic hierarchy process (AHP), analytic network process (ANP), preference ranking organization method for enrichment evaluations (PROMETHEE), and their families (Zavadskas et al., 2014). Nevertheless, the basic working principle of any MCDM method is the same: the selection of criteria, alternatives, aggregation methods, and ultimately alternatives based on weights or outranking. MCDM can help making individual decisions as well as group (e.g., board) decisions, because all MCDM stages can be carried out individually or collectively.

The TOPSIS (technique for order preference by similarity to the ideal solution) selects the alternative closest to the ideal solution and furthest from the negative ideal alternative. The classical TOPSIS method is based on information about attribute from decision maker. The solution is aimed at evaluating, prioritizing, and selecting, and the only subjective inputs are weights (Roszkowska, 2011).

The AHP (analytic hierarchy process) uses a multi-level hierarchical structure of objectives, criteria, sub-criteria, and alternatives. The pertinent data is derived by using a set of pair-wise comparisons. These comparisons are used to obtain the weights of the importance of the decision criteria (Triantaphyllou, 2013). This method entails mechanisms ensuring the consistency of pair-wise comparisons.

The AHP disadvantage is that many decision problems cannot be built as hierarchical because of dependencies (inner/outer) and influences between and within clusters (criteria, alternatives). Analytic network process (ANP) is the

development of AHP, which provides a general framework to deal with decisions without making assumptions about the independence of higher-level elements from lower level elements and about the independence of the elements within a level. The control hierarchy, critical for ANP analysis, provides overriding criteria for comparing each type of interaction that is intended by the network representation (Gencer and Gürpinar, 2007).

The PROMETHEE (preference ranking organization method for enrichment evaluations) methods belong to the class of outranking methods. Its descriptive complement is known as a geometrical analysis for interactive aid. The starting point of the PROMETHEE technique is the assessment matrix. In this matrix, the alternatives are assessed on the different criteria (evaluations involve numerical data). Implementation of the PROMETHEE requires additional information on the weights of the criteria and decision maker's preference function. Decision maker's weights and preference function when comparing the contribution of the alternatives with respect to each criterion (Mousavi et al., 2013).

ELECTRE is a method for dealing with the problem of ranking actions from the best option to the worst. Actions are evaluated (for at least one criterion) on an ordinal scale or on a weak interval scale. Preferences in ELECTRE methods are modeled by using binary outranking relations. The construction of an outranking relation is based on two major concepts: concordance and non-discordance. Through the use of probabilistic distributions and expected utility criterion, imperfect knowledge can be taken into account in ELECTRE methods (Figueira et al., 2016, pp. 2–10).

MCDMs are well investigated when it comes to the succour they provide to financial management (Steuer and Na, 2003; Spronk et al., 2016). However, there are no publications that provide bibliometric studies on how MCDM supports CSR. The purpose of this part of the paper is to find if, in the literature, MCDM tools are recognized as instruments that can be harnessed in CSR managing and if there are knowledge gaps in the area. To this end, an extensive search was carried out in December 2016 to find specified words in titles, abstracts, keywords, and research methodologies of the papers included in the comprehensive Scopus database. The specified words included: "corporate social responsibility" and "multi-criteria (multi-criteria) decision methods (tools, techniques)" or "technique for order preference by similarity to the ideal solution," "analytic hierarchy process," "analytic network process," "preference ranking organization method for enrichment evaluations," or their acronyms (respectively: TOPSIS, AHP, ANP, PROMETHEE, or ELECTRE). In the database, only 63 publications were found; however, after eliminating the non-relevant papers, 41 publications were included in the final analysis. The result of the analysis is presented in Table 2.

Table 2

MCDM in support for decision on CSR – application and key concepts – bibliometric study results

Way of using MCDM tools for CSR management	Key concepts	Publications	Type of MCDM tool used
MCDM tools as a support for managerial decisions (investment decisions, product decisions)	Defining the priority for managerial decisions Designating social/environmental goals particularly important for specific sectors Identifying stakeholders' goals Sustainable credit decisions Managing product lifecycle	Taylor, 2014 Sardinha et al., 2010 Dreyer et al., 2010 Esteves, 2008 Chang and Yeh, 2016 García-Melón et al., 2016 Petrillo et al., 2016 Zhao and Li, 2015 Manente et al., 2015 (p. 307–322) Zeidan et al., 2015 Jindal and Sangwan, 2016 Chang, 2015 Guoliand and Sijing 2010	AHP hybrid techniques in the field of MCDA fuzzy-based ANP, fuzzy TOPSIS, TOPSIS
MCDM used to evaluate CSR practices	Giving priority to indicators representing non-financial outcomes Internal and external evaluation of CSR policy Ranking companies with respect to their CSR policy Criteria for socially responsible investment Measuring CSR	Venturalli et al., 2016 Wang et al., 2015 Cuesta González de la, 2015 Costa and Menichini, 2013 Stankova, 2015 Shanmugam et al., 2015 Carnero, 2015 Zhao et al., 2015 Lamata et al., 2016 Doukas et al., 2014 Chen and Fan, 2011 Aravossis et al., 2006	AHP, Fuzzy AHP, Fuzzy-AHP-TOPSIS, 2-tuple TOPSIS
MCDM tools to support sustainable supply chain management being a component of firm's CSR policy	Setting criteria for supplier selection to meet CSR requirements Environmental management in the product lifecycle Managing supply chain risk and resilience Supply chain equilibrium with respect to externalities	Raut et al., 2015 Cruz, 2013 Zhen et al., 2012 Sivakumar at al., 2015 Karthik et al., 2015 Wang and Pan, 2014 Govindan et al., 2013 Huo, 2012 Jin, 2011 Cruz, 2009	AHP ANP and Decision-Making Trial and Evaluation Laboratory (DEMATEL) fuzzy TOPSIS

Table 2 cont.

Way of using MCDM tools for CSR management	Key concepts	Publications	Type of MCDM tool used
MCDM tools for exploring firms environmental/ social consciousness	Corporate environmental/ social consciousness	Ceh and Bu, 2013	fuzzy AHP
MCDM tools to assess managerial competences necessary to perform within CSR policy	Managerial competences, human resources management	Asenjo and Bueno, 2015	AHP
MCDM tools used to assess the importance of CSR drivers	CSR drivers Stakeholders	Achabou et al., 2015	AHP
MCDM tools used for assessing the quality of CSR reporting	Communication of CSR	Manente et al., 2014 (pp. 234–285)	AHP
MCDM tools used for assessing the financial and non-financial firm's performance	Firm's value Value added Sustainable development	Huang and Quin 2010	AHP, TOPSIS
MCDM tools used to evaluate the quality of firm's management with respect to environmental outcomes	Corporate governance Environmental management	Merard et al., 2013	ELECTRE III

Source: Author's own elaboration

The literature on using MCDM to support CSR has been developing rapidly. All papers found under the study except for two were published in or after 2010. The most-often-exploited MCDM method used in the studies on CSR is

AHP and its developments. The reason can be its simplicity. The second-most-often-used method is TOPSIS. In studying MCDM exploitation to support CSR, two perspectives are used: the perspective of internal stakeholders and external stakeholders. MCDMs are suggested to support implementing the CSR concept in one management area (HR, credit decisions, reporting) or in a firm's overall management. Among the analyzed research papers, three important research avenues can be recognized.

The first strand (with respect to the number of publications – 13) is represented by publications where MCDMs are seen as tools that can support managerial decisions (investment decisions, product development decisions) when the responsibility for stakeholder interest is an important goal of a corporation. The key concepts of this strand in the literature are to define priorities, designate goals, and set criteria for diverse managerial decisions. The publications fueling the trend are the newest – most of them were published in 2015 and 2016. This can be a signal of developing a new trend in the research on MCDM for CSR. However, the number of papers is very small, and a comprehensive study is still needed. Then, sector-specific and country-specific investigations may reveal differences in goals prioritization. By this way, such studies may contribute to the improvement of CSR standards.

The second strand (12 publications, published mostly in 2015 and 2016) focuses on using MCDM to evaluate a firm's quantitative and qualitative outcomes in terms of the values created for multiple stakeholders. The key concept in the trend is communication (informing and reading) of a firm's heterogenic results. This requires prioritizing indicators reflecting business outcomes and ranking companies with respect to their social and environmental performance. One separate study uses AHP to evaluate the quality of CSR reporting (Manente et al., 2014). The communication's main purpose is to enable investors and other stakeholders to run models or make their own predictions about the future value creation potential of the organization. Since socially responsible investment market size is growing, this type of research is extremely necessary. Knowledge of the priorities of shareholders and stakeholders would enhance the transparency of CSR and fiduciary-duty fulfilment.

The third strand is represented by ten publications focusing on MCDM usage in green (or responsible) supply-chain management. MCDM tools are very popular in supply chain management, and thereof it is natural that new criteria for supplier selection are managed with tools already well-tested in the area. Knowledge on how MCDM can be used in managing relationships with suppliers can further inspire research on using MCDM in managing relations with other stakeholders.

Additionally, a bibliometric study revealed that some proper publications covering MCDM and CSR exist. Selected issues include quality of CSR manage-

ment, competence evaluation, or environmental/social consciousness of the firms. The important study of Achabou et al. (2015) exploits AHP to improve the understanding of value drivers. This study links CSR to VBM.

Considering the fact that the literature on CSR is vast and the literature on multi-criteria decision methods is overwhelming (almost 15,000 papers solely on AHP and its applications), the collection of papers analyzed in the study may be seen as a harbinger for a new research avenue. The field is promising since it covers a number of today's managerial issues and provides a well-tested tool (MCDM).

