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Jakub Bartak*

Does income inequality hamper human capital accumulation in OECD countries?**

1. Introduction

The phenomenon of income inequality has become a widespread concern of economic thought in recent years. Income disparity analyses are not limited to Marxist or Keynesian economics anymore but are also intensively undertaken in mainstream economics. Most research in this area focuses on the consequences of the absolute level and dynamics of income inequality. Many scholars have attempted to explain the impact of the income distribution on economic processes through a variety of channels, including human capital (Galor, 2011a); political processes (Alesina and Rodrik, 1994; Acemoglu, 2003; Rajan and Zingales, 2006); incentives for working hard (Bell and Freeman, 2001; Kuhn and Lozano, 2008); physical capital accumulation (Kaldor, 1955), social capital (Alesina and Perotti, 1996; Uslaner and Brown, 2005; McKnight and Nolan, 2012), and most recently through financial stability channels (Fitoussi and Saraceno, 2010; Ranciere and Kumhof, 2010; Stiglitz, 2012; Tomkiewicz, 2012).

Although each of these problems provides many interesting research questions, the channel of human capital seems to require the most urgent inquiry. First of all, human capital is accepted by many as the main engine of economic development (Becker, 1994; Benhabib and Spiegel, 1994; Hanushek, 2013). Second, the theory behind income inequality and human capital relationships is well-grounded in economic thought. Nonetheless, this relationship is still not fully exploited in the empirical literature. Consequently, the aim of the present paper is to advance empirical research in this area and to provide evidence on the effects of income inequality on human capital accumulation in OECD countries.

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The structure of the paper is as follows: Part 1 presents a theoretical background for the present inquiry. Part 2 focuses on empirical research methods, and Part 3 describes data sources and variable definitions. Part 4 presents the estimation results, followed by the conclusions.

2. Theoretical underpinnings

The most-prominent theoretical research on the interdependencies between income inequality and human capital was conducted by Galor (Galor and Zeira, 1993; Galor, 2011a, 2011b), who suggests that the impact of income inequality on human capital is clearly negative and stems from the fact that a high concentration of income and wealth empowers only a few to make human capital investments. While this is not a problem in the case of physical capital (as the high investments of a few rich individuals may compensate for the lack of these investments among the numerous poor), it makes an investment in human capital sub-optimal. Galor argues that individual human capital accumulation is subject to diminishing returns, as a human being's capacity to learn is constrained by various physiological factors. Therefore, it is impossible for a few rich individuals to accumulate such a big stock of human capital that would compensate for the lack of human capital among the poor. The argument is at the core of the unified growth theory (Galor, 2011b), according to which income inequalities inhibit growth in those economies where human capital is the main engine of development.

Theoretically, the negative impact of wealth and income inequality on human capital can be mitigated by efficient credit markets, so that all individuals (including those poor) can borrow funds for investment. Under the conditions of perfectly competitive markets, it does not matter whether the investments in human capital are made from borrowed funds or from assets accumulated in previous periods. Economic reality shows, however, that there are significant market failures, particularly in the market of loans for human capital investments. The high costs of monitoring and difficulties in securing education loans boost the price of credit much above an efficient market price. As a result, many authors argue (Banerjee, 2004; Attanasio and Kaufmann, 2009; Kaufmann, 2014) that the costs of loans for education are so high that they discourage human capital investments.

Insufficient investments in human capital are undoubtedly offset by publicly subsidized schooling at all levels of education. This does not mean, however, that income inequalities do not play any role in countries offering such services free of charge, as individuals need to incur other types of expenses on human capital than tuition fees. The Polish example shows that, despite the large availability of public education offered, there are still significant constraints for investments in human capital among the poor. This is documented by, among others, educational horizontal inequality (indicating the low share of students from poor families on prestigious educational paths) and evidence of the impact of the financial situation of a household on educational achievements (Herbst and Rok, 2014; Czarnecki, 2015; Rószkiewicz and Saczuk, 2015).