Considering that the research strand is immature, it makes no sense to point to research gaps. The research perspectives are outlined. The integration of financial management in a strategy based on the CSR concept needs further investigation, because little has been done to evaluate CSR as value driver (except the study of Achabou et al., 2015) and nothing to assess its costs. Particularly linking financial and non-financial items at different levels of management (strategic, operational, tactic) is necessary. Then, more must be done to explore how to appropriately balance incentives for managers who are responsible for creating for and distributing among multiple stakeholders. The missing approach in the field is the macroeconomic perspective on priorities and outcomes. This, however, requires another theoretical framework.

5. Conclusion

When the maximization of financial efficiency constitutes a common denominator for the evaluation of a firm's outcomes, the integrity and purposefulness of the firm's management are safeguarded. However it is recognized that not only the creation of value for stakeholders is socially accepted and desirable. The maintenance of corporate legitimacy requires a new perspective on business commitments. Business today faces a managerial transition to adapt new decision-making criteria and a course of action; namely, "corporate sustainability." Corporate social responsibility can be embedded in (or fostered by) value-based management. In any case, adopting CSR as part of a firm's strategy and operations requires changed standards for decision-making. Decision-makers face the challenge of following tangible and intangible goals of multiple stakeholders. The imperfect instrumentality of decision-making may bring about two undesirable consequences. The first would be the silent but definitive subordination of non-financial outcomes to financial outcomes, which may result in losing chances of a firm's sustainable growth as well as in an increase of negative externalities. The second would be the exploitation

of the CSR idea to increase the power of managers over a firm's resources, resulting in the increase of agency costs. Both consequences would result in the erosion of the CSR and VBM concepts.

Multiple-criteria decision-making (MCDM) methods is the field of operational research that brings about a lot of insights into structuring and solving decision and planning problems involving multiple criteria (including qualitative and quantitative criteria). The MCDM methods helps to improve the quality of decisions by making them more explicit, rational, and efficient. This paper presents the result of a bibliometric study where the Scopus database was deeply searched to find all scientific papers devoted to CSR and Multiple-criteria decision-making (MCDM). To the author's best knowledge, this paper is the first where such literature review results are provided. 41 publications were included in the final analysis. It was discovered that papers aimed at using MCDM to enhance CSR management are mostly newer publications (most of them published in 2015 and 2016), which proves that the strand of the literature is emerging.

Among the analyzed research papers, three important research avenues emerged. In the first avenue, MCDMs are seen and used to enhance managerial decisions where a number of heterogenic goals must be achieved. The key concepts of this strand in the literature are to define priorities, designate goals, and set criteria for diverse managerial decisions. This corresponds with the problem described in the theoretical framework of the paper that there is a need for more-rational decisions in terms of heterogenic goals.

MCDM tools can be used by both internal and external stakeholders. The second avenue is where MCDMs are seen and used to evaluate a firm's quantitative and qualitative outcomes in terms of values created for multiple stakeholders. The key concept in the trend is the communication of CSR. Here, MCDMs reduce information asymmetry and enhance stakeholder's decisions. A more-transparent CSR enhances fiduciary duties fulfilment (for internal stakeholders) as well as portfolio management (for external stakeholders).

The third trend is a natural transfer road of MCDMs into the CSR field. Green supply-chain management as a research area fueled ideas on using MCDMs to manage the supply chain when CSR is adopted into the enterprise.

Other papers analyzed in the study represent proper ideas on using MCDMs to support CSR (e.g., competences evaluation, corporate consciousness examination, etc.). This indicates that there are many possible fields of harnessing MCDM in studying CSR's theories and practices.

Despite the fact that some studies focused on both CSR and finance, little is still known about how MCDMs can be used to integrate financial management and CSR. The important issue is to study compensation schemes where managers are required to achieve heterogenic goals.

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Trading volume and volatility patterns across selected Central European stock markets from microstructural perspective

1. Introduction

Market microstructure can be defined as specific local rules in a given market and/or anomalies reflecting patterns in price, trading volume, or volatility and more data from a stock market that is relevant with respect to trading activity.

Nowadays, there has been a revival of this notion in the context of electronic trading and the numerical capacities of fast computers supporting trading. One of the most-important topics in empirical stock market studies in the framework of microstructure is recognizing patterns of volatility and trading volume seasonality. This is an important issue with respect to risk management, arbitrage, and speculation. Based on the patterns in the past, market participants can try to maximize their returns and minimize risk. In addition, knowledge of market microstructure can help the market governance in the establishment of new rules of trading in order to support the creation of a more-efficient trading system. This type of empirical research has been conducted for several developed stock markets; however, to the best of our knowledge, there are no studies on the issue for emerging stock markets, especially for the stock markets in CEE countries.

Another advantage of this study is that it utilizes high-frequency data. This kind of data is very important in order to analyze questions related to the negotiation process and trading patterns (comp. Wood, 2000; Tsay, 2010) that are seldomly used in the Polish market for a historic perspective of high-frequency data.

The variables investigated in this contribution are trading volume and volatility. The timeframe of this work comprises trading sessions over several months in

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2016. We use this timeframe due to the availability of data. In light of the empirical studies for developed stock markets, the U and L patterns can be considered as stylized fact on these stock markets.

We are looking out for patterns during the trading session of the selected CEE stock markets, trying to match the results of stock markets around the world that display similar behavior (a U- or L-shaped pattern).

As the opening is the most-volatile time of the trading day, easing throughout the day and bumping up at the end results in a U-shaped pattern of trading. The other observable pattern is opening high and simmering down throughout the day until closing (as the L-shaped designation suggests). With respect to trading volume, some authors point to peculiar characteristics when analyzing several-minute intervals. A similar picture is expected for the most-traded stocks in the stock exchanges of Austria, Germany, and Poland.

A simple approach has been utilized to model volatility and trading volume. We consider 5-minute absolute logarithmic returns as a measure of volatility and sum of trading volumes within each 5-minute period during the day. Anticipating some of the results found, we stress that volatility follows more of an L-shaped pattern, with daily highs in the opening and declining throughout the day (with a bit of a bump after lunch time). In the case of trading volume, the pattern detected in our study and reported in the literature is U-shaped, with high activity in the beginning and at the end of the trading day.

This study is justified by the absence of this sort of investigation (and comparative studies) for the selected stock markets in Central Europe. Even though the topic has received great attention in developed markets such as the NYSE, London Stock Exchange, and Tokyo Stock Exchange, there is a lack of similar studies – especially regarding smaller stock markets like the Austrian or Polish markets.

The findings of this research will help answer some questions; e.g., do trading volume and volatility exhibit U-shaped or L-shaped patterns, respectively, and behave similar to other especially-developed markets? Do they influence each other? Before answering these questions, we overview the selected contributions concerned with the shape of trading volume and volatility in Section 2 of this paper. The methodology used in this contribution is presented in Section 3. The empirical results and their evaluation are provided in Section 4. Section 5 concludes.

2. Literature overview

The investigation of market microstructure has been done several times for developed markets, in many forms, and by several methods.

In one of the earliest studies on market microstructure, Wood et al. (1985) analyzed the behavior of returns and trading volume at the micro level of the New York Stock Exchange. They found higher returns and higher variance in the first 30 minutes after the start of trading.

In a study by Jain and Joh (1988) (also based on data from the New York Stock Exchange), the authors showed that returns depend on the trading hours. Moreover, during some hours of the day, a rise in trading volume can be detected. They supplied empirical evidence on the joint characteristics of hourly common stock trading volume and returns. Average trading volume exhibits significant differences across the trading hours of the day and across the days of the week. In addition, the average returns depend not only on the hours of the day but also on the days of the week.

Different patterns of volatility have been found in several contributions in the financial literature, such as the work of Lockwood and Linn (1990). The authors examined the variance of hourly market returns on the NASDAQ. They found that return volatility falls from the opening hour until early afternoon and rises thereafter and is significantly greater for intraday versus overnight periods.

Andersen and Bollerslev (1997) supplied evidence of strong intraday periodicity and seasonality of two different asset classes (foreign exchange and securities) traded under widely varied market structures.

In further contributions by Andersen and Bollerslev (1998) (who investigated Deutsche mark-dollar volatility) and in McInish and Wood (1992) (who investigated the bid-ask patterns of stocks from the New York Stock Exchange), a U-shaped pattern is visible.

Andersen et al. (2000) analyzed the intraday volatility of 5-minute Nikkei 225 returns and found a double U-shaped pattern related to the opening and closing of the separate morning and afternoon trading sessions.

Nishimura et al. (2012) found that the volatility pattern is U-shaped in Shanghai and W-shaped in the Tokyo Stock Exchange (in their framework of investigations of spillover effects between China and Japan using 5-minute high-frequency data).

In a more-recent contribution, Agarwalla and Pandey (2013) focused on a developing stock market (Bombay Stock Exchange). They check the expiration day effect on intraday volatility and find that the volatility of the stocks increases in the last half hour of trade on the expiry day but not during the other time intervals in this stock exchange. Tilak et al. (2013) established a U-shaped pattern based on intraday data for the main index (CAC40) for the Paris Stock Exchange. Also in the case of trading volume, the pattern found was U-shaped with high trading activity in the beginning and at the end of the trading day.

Buckle et al. (1998) established the L-shape pattern and other significant patterns in their framework of investigations of the Short Sterling interest rate and FTSE 100 stock index future contracts traded on the London International Financial Futures and Options Exchange (LIFFE).

Analyzing securities listed on the Shanghai Stock Exchange, Tina and Guo (2007) found that volatility follows more of an L-shaped pattern, with daily peaks in the opening and easing throughout the day (with a bit of a bump after lunchtime).

Chan et al. (1995) and Abhyankar et al. (1997) reported U-shaped and M-shaped volatility patterns for NASDAQ and the UK stocks, respectively.

While searching for intraday patterns on the Tokyo Grain Exchange (TGE) and announcements of public information, Eaves and Williams (2010) found that intraday volume is U-shaped and intraday volatility is closer to L-shaped. The contributors found that, after accounting for the public information in preceding auctions for the same commodity, for earlier trading in other commodities, and for trading on overseas markets open overnight in Tokyo, the intraday patterns are by and large flat.

Hussain (2011) takes into account the strong intraday seasonal pattern in return variability before attempting to model the conditional volatility. His study provides intraday evidence on the relationship between return volatility, trading activity, and market liquidity variables at the aggregate level for DAX30 constituents. The author detects a reverse-J-shaped pattern of intraday bid-ask spreads with the exception of a major bump following the intraday auction at 13:05 CET. According to the author, the aggregate trading volume exhibits L-shaped pattern for the German blue chip index, while German index volatility displays a somewhat reverse-J-shaped pattern with two major bumps at 14:30 and 15:30 CET. These results are contrary to the U-shaped pattern found in previous studies. His empirical findings demonstrate that contemporaneous and lagged trading volume and bid-ask spreads have a numerically small but statistically significant effect on return volatility. In addition, his results also indicate asymmetry in the effects of volume on conditional volatility.

Będowska-Sójka (2013) investigated the averages of absolute DAX and CAC40 returns within five-minute periods and examined the reaction of these indices to the macro surprises from two economies (the German and the American).

In one of the most-recent contributions, Silva Da Costa et al. (2015) analyzed market microstructure with high-frequency data for all stocks that participate in the Ibovespa index, a traditional and influential Latin American index. They modeled volatility with a straightforward method using standard deviation as a proxy, and classified the volume traded of all Ibovespa stocks in every 10-minute interval of the trading days sampled. They found similarities and dissimilarities of their results with previous investigations documented in

the financial literature, such as the stylized facts: L-shaped pattern for volatility and U-shape for trading volume. One interesting finding is that, during the most-active trading time, volatility slumps in the interval that comprises the closing call; on the other hand, the second-most-active trading time (the opening) displays extreme volatility.

The rest of the article is organized as follows: the next section describes the methodology applied. The fourth chapter contains the described dataset and subsequent results. The last section concludes the paper.

3. Methodology

Flexible Fourier Form (FFF regression) introduced by Gallant (1981) and later used by Andersen and Bollerslev (1997, 1998), Laakkonen (2014), and Będowska-Sójka (2013) seems to be the most-frequently-used method of modeling periodicity in high frequency data. Let T be the number of days in a sample and the number of equally spaced periods in one day. The volatility of logarithmic return $r_{t,n}$ ($t = 1, \ldots, T$, $n = 1, \ldots, N$). The volatility of logarithmic return $r_{t,n}$ ($t = 1, \ldots, T$, $n = 1, \ldots, N$) divided into daily volatility component σ_t, intraday volatility component $s_{t,n}$, and random error term $Z_{t,n}$, so $r_{t,n}$ is expressed as:

$$r_{t,n} - E\left(r_{t,n}\right) = \frac{\sigma_t}{N^{1/2}} s_{t,n} Z_{t,n} \tag{1}$$

The component $E(r_{t,n})$ is replaced with unconditional mean $\bar{r}$ and the σ_t can be estimated with various methods. In this paper we use robust to price jumps estimator medRV (Andersen, 2012) which is defined as

$$\hat{\sigma}_t^2 = \frac{\pi}{6 - 4\sqrt{3} + \pi}\left(\frac{M}{M-2}\right)\sum_{i=2}^{M-1} \text{med}\left(\left|r_{t,i-1}\right|, \left|r_{t,i}\right|, \left|r_{t,i+1}\right|\right)^2$$

The daily component is eliminated, both sides are squared, and logarithms are taken. After this, Equation (1) becomes

$$2\ln\frac{\left|r_{t,n} - \bar{r}\right|}{\hat{\sigma}_t \,/\, N^{1/2}} = 2\ln\left(s_{t,n}\right) + 2\ln\left(Z_{t,n}\right)$$

We are interested in modeling component for intraday volatility $s_{t,n}$.

For this purpose trigonometric functions are used:

$$f_{t,n} = \delta_1 \frac{n}{N_1} + \delta_2 \frac{n^2}{N_2} + \sum_{p=1}^{P}\left(\theta_p \cos\left(\frac{2\pi p}{N} n\right) + \varphi_p \sin\left(\frac{2\pi p}{N} n\right)\right) + \sum_{k=1}^{K} \gamma_k D_{k,t,n} + \varepsilon_{t,n} \qquad (2)$$

where $f_{t,n} = 2\ln \frac{|r_{t,n} - \bar{r}|}{\frac{\hat{\sigma}_t}{N^{\frac{1}{2}}}}$, $N_1 = \frac{(N+1)}{2}, N_2 = \frac{(N+1)(N+2)}{6}$ are normalizing factors and $D_{k,t,n}$ are indicator variables. An estimate of intraday volatility is obtained as $\hat{s}_{t,n} = \exp\left(\frac{\hat{f}_{t,n}}{2}\right)$, and the normalized seasonality estimate is:

$$\tilde{s}_{t,n} = \frac{T \cdot \hat{s}_{t,n}}{\sum_{t=1}^{T}\sum_{n=1}^{N} \hat{s}_{t,n}}$$

In the regression above, we use indicator variables for day-of-the-week-effect testing. We test the null that there is no day-of-the-week effect at the company level. For this purpose, we estimate the regression models twice: first without dummy variables (restricted model) and next with dummy variables (unrestricted). Then, we test if there is a day-of-the-week effect. Formally, null hypothesis H_0: $\gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = \gamma_5 = 0$ is verified with an F-test.

A similar method of modeling and testing can be applied to series of raw trading volumes (we insert values of trading volumes in the place of $f_{t,n}$). Similarly, Manganelli (2005) models the daily periodicity of series of volatilities, volumes, and durations (although using piecewise linear spline functions).

4. The data and empirical results

4.1. Descriptive statistics and autocorrelation patterns

We take into account three sets of high-frequency data with five-minute sampling frequency: all companies listed in DAX, 19 companies (without ATS) of the ATX index, and all from the WIG20 index. The prices of the DAX and ATX companies come from 2016-01-11 to 2016-07-01 and WIG20 from 2014-01-02 to 2014-06-30. As a measure of volatility, we use absolute logarithmic returns. In addition, we take into account volumes over five-minute periods to investigate the intensity of trading. In Tables 1, 2, and 3, we present descriptive statistics of the variables under study.

Table 1

Descriptive statistics of five-minute-frequency logarithmic returns

ATX					
statistic	**min**	**1st quartile**	**median**	**3rd quartile**	**max**
mean	−0.0107	−0.0038	−0.0014	−0.0014	0.0018
s.d	0.1620	0.2220	0.2676	0.2756	0.3261
kurtosis	6.1790	29.7100	226.2000	1274.0000	1497.0000
skewness	−71.9000	−13.3100	−0.1890	−11.3800	1.1680
LB	10.6500	74.5700	88.1900	103.4000	153.3000
DAX					
statistic	**min**	**1st quartile**	**median**	**3rd quartile**	**max**
mean	−0.0047	−0.0008	0.0000	0.0000	0.0009
s.d	0.1305	0.1463	0.1599	0.1784	0.1910
Kurtosis	2.8760	5.4400	9.2180	12.0400	14.1400
skewness	−0.6317	−0.1953	0.0147	0.0612	0.2306
LB	11.7300	25.7000	32.7300	33.8800	39.0300
WIG20					
statistic	**min**	**1st quartile**	**median**	**3rd quartile**	**max**
mean	−0.0049	−0.0013	−0.0010	−0.0002	0.0008
s.d	0.1459	0.2352	0.2656	0.2652	0.2932
Kurtosis	6.3970	14.1900	47.4300	958.8000	1087.0000
skewness	−37.5200	−3.3880	−0.4188	1.5360	0.2844
LB	16.6000	106.5000	149.3000	250.6000	395.8000

Source: own elaboration

Table 2

Descriptive statistics of five-minute-frequency absolute logarithmic returns

ATX					
statistic	**min**	**1st quartile**	**median**	**3rd quartile**	**max**
mean	0.0962	0.1251	0.1409	0.1424	0.1621
s.d	0.1304	0.1782	0.2166	0.2334	0.2952
Kurtosis	15.2600	52.1200	601.0000	1868.0000	2079.0000
skewness	2.7070	4.4850	13.4000	23.9600	31.3300
LB	83.3700	864.8000	1389.0000	1638.0000	2242.0000

Table 2 cont.

DAX					
statistic	**min**	**1st quartile**	**median**	**3rd quartile**	**max**
mean	0.0922	0.1017	0.1082	0.1249	0.1350
s.d	0.0924	0.1029	0.1173	0.1273	0.1350
kurtosis	7.2880	12.8500	24.6800	32.6200	40.8900
skewness	2.0280	2.6300	3.0920	3.3650	3.7060
LB	1822.0000	3579.0000	4423.0000	4171.0000	4655.0000
WIG20					
statistic	**min**	**1st quartile**	**median**	**3rd quartile**	**max**
mean	0.0923	0.1164	0.1336	0.1336	0.1472
s.d	0.1130	0.1865	0.2236	0.2275	0.2557
kurtosis	9.6920	25.9300	92.1000	1358.0000	1803.0000
skewness	2.2680	3.1920	4.9910	18.8900	28.0400
LB	117.8000	808.4000	1629.0000	1515.0000	2284.0000

Source: own elaboration

Table 3

Descriptive statistics of volumes over five-minute periods

ATX					
statistic	**min**	**1st quartile**	**median**	**3rd quartile**	**max**
mean	242.00	1450.00	2283.00	4088.00	3912.00
s.d	500.40	2252.00	4595.00	6769.00	7608.00
kurtosis	39.59	100.40	237.50	375.80	514.30
skewness	4.55	7.28	9.48	11.61	12.95
LB	669.70	1895.00	4703.00	6482.00	9785.00
DAX					
statistic	**min**	**1st quartile**	**median**	**3rd quartile**	**max**
mean	2331.00	5002.00	14230.00	26200.00	34730.00
s.d	3529.00	6929.00	18110.00	32390.00	43060.00
kurtosis	63.15	402.20	902.90	1142.00	1680.00
skewness	5.37	12.28	20.43	20.94	27.60
LB	1305.00	5463.00	8724.00	11390.00	15080.00

Table 3 cont.

WIG20					
statistic	**min**	**1st quartile**	**median**	**3rd quartile**	**max**
mean	287.50	1432.00	4883.00	10580.00	15360.00
s.d	1078.00	3525.00	18920.00	37600.00	49740.00
kurtosis	61.13	174.10	797.50	1119.00	2022.00
skewness	5.71	10.29	26.62	25.28	36.52
LB	6.96	138.30	977.30	1909.00	3259.00

Source: own elaboration

The descriptive statistics (kurtosis and skewness) indicate a departure from normality for all companies under study. This is confirmed with the Jarque-Bera test. For all series from ATX, a null hypothesis of the Ljung-Box test is strongly rejected. This is not the case for five return series from DAX and two return series from WIG20. There is no autocorrelation (at the 5% level) in nine series of absolute returns and four returns of volumes from WIG20. In most of the remaining cases of absolute series, we observe a well-known pattern in the autocorrelation function. In Figure 1, we present the autocorrelation function of Austrian company VOE, German company DAI, and Polish PZU (all figures are available from the authors upon request). Further examination is performed for these companies, with an observed autocorrelation in absolute returns series at a 1% significance level. Polish companies excluded from the analysis are KGHM, PGE, EUROCASCH, TAURON, ASSECOPOL, JSW, HANDLOWY, SYNTHOS, and KERNEL.

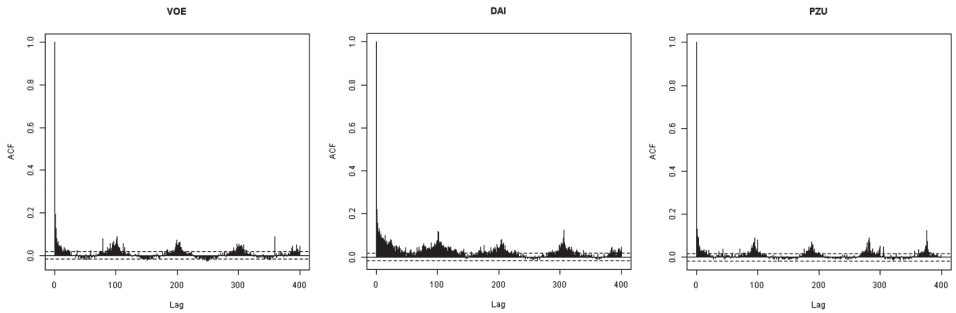

Figure 1. ACF of absolute returns for selected companies

Source: own elaboration

We conduct a similar analysis for trading volumes. Some companies from WIG20 present a lack of autocorrelation due to the Ljung-Box test with 15 lags; however, this is indeed not the case if the number of lags increases. These companies are PKOBP, PKNORLEN, BZWBK, BRE, and SYNTHOS.

In Figure 2 below, we present some examples of autocorrelation function plots (Austrian RBI, German CBK, and Polish ASSECOPOL). For all DAX companies, a clear pattern of seasonality is observed. This is the case only for Austrian companies ANDR, EBS, OMV, RBI, TKA, and VOE, and only in the case of Polish companies KGHM, KERNEL, and PGE. In most cases (ASSECOPOL, BRE, BZWBK, HANDLOWY, PEKAO, PKNORLEN, SYNTHOS, and TPSA), we observe high seasonal peaks at the end of trading hours.

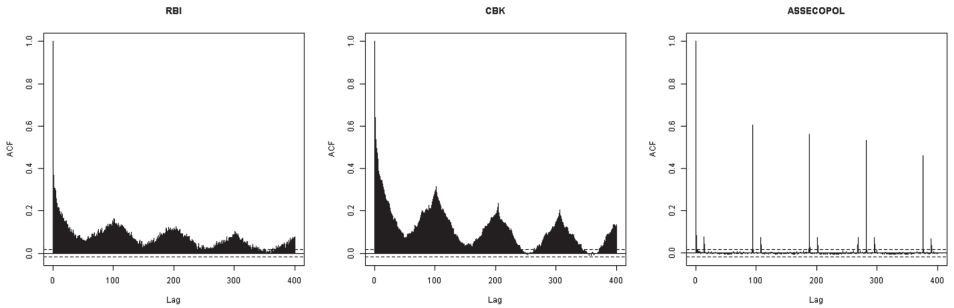

Figure 2. ACF of five-minute returns for selected companies

Source: own elaboration

Intraday volatility pattern

To investigate intraday patterns in volatility, we compute the mean of absolute returns (with each five-minute period). We observe some differences in the shapes. In Figure 3, we present the typical shapes of intraday patterns.

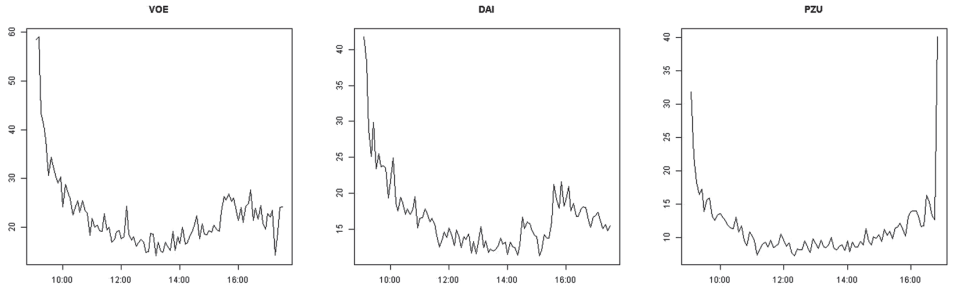

Figure 3. Intraday volatility pattern of selected companies

Source: own elaboration

The intraday patterns of ATX companies are, in most cases, L-shaped or reverse-J-shaped (clear exceptions are CWI, LNZ, RHI, SBO, TKA, UQA, and VER) with a very high peak at the beginning of the trading day. A similar conclusion can

be drawn with respect to the DAX companies. The averages of absolute returns are the highest at the opening and decay during the rest of the day. In many cases, one can note an increase at 16 CET. This can be viewed as the impact of announcements regarding US macroeconomic indicators. In the case of Polish companies, a clear shape of the letter U can be recognized, with the highest peak near the closing hour.

We apply the methodology described in the previous section to discover if there is a significant difference in volatility across the days of the week at the company level. In the regression (2), we use dummies for the day-of-the-week effect. For this purpose, we estimate the regression models twice: first without dummy variables (restricted model) and second with dummy variables (unrestricted). Then, we test if there is a day-of-the-week effect. Formally, the null hypothesis is given as H_0: $\gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = \gamma_5 = 0$. The testing is performed with an F-test. The number of trigonometric functions is based on the Bayesian Information Criterion and does not exceed eight. In all companies under study, we reject the null at a 1% significance level. This confirms the day-of-the-week effect observed in high-frequency data. In Figure 4, we present the periodic intraday pattern of German company ADS. We observe differences in shapes (some are rather U-shaped) and different ranges.

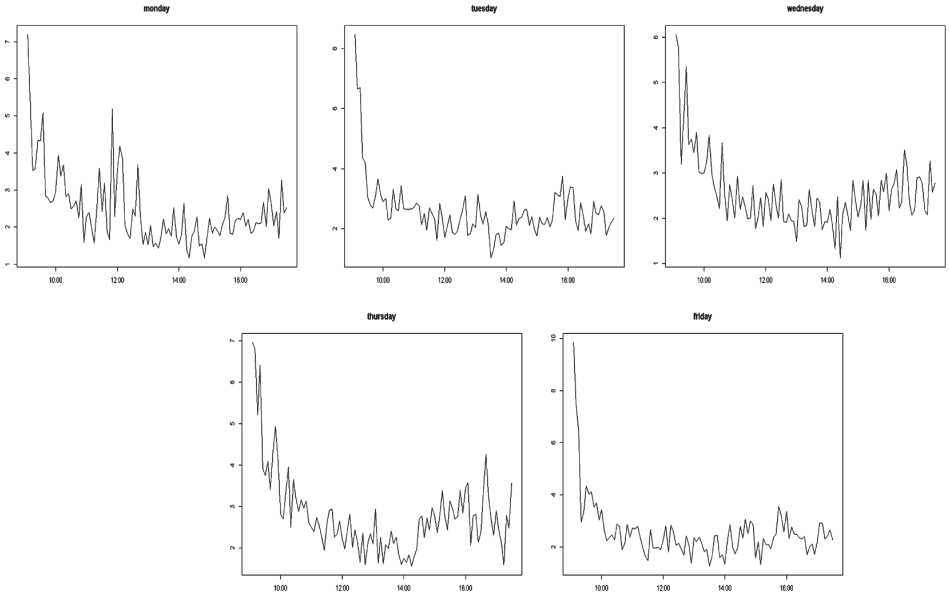

Figure 4. Intraday pattern of German company ADS

Source: own elaboration

Intraday volume pattern

The intraday patterns of volume are the most-regular only for DAX companies. We observe a shape of the letter U, with two peaks at 11:55 (in most cases). These peaks can be related to the industrial production announcement at 12:00 in Germany and/or other announcements in the US and possible leakage of this information (the second peak could be identified at 13:10). The patterns of ATX companies are very messy. We can specify that companies ANDR, EBS, IIA, OMV, VOE, and WIE have a similar and evident peak at around 12 CET. The volume patterns of the Polish stock mentioned above are in line with the autocorrelation function (in such cases, we notice reversed L-shaped patterns). The patterns of companies JBW, KERNEL, KGHM, PGE, PGNIG, PKOBP, and PZU are all of the form of a U, whereas BOGDANKA and GTC are not of typical shapes. In Figure 5, we present the typical shape of intraday pattern for selected companies (Austrian ANDR, German BAYN, and Polish BRE).

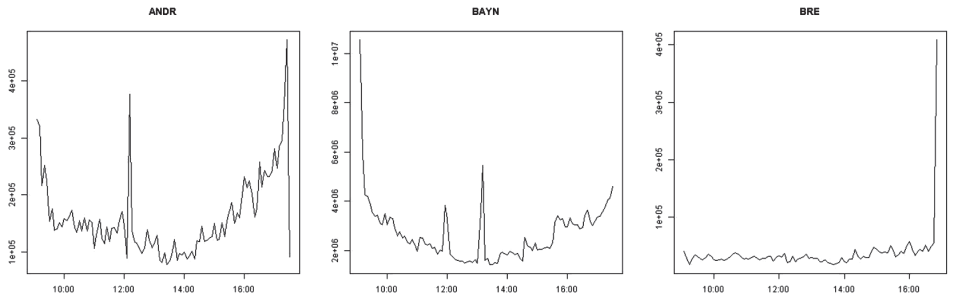

Figure 5. Intraday pattern of volumes for selected companies

Source: own elaboration

To investigate deeper trading activity, we use the trading volumes for each day of the week separately. In the case of DAX companies, the peaks at 11:55 and 13:10 (mentioned previously) are observed only on Friday. These peaks may reflect the impact of the information content of macroeconomic announcements both in the USA and Germany. For all other days, U and reversed-J shapes are typical. In Figure 6, the intraday pattern of BAYN is presented for each day of the week.

The same observation can be made with respect to the ATX companies mentioned above. The high peaks are observed only on Friday. For all other days, a disturbed U-shape is observed most often, with the largest value occurring at the beginning of the trading day. For Polish companies, a reversed-L shape and disturbed-U shape are observed most frequently, but there are days where none of the typical shapes can be recognized.

We test the day-of-the-week effect with the method used above (regression), but we now apply it to trading volumes. The conclusions are the same as for volatilities. The day-of-the-week effect is confirmed in all cases under study.

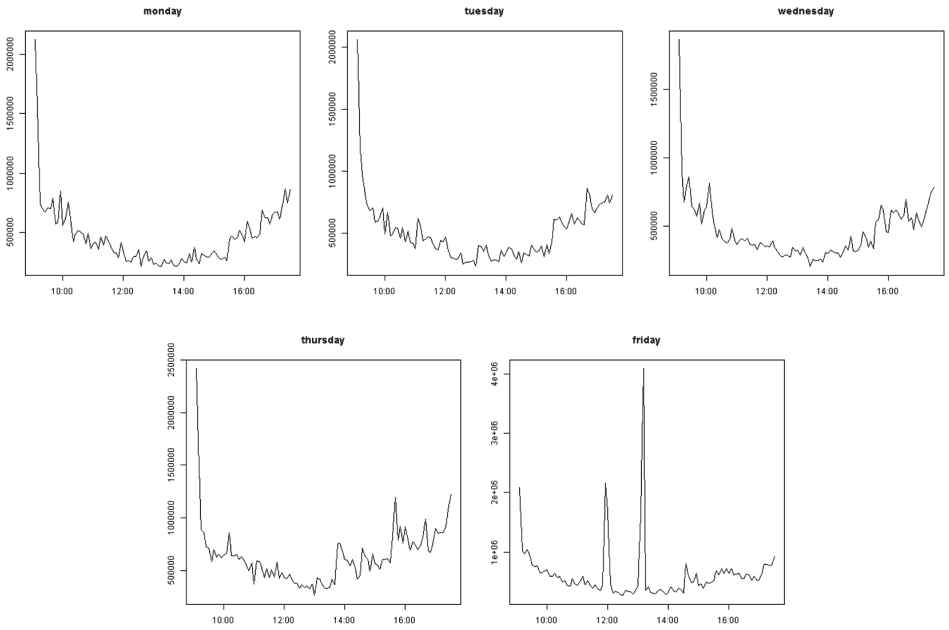

Figure 6. Intraday volume pattern of BAYN
Source: own elaboration

5. Conclusions

The aim of this paper was to show the differences in intraday patterns of volatilities and volumes across markets at the company level. In addition, the paper shows the practical usefulness of Flexible Fourier Form regression as a method of modeling periodicity in an intraday data. Moreover, the use of dummy variables in regression allows us to show the existence of the day-of-the-week effect in intraday data. We conclude that the regularity of autocorrelation and intraday patterns depend on the maturity level of the market under study. In the case of DAX companies, we observe the most-regular patterns of seasonality in autocorrelation functions, either for volatilities or volumes. A similar conclusion can be made for intraday patterns. For the ATX and DAX companies, a shape of the letter L or a reversed J is observed (which is in line with previous research) with an increase before 16 CET. The situation is different for Polish companies, which

are U-shaped (this is the case if clear pattern can be recognized). The analysis of intraday patterns of volumes leads to similar conclusions. We noticed U-shaped or reversed-J patterns for almost all DAX companies and for a few Austrian and Polish companies (here, the reversed-L shape is observed frequently).

To investigate the trading activity deeper, we use the volatilities and trading volumes for each day of the week separately. Either volatilities or volumes patterns are characterized by the day-of-the-week effect. In the case of ATX and DAX companies, the peaks in volumes are observed only on Friday, probably due to the high concentration of different kinds of announcements on Friday (both in Germany and the US). For all other days, the U and reversed-J shapes are typical. The same conclusion can be drawn for all companies under study.

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Earn-outs to bridge gap between negotiation parties – curse or blessing?

1. Motivation for using earn-outs

A number of circumstances have to be tackled and decided upon by the participating parties in the course of a company transaction. The main problem for the concerned parties (valuation subjects) is obviously the **valuation** of the company in question (the valuation object). Apart from a variety of possible valuation methods at their disposal, the aspired goals of the transaction, the subjective decision fields, and the expectations of the future performance of the company measured by its related future payments all play a decisive role in its valuation (Hering et al., 2016).

The computed marginal price as a maximal (minimal) willingness to pay (demand for payment) of the buyer (seller) is a crucial figure to evaluate the advantageousness of a company transaction (Hering and Toll, 2015; Hering et al., 2015b). If the marginal price of the seller is below the marginal price of the buyer, **the area of agreement is positive**, and there is a chance to reach a negotiation settlement. If, however, the minimum demandable price of the seller is higher than the maximum payable price of the buyer, there is **no potential area of agreement** in the initial round of negotiations. In this case, it is not as simple for the negotiating parties to yield an acceptable outcome for both sides of the negotiation. Around 90% of all initiated transaction processes are never closed and never result in a purchase contract (Borowicz et al., 2009, p. 77) since the conflicting points cannot be resolved (especially the question about an acceptable level of purchase price). The purchase price is particularly crucial, since it mirrors not only the expectations of any future payment surpluses of the company but also the number of additional conflicts that are channeled into it.

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As far as company transactions are concerned, it is certainly clear that the **information levels** of the concerned parties are different, which can be a main cause for divergent price expectations. The seller has an information advantage and is able to judge the future performance of the company more accurately than the buyer (Caselli et al., 2006, p. 97). The kind of information asymmetry depends on a number of company- and buyer-related factors (Kohers and Ang, 2000; Datar et al., 2001; Reuer et al., 2004). For instance, a listed company is subjected to certain corporate publicity regulations, which offers high transparency. The level of information asymmetry can also be inferred from the nature (tangible/intangible) and extent of the existing assets of the company. Companies that hold mainly intangible assets are more difficult to evaluate than those ones that possess assets for which market prices exist (Coff, 1999). The higher the efforts in research and development within a company or within a related branch, the more difficult it is to judge the future potential for success of the company from the viewpoint of a third party. If the buyer comes from a different line of business, it will be harder for him to get an idea about the potential future development of the company compared to someone who is familiar with the existing markets and technologies of this particular branch of industry (Coff, 1999). If the buyer and seller come from different nations, it is clear that the buyer has a knowledge deficit regarding the culture, habits, institutional circumstances, and market conditions of the target nation (Mantecon, 2009, p. 640). Apart from this, the regulations for disclosing information may differ from state to state such that the information asymmetry may be increased even further. If the former management of the company is on the buyer-side, the mentioned information asymmetries may only partially exist, since the executives are at least as well-informed as the former owners about the chances and risks of the transaction.

The question now is how the existing differences in price expectations of the transaction parties can be overcome such that an initial non-existent area of agreement encountered during the negotiations can be reversed into a consensus. For this purpose, many ways basically exist. For instance, the seller can give guarantees to pay corresponding compensations to the buyer if the expected targets of the company will not be reached. Besides this, **earn-outs** can be used to make the purchase price dependent on the future performance of the company (Toll and Rolinck, 2014). After a short characterization, we will discuss the suitability of earn-outs from the viewpoint of the buyer as well as the seller in the present contribution. Thereby, not only are the disadvantages addressed, but also the advantages. The contribution ends in Section 4 with a summary of our findings.

2. Characterizing earn-outs

2.1. The basic idea

Earn-outs are useful in separating the purchase price into an upfront fixed payment that is due at the transfer date (**base price**) and into a deferred variable part (**earn-outs**), whereby the variable components of the purchase price depend on the future economic development of the company or the realization of certain conditions that are laid out in a contract (Kohers and Ang, 2000, p. 445; Del Roccili and Fuhr, 2001, p. 88; Craig and Smith, 2003, p. 45; Reuer et al., 2004, p. 20; Frankel, 2005, p. 22; Caselli et al., 2006, p. 98; Ragozzino and Reuer, 2009, p. 858; Cain et al., 2011, p. 152).

For the enforcement of a company transaction by utilizing earn-outs we can distinguish between an improvement-option model and a multistage company purchase (Weiser, 2004, p. 513; Knauer and Pex, 2011, pp. 401–402). Whereas the buyer acquires only a certain part of the company in a **multistage company purchase** and is granted the right from the seller to buy further parts of the company at fixed exercise prices, the company is, by utilizing an improvement-option model, transferred completely to the buyer at the transfer date. In contrast, by means of an **improvement-option**, the fixed part of the purchase price (which becomes due at the closing of the transaction) is supplemented by additional payments that depend on the future performance of the company and may increase or even reduce the upfront fixed payment. Both variants normally increase the likelihood of a positive negotiation outcome. The granting of a call option enables the buyer to transfer a part of the economic risk to the seller so that the buyer is often willing to accept a higher purchase price for this opportunity. The seller receives the improvement-option for making concessions to the base price.

2.2. Elements

As a foundation for the computation of the additional payments, we must define a certain **metric** (Frankel, 2005, p. 22–23; Cain et al., 2011, pp. 155–156). Mostly, it is an observable performance measurement of accounting that can be precisely quantified and is inter-subjectively verifiable. For this purpose, sales, annual net profits, operating income, EBITDA, EBIT, or cash flow can be taken into consideration, to name just a few (Del Roccili and Fuhr, 2001, p. 90; Gundersen, 2005, p. 2; Caselli et al., 2006, p. 99). It is also possible to define non-financial metrics; e.g., the grant of a certain patent or the continued success of a valuable costumer relationship (Ziegler, 2016, p. 227). It is of great importance to choose a performance measurement that is complementary to the targets of the

buyer (e.g., concerning the maximization of profits, market share, technological leadership, etc.).

As the **basis for assessment**, we denote that part of the metric that is the numerical basis for the determination of the absolute level of the additional payments during the earn-out period (Weiser, 2004, p. 513). This may be the complete metric or only part of it. The absolute amount of the additional payments depends on the **participation** of the seller in reaching the basis for assessment whereby this participation will be contracted in a fixed or variable manner. It is conceivable that a certain earn-out payment will become due at the crossing of a pre-defined threshold or will change proportionally with the level of the assessment basis (Frankel, 2005, p. 24; Gundersen, 2005, p. 2).

The **earn-out period** is not defined consistently in the literature, but it typically has a time span from two up to five years (Datar et al., 2001, p. 202; Del Roccili and Fuhr, 2001, p. 88; Reuer et al., 2004, p. 20; Caselli et al., 2006, p. 99; Cain et al., 2011, pp. 156–157). Possible payment dates are within or at the end of the earn-out period, whereby the payments can be made in fixed or variable amounts as well as in cash or the form of company shares.

2.3. Functions

A central problem of company transactions is the information asymmetry between the negotiation parties (Datar et al., 2001), which can be overcome or at least mitigated by the **signaling function** of earn-outs (Datar et al., 2001, p. 231; Del Roccili and Fuhr, 2001, p. 88; Reuer et al., 2004, p. 20; Caselli et al., 2006, pp. 98–99; Ragozzino and Reuer, 2009, p. 876). If the negotiation situation comes to a stalemate and the marginal price of the seller is above that of the buyer, there is no area of agreement between the negotiation parties. The earn-out method allows the buyer to transfer a part of the business risk of not realizing the expected future performance of the company to the seller (Kohers and Ang, 2000, p. 445; Reuer et al., 2004, p. 20) and increases his willingness to pay a higher purchase price in return (Frankel, 2005, p. 22). On the other hand, the seller is willing to reduce the fixed purchase price claim if he is confident that the remaining part of the "desired price" can be realized by means of earn-outs. Thus, the limits of their respective **willingness to concede**, as far as the purchase price is concerned, can approach each other and can open a window of opportunity for a positive area of agreement (Del Roccili and Fuhr, 2001, p. 88; Ziegler, 2016, p. 226).

From the viewpoint of the buyer, the company transaction is an investment. Financial means must be raised, which may come from various sources. Besides the classical instruments of debt and equity financing, earn-outs can make a **contribution to funding** (Craig and Smith, 2003, p. 46; Gundersen, 2005, p. 2).

It is characteristic for earn-outs that the purchase price is not paid in a one-off payment but is spread over the earn-out period in the form of one or more payments depending on the ex-post company success. This form of purchase-price distribution is similar to a loan that is granted from the seller to the buyer and is paid back by means of earn-out payments.

An earn-out agreement has an **incentive and motivation function** for the seller to remain active and to provide his specific skills and knowledge within the target's management. In this manner, he is able to keep control over the determining metrics to realize the desired price in a proactive way (Datar et al., 2001, p. 202; Del Roccili and Fuhr, 2001, p. 88; Kohers and Ang, 2000, pp. 447–448; Caselli et al., 2006, pp. 98–99; Cain et al., 2011, p. 152).

3. Assessment of earn-outs from vantage points of negotiation parties

3.1. Suitability of earn-outs from buyer's viewpoint

Because of the deferral of the purchase price, the seller is still faced to the risk of not realizing the expected future success of the company such that an agreement on earn-outs is especially interesting for the buyer if the future development of the target cannot be predicted or can be predicted only under severe difficulties (Toll and Rolinck, 2014, pp. 156–158). The **risk to overpay is reduced** in case the company will not live up to its expectations in the foreseeable future (Kohers and Ang, 2000, pp. 446–447; Del Roccili and Fuhr, 2001, p. 89; Caselli et al., 2006, p. 98; Ragozzino and Reuer, 2009, p. 859). Apart from this, the buyer spares valuable cash. The buyer has fewer problems raising the appropriate financing for the acquisition of the company since the payments become due no earlier than when the company is on the road to success. For fixing the additional payments, the transaction parties must exercise caution to prevent them from having a "strangling" effect. This could take away incentives from the buyer to undertake his part of the necessary commitments for reaching the economic success during the earn-out period. This can be alleviated by capping the additional payments (Caselli et al., 2006, p. 99; Ragozzino and Reuer, 2009, p. 860) or by the decreasingly structured participation of the seller. Moreover, the earn-out period should not be too long since the buyer may have more problems to integrate the target into his current corporate structure the more that time passes (Ziegler, 2016, p. 228).

The transfer of the **financing function** to the seller means that the buyer spares liquid capital and needs to raise less debt and has fewer obligations to pay for interest and amortization (Del Roccili and Fuhr, 2001, p. 89). The variable parts

of the purchase price can be financed partially through retained earnings. However, the seller needs to be assured that the buyer actually honors his pledge to make the promised additional payments, which may become due dependent on metrics that only indirectly relate to liquidity (like the grant of a certain patent or the development of a new product). To face these problems, it lends itself to draft the possible earn-out payments at the closing date to a deposit on a fiduciary account or to secure the payments by backing them with assets or by a bank guarantee (Hilgard, 2010, p. 2916; Ziegler, 2016, p. 231). However, the capital commitment by using a fiduciary account undermines the intended financing function.

Company transactions are often characterized by the fact that the information about the company is distributed unevenly between the negotiation parties. The main cause is that the seller has inside information about the company, whereas the buyer only can obtain beneficial knowledge by analyzing past annual financial statements. With respect to an information economic context, pre-contractual asymmetric information entails the danger of **adverse selection**. Akerlof illustrated the concept of adverse selection with the aid of used-car markets (Akerlof, 1970). If the situation of a used-car buyer is one-to-one transferred to the buyer of a company, we can indeed observe parallels. Adverse selection occurs because of an information gap between the buyer and the seller, which exists ex-ante. Only the seller is really informed about the true quality of the company and has the incentive to present his company most favorably. Thus, the buyer must carry a quality risk and is inclined to assume only an average quality of the valuation object. He is therefore only willing to pay an average purchase price. However, the seller of a company of above-average quality may not be willing to accept a below-average price. A transaction to an average price is only attractive for those sellers who offer companies with below-average quality. Hence, only companies with below-average quality are offered for sale at this price. To let a seller of a company with good quality realize his desired transaction price, the potential buyer must be persuaded to increase his willingness to pay by signaling this higher quality to the buyer-side. Such a **signal** could be the implementation of earn-outs into the purchase contract (Caselli et al., 2006, pp. 98–99). The seller signals his pledge to carry a part of the entrepreneurial risk beyond the closing date of the transaction. This is an important signal to the buyer that the risks to actually overpay are diminished (Reuer et al., 2004, p. 20; Ragozzino and Reuer, 2009, p. 859). In return, he may be willing to accept a higher purchase price. Thus, we can state that the concession of the seller to arrange a performance-related price facilitates the burden to the buyer to distinguish between valuable and less-valuable companies and reduces the risk for him to overpay for the company.

If the seller will carry on management of the company, the agreement on earn-outs **gives him an incentive to make greater efforts towards the company's**

success (Baums, 1993, pp. 1275–1276; Del Roccili and Fuhr, 2001, p. 89; Weiser, 2004, p. 516; Knauer and Pex, 2011, pp. 403). Moreover, this has the additional advantage for the buyer that **valuable knowledge is retained** within the company (Del Roccili and Fuhr, 2001, p. 89). Especially, if we consider owner-managed companies, the seller will have enlarged knowledge with regard to customers, markets, and their corresponding technologies.

If the seller is managing the business, the buyer could be confronted with the problem of **moral hazard**. Here, we have a bilateral cooperation in which a principal (buyer) delegates a better-informed agent (seller) to carry out a certain task (managing the business) (Jensen and Meckling, 1976). Here, we have a special situation since the interests of both agents oppose each other and at least one party has superior information, which he could opportunistically exploit. Even if both information levels are (nearly) identical at the transfer date, that of the managing party will increase over time (Behringer, 2004, p. 247). Since the level of earn-outs is a matter of conflict between both parties, the seller has an incentive to exploit this information advantage and influence the basis of assessment defining the earn-outs for his own benefit and to the detriment of the principal (Frankel, 2005, p. 24; Baums, 1993, p. 1276; Behringer, 2004, pp. 247–248). If the annual net profit is used as a basis for assessment, the temptation for the seller is high to postpone necessary expenditures like those needed for maintenance or research and development (Del Roccili and Fuhr, 2001, p. 90). If sales are the basis for assessing the additional payments, it is possible for the seller to increase sales in the short term by offering price discounts or by increasing advertising, which may deteriorate the future prospects of the company in the long term. Also, leeway in accounting rules like options to capitalize or valuation options can be exploited in the seller's favor (Gundersen, 2005, pp. 2–3). Not least, it is required to agree on associated post-closing non-competition clauses (Gundersen, 2005, p. 2) to enjoin the managing seller from poaching employees and/or customers as well as passing internal information to competitors for his own benefit (Baums, 1993, p. 1276).

There are manifold **possibilities to manipulate** for the seller that must be *prevented* by appropriate measures. Thus, the buyer should covenant that he is able to exercise extensive rights of participation and control (Baums, 1993, p. 1276; Behringer, 2004, p. 247). The integration of a catalog of transactions into the purchase contract that are subject to approval would also counteract manipulations. To prevent the omission of necessary operating expenditures, a budget for research and development or certain principles for carrying out investments and depreciations could be set out in the contract (Frankel, 2005, p. 24). Apart from this, it would lend itself to integrate the acquired company into the investment controlling of the acquiring company. The best protection against manipulations would be to define the basis for assessment for the earn-outs that is least-prone

to error and can be precisely defined. Thereby, it could be specified how any exceptional circumstances should be handled. To prevent litigation, it is useful to exemplify the computation of the basis for assessment within the appendix of the purchase contract (Hilgard, 2010, p. 2914; Ziegler, 2016, p. 228).

Should the seller resign from the company after the sale, his influence on the success of the company and the outcome of the decisive quantities (which determine the additional payments) is diminished. He has to reckon that the buyer will act opportunistically and will try to prevent further earn-outs. Of course, the seller wants to counteract such behaviors by means of an appropriate drafting of the contract. For this purpose, concrete arrangements for the form of management, determination of the governing metrics (which define the additional payments), and participation and control rights have to be made (Gundersen, 2005, p. 3; Baums, 1993, p. 1276). These arrangements can strongly **restrict** the buyer **in his entrepreneurial freedom** since he may not be able to realize important projects, like the integration of the acquired company (Datar et al., 2001, p. 203; Frankel, 2005, p. 24). Furthermore, he loses a certain degree of flexibility since he must first assess the conformity of upcoming decisions with contractual agreements and has to coordinate them with the seller. If the buyer is concurrently managing the company, he has to take care that the contractual agreements will not restrict his entrepreneurial freedom to act too much; in particular, as far as the realization of possible synergy effects is concerned (Behringer, 2004, p. 250; Weiser, 2004, p. 517). Otherwise, a corporate transaction combined with earn-outs is unattractive from the buyer's viewpoint.

A contract that takes into account all possible contingencies that may occur in the wake of a transaction needs to be considerably complex (Ragozzino and Reuer, 2009, p. 860). The resulting **high transaction costs** reduce the advantageousness of an agreement on earn-outs (Datar et al., 2001, p. 203; Reuer et al., 2004, pp. 19–20; Frankel, 2005, pp. 22–25) since it is almost impossible to consider all contingencies, and it is foreseeable that arguments concerning the proper interpretation of the agreements could arise ex-post. The related potential costs are initiation and contractual costs as well as the costs for safeguards (e.g., for the adaptation of the contract to changed conditions) and enforcement (e.g., for legal fees).

3.2. Suitability of earn-outs from the seller's viewpoint

Utilizing earn-outs is especially useful from the perspective of the seller if he does not succeed in realizing his price expectations in the first place or has difficulties in finding a buyer for his company (Del Roccili and Fuhr, 2001, p. 89; Behringer, 2004, p. 247; Hilgard, 2010, p. 2913; Toll and Rolinck, 2014, pp. 158–159). Primarily, an agreement on earn-outs provides an **opportunity to**

proceed with a corporate transaction that would not be realizable without the implementation of such an instrument (Cain et al., 2011, p. 152). By declaring his motivation to accept a performance-related price and to assume some part of the risks, he widens the spectrum of potential buyers.

By means of a preparedness to agree on earn-outs, the seller sends an important signal to potential buyers. However, the seller will only do this if he is truly convinced of the future potential for success of his company (Caselli et al., 2006, pp. 98–99). A buyer will tend to estimate the quality of such a company higher and will be willing to accept a higher purchase price than without such a signal. It can be taken for granted that an agreement on earn-outs has an impact on **achieving a higher selling price** (Del Roccili and Fuhr, 2001, p. 89). In addition, it is possible for a managing seller to influence the level of the purchase price further on proactively by accepting performance-related earn-outs (Datar et al., 2001, p. 203).

On the other hand, by agreeing to a partially performance-based selling price, the seller takes the risk that he will **fail to receive his desired selling price** and must be even prepared to suffer a potential total loss of additional payments (Del Roccili and Fuhr, 2001, p. 90). It is conceivable that the buyer is incapable of making the contractually arranged additional payments to the seller if he is in a situation of insolvency or short of liquidity. Hence, the seller bears the credit risk of the buyer, which of course can be alleviated by agreements on collateral.

Especially in the cases in which the seller carries on managing the business, he has increased pressure to succeed and **cannot terminate his engagement in the company** (which may have been the initial (main) motive for the corporate sale) (Baums, 1993, p. 1275). This also holds true if he is not actively involved in management anymore but must execute certain contractually arranged participation and control rights. Furthermore, a seller who still manages the business may experience **motivational problems** (Meuli, 1996, p. 83). While forgoing the prompt appropriation of a fair and just selling price (in his view), he is instead responsible for achieving certain performance targets but is not allowed to reap the ripe and well-earned "fruits" and keep them all for himself.

From the seller's viewpoint, contractual obligations can have a negative effect on the **freedom to act** (Baums, 1993, p. 1276). If he still runs the business, he has to manage the company as stipulated in the contract. If he resigns from the company, there could be a post-contractual competition restraint to keep him from exploiting inside information for his own advantage.

If the seller leaves the company at the transfer date, he is in danger of **suffering disadvantages by the opportunistic behavior of the buyer**. The buyer will try to use his full creativity to keep the earn-outs as minimal as possible (Frankel, 2005, p. 24). Apart from the exploitation of leeway in accounting rules, concealing the basis for assessment (Behringer, 2004, pp. 246–248) or shifting the earnings

to years that are beyond the earn-out period (Del Roccili and Fuhr, 2001, p. 90; Frankel, 2005, p. 24; Ziegler, 2016, p. 228), the seller faces further risks. Maybe he must defend himself against efforts by the buyer to sell the company to a third party or transfer its headquarters abroad (Del Roccili and Fuhr, 2001, p. 91). As a result, it could happen that the accounting rules change and the performance measures determined from the annual financial statements become incomparable as a result (Craig and Smith, 2003, p. 47). If the buyer is already in possession of one or more companies, he will try to integrate the purchased company into his current corporate structure. This can go even so far that the business operations of the target company are completely or partially transferred to another company or certain operating units are united under the roof of a corporate group (Gundersen, 2005, p. 2; Caselli et al., 2006, p. 99). In this case, the seller is exposed to the risk of a distorted success indicator concerning the acquisition object if arbitrary transfer prices are used in accounting during the earn-out period (Datar et al., 2001, p. 203). Thus, the computation of the basis for assessment of the earn-outs would be made more difficult at best. In the extreme case, the basis for assessment would no longer reflect the actual economic success of the target.

The seller must be especially careful to not be discriminated against if the buyer manages the company within the earn-out period. The seller could be in danger of being exposed to **manipulations** that affect the additional payments and unable to do anything against them (Baums, 1993, p. 1274; Behringer, 2004, pp. 246–248; Weiser, 2004, p. 517; Hilgard, 2010, p. 2913). Because of this reason, the earn-out period should be not too short. This would rather increase the incentives for the buyer to shift earnings from the earn-out period to subsequent years. On the other hand, the opportunities for the seller to influence and control are fewer the longer the earn-out period is. Hence, supplementary to an agreement on earn-outs, the seller will often demand the additional (minimal) assurance that he is contractually guaranteed the opportunity to exert influence (e.g., in the position of a managing director or as a member of supervisory or advisory boards) during the earn-out period (Gundersen, 2005, p. 3; Behringer, 2004, p. 248).

4. Summary and outlook

Earn-outs are an interesting approach to overcoming divergent price expectations. However, there is a substantial potential for conflict in the formulation and implementation of a concrete agreement on earn-outs (Del Roccili and Fuhr, 2001, p. 89). Thus, the disparate interests of the conflicting parties (especially with regard to the price) and their different information levels require a relatively complex contract arrangement, which is associated with high transaction costs.

Of course, existing information asymmetries could be mitigated in the beginning by considering valuation reports and/or exercising due diligence in investigating the company. However, these asymmetries cannot be completely removed even by these means. The use of earn-outs out of the pure wish of creating seemingly better financing for the transaction seems to be inappropriate (Meuli, 1996, p. 90). For this purpose, there are a number of less-complex contractual means available, like re-investments, vendor loans, or company purchase on an annuity basis. Because of the significant potential for conflict, it is recommended to set out certain procedures in the purchase contract (which could come into effect during mediation in the case of lawsuits). For this purpose, it is possible to appoint certain arbiters or arbitration courts (other than an auditor) in advance (Baums, 1993, p. 1275; Hilgard, 2010, p. 2917). To avoid such confrontations from the start, we must pay special attention to the careful and precise formulation of the earn-out agreement. In particular, we must take great care in writing a clear definition of the process that determines the profit sharing as well as a diligent provision of the rights and duties of the transaction parties (Weiser, 2004, p. 518). If the above-mentioned aspects are considered for the arrangement of a company transaction, the earn-out method can be truly beneficial for both negotiation parties and can contribute to the final success of otherwise-impossible-seeming transactions (Del Roccili and Fuhr, 2001, p. 93).

The corresponding literature on earn-outs consists in large part of publications that analyze this topic by the means of empirical post-studies, which address the Anglo-Saxon area in particular (Kohers and Ang, 2000; Datar et al., 2001; Reuer et al., 2004; Cain et al., 2011). However, the situation in the European Economic Area (and especially in Germany) has been studied only marginally (Ewelt-Knauer et al., 2011; Heimann et al., 2012). Unfortunately, data from ex-post studies can only give minor information for managerial decisions with a future perspective. Hence, there is a substantial demand for further research on ex-ante considerations for the determination of company transactions involving earn-outs. In the main part of the literature dealing with valuation problems, finance-theoretical valuation approaches are used (Crasselt and Lukas, 2008; Tallau, 2009a; Tallau, 2009b; Tallau, 2010; Ihlau and Gödecke, 2010). However, valuation methods based on financing theory assume a fictitious perfect market (Markowitz, 1952; Gordon, 1959; Modigliani and Miller, 1963; Sharpe, 1964; Lintner, 1965; Mossin, 1966; Black and Scholes 1973; Cox et al., 1979; Rappaport, 1981; Koller et al., 2010, Damodaran, 2011). These methods do not take into account the individual expectations of the specific valuation subject. Instead, they pursue a futile quest for the one true value that must be generally valid. Such methods are inappropriate to indicate the limit of the concession willingness of a decision maker under realistic conditions (Hering et al., 2014a, p. 49; Hering et al., 2014b, p. 41; Her-

ing et al., 2015a). For this purpose, investment-theoretical methods are more appropriate. Hence, for company transactions involving earn-outs, there seems to be a need to develop investment theory-based valuation methods that consider both existing market imperfections (e.g., debt limits or bid-ask spreads) and the individual expectations of a specific decision maker.

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SUMMARIES

Mateusz Codogni, Joanna Duda, Rafał Kusa: **Entrepreneurial orientation in high--tech and low-tech SMEs in Malopolska region** ▪ Managerial Economics 2017, vol. 18, no. 1

JEL Classification: L2, L26

Keywords: *SME, entrepreneurial orientation (EO), high-tech enterprises, low-tech enterprises, innovativeness*

The aim of this paper is to examine the entrepreneurial orientation (EO) of SMEs in the Malopolska region of Poland. Our specific aim is to confirm the relationship between selected company characteristics (the level of technological development and stage of organizational development) and entrepreneurial orientation. A survey was conducted in a group of 95 SMEs that form high-tech and low-tech industries in the Malopolska region. Our findings suggest that enterprises representing the high-tech industry exhibit higher EO than those from the low-tech industry. The findings display an imbalance in EO dimensions in both groups of enterprises, showing that innovativeness plays the most important role in enterprises from high-tech industries. The results suggest an inverse monotonic relationship between EO and a company's age, but they do not confirm any relationship between the EO and a company's size. Our results contribute to the theory of entrepreneurship by identifying the dependence of EO on industry type (low-tech versus high-tech) and company age.

Anna Czapkiewicz, Tomasz Wójtowicz: **Spatial contagion between stock markets in Central Europe** ▪ Managerial Economics 2017, vol. 18, no. 1

JEL Classification: G01, G11, G15

Keywords: *contagion, CEE markets, risk management, tail dependence, copula function*

In this paper, we investigate contagion between three European stock markets: those in Frankfurt, Vienna, and Warsaw. Two of them are developed markets, while the last is an emerging market. Additionally, the stock exchanges in Vienna and Warsaw are competing markets in the CEE region. On the basis of daily and intraday returns, we analyze and compare the dependence between the major indices of these markets during calm and turbulent periods. A comparison of the dependence in the tail and in the central part of the joint distribution of returns (via a spatial contagion measure) indicates strong contagion among the analyzed markets. Additionally, the application of a conditional contagion measure indicates the importance of taking into account the situation on other markets when contagion between two markets is considered.

Andrzej Czyżewski, Łukasz Kryszak: **Agricultural income and prices. The interdependence of selected phenomena in Poland compared to EU-15 member states** ▪ Managerial Economics 2018, vol. 18, no. 1

JEL Classification: Q11, Q12, Q14

Keywords: *agricultural income instability, price gap, subsidies and payments, incomes of family-run agricultural holding, net income*

The aim of this paper was to analyze the changes in various agricultural income measures in Poland since 2004 as compared to the situation of the EU-15 member states. Another objective

was to examine the mentioned changes against prices. The main source of income data was the FADN database. Incomes of agricultural holdings in Poland are significantly lower than of those in most of the analyzed member states; however, this is the result of their smaller average area – their efficiency per hectare is relatively high. Polish agricultural holdings are also characterized by their comparatively small dependence on payments (although this is growing). Agricultural incomes are highly unstable, which refers to changes in price relations. This instability is particularly evident in countries with smaller farms and, thus, lower income per farm.

Anna Doś: **Multi-criteria decision methods for CSR management – literature review** ▪ Managerial Economics 2017, vol. 18, no. 1

JEL Classification: G30, L21, M14

Keywords: *financial management, business sustainability, value-based management, decision-making*

Business today faces a managerial transition to adapt a new decision-making criterion and a course of action; namely, "corporate sustainability." Corporate social responsibility can be embedded in (or fostered by) value-based management. In any case, adopting CSR as a part of a firm's strategy and operations requires changed standards for decision-making. Decision-makers face the challenge of following tangible and intangible goals of multiple stakeholders. This study provides insights into how multi-criteria decision tools can be harnessed to operationalize CSR. The method applied in the article is a systematic international literature review. The findings suggest that papers aimed at using MCDM to enhance CSR management are mostly newer publications. Three important research avenues have emerged. In the first avenue, MCDMs are seen and used to enhance managerial decisions where a number of heterogenic goals must be achieved. The second avenue is where MCDMs are seen and used to evaluate a firm's quantitative and qualitative outcomes in terms of values created for multiple stakeholders. The third trend is connected with sustainable supply-chain management.

Henryk Gurgul, Robert Syrek: **Trading volume and volatility patterns across selected Central European stock markets from microstructural perspective** ▪ Managerial Economics 2017, vol. 18, no. 1

JEL Classification: G15, G19

Keywords: *high frequency data, flexible Fourier form regression, intraday patterns*

In this paper, the intraday patterns of trading volumes and volatilities as well as autocorrelations are investigated using high-frequency data. The analysis is performed for companies listed in the main German, Austrian, and Polish indices with the aid of Flexible Fourier Form regression. We have found some similarities to prior investigations in light of stylized facts about intraday patterns. We noted the differences in intraday patterns and autocorrelations across markets, which depend on the maturity level of the market. The most-regular patterns are observed for DAX companies. Additionally, using day-of-the-week dummies, we discover some peaks that can be associated with macroeconomic announcements in Germany and the US. This leads to conclusions that the day of the week and announcements should be taken into account in modeling volatilities (returns) and volumes from high-frequency data.

Christian Toll, Jan-Philipp Rolinck: **Earn-outs to bridge gap between negotiation parties – curse or blessing?** ▪ Managerial Economics 2017, vol. 18, no. 1

JEL Classification: D92, G00, G30, G34

Keywords: *mergers and acquisition, asymmetric information problem, earn-out*

An agreement upon the terms of company transactions is aggravated by the existence of differ-ent information levels concerning the negotiation parties; this can be seen as a basic cause for divergent price expectations. Hence, the question is how the existing differences in price expectations of the transaction parties can be handled to reach a consensus, even when there is no area of agreement in the initial round of negotiations. Earn-outs are an interesting approach in overcoming divergent price expectations by making the purchase price dependent on the future performance of the company. However, formulating and implementing earn-outs may have a substantial potential for conflict. The present contribution shows which advantages and disadvantages the transaction parties face if an agreement regarding earn-outs is made.

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- the Abstract is concise and informative,
- the facts and interpretations are satisfactorily separated in the text,
- the interpretations and conclusions follow from the data,
- the length and structure of the paper is appropriate,
- the paper can be shortened without loss of quality,

- all the tables and figures are necessary,
- the diagrams and photographs are of good quality,
- there are all essential figures that should be prepared,
- all the references are exact,
- the manuscript requires proof reading by native speaker,
- there is sufficient attention given to previous research.

5. The names of the referees of particular articles are classified.

6. Once a year the journal publishes the complete list of referees.