The mechanism described above is believed to be magnified by fertility differentials between the poor and the rich (Becker et al., 1994; Dahan and Tsiddon, 1998; De La Croix and Doepke, 2003). If poor families choose to have many children (who will receive little education), then the supply of unskilled labor will increase. Accordingly, this will further lower the wages of low-skilled workers and hinder investments in human capital in the next generation. Such a conclusion is based on the negative correlation between fertility and income, which has been observed in the overwhelming majority of modern economies (Kremer and Chen, 2002). Recent evidence shows, however, that this argument may lose its significance, as the pattern of this relationship is rather U-shaped than linear. This means that both poor and rich families decide to have more children than middle-class households (Hazan and Zoabi, 2015).

The economic literature also indicates the indirect impact of inequalities on human capital accumulation through the channel of social capital. Many scholars argue that social capital reduces the investment costs of education, facilitating the spill-over effects of human capital at the family and local community levels, and provides additional incentives for education (Coleman, 1988; Schuller, 2001; Piazza-Georgi, 2002; Acar, 2011). Thus, low social capital is believed to be a barrier to the development of human capital (Wosiek, 2014). At the same time, there are compelling theoretical and empirical arguments pointing to the negative impact of income inequality on social capital, resulting from a lack of trust inherent to unequal societies (Uslaner and Brown, 2005; Greiner et al., 2012) and from status anxiety that pushes individuals to compete for status (Pickett and Wilkinson, 2009). Therefore, by hindering social capital, income inequalities are believed to block the development of human capital.

All of the above arguments suggest the strong impact of income inequality on human capital. In particular, it can be assumed that low income inequalities tend to facilitate human capital accumulation and that an unequal distribution of income is a barrier to the development of this production factor.

3. Empirical strategy

In order to verify the effects of income inequality on the accumulation of human capital in OECD countries, estimates of the dynamic panel model were conducted. The model was estimated by means of the System Generalized Method of Moments (SGMM), a method developed by Arellano and Bover (Arellano and Bover, 1995).

This method was chosen for several reasons. First of all, theoretical considerations indicate that the accumulation of human capital depends on various factors, not just on income inequalities. Therefore, one should look for the appropriate control variables. Yet, some human capital determinants (such as institutional solutions in the educational sphere that determine the quality of the schooling system) are extremely difficult to measure. The lagged dependent variable may serve as a proxy for these determinants. The inclusion of such a variable among the regressors reduces the risk of omitted-variable bias; but at the same time, it gives concerns about the endogeneity of this variable. Moreover, the endogeneity problem also applies to other explanatory variables, which makes the static panel models the incorrect choice. In addition, the available data forms a short panel, which makes using a static model with fixed effects (as a solution to omitted-variable bias) inappropriate. Therefore, it seems reasonable to use SGMM, which was designed to address the above-mentioned econometric issues. SGMM combines equations based on variables in the first differences (where explanatory variables are instrumented with lagged values of those variables) with equations based on variables in absolute levels (which are instrumented with lagged first-differenced variables). Instrumenting explanatory variables allows us to reduce the problem of endogeneity. What is more, for short panels, SGMM is preferred to its sister method (FDGMM – First Difference GMM), as it increases the efficiency of estimation (Dańska-Borsiak, 2009, p. 30; Brzezinski, 2013, p. 14). Consequently, SGMM was chosen as an estimation method. To check the consistency of the SGMM estimator, the Sargan-Hansen test (testing the joint validity of instruments) and AR(2) test (testing if the error term is not second-order serially correlated) were conducted and reported.

The regression model of human capital inflow adopted in this paper is as follows:

$$H_{i,t} = \alpha_1 H_{i,t-1} + \alpha_2 \mathrm{Ineq}_{i,t-1} + \alpha_3 X_{i,t-1} + \eta_{i,t} \qquad (1)$$

where:

$H_{i,t}$ – inflow of human capital in *i*-country in *t* time period,
$H_{i,t-1}$ – inflow of human capital in *i*-country in $t-1$ time period,
$\mathrm{Ineq}_{i,t-1}$ – income inequality in *i*-country in $t-1$ time period,
$X_{i,t-1}$ – set of control variables in *i*-country in $t-1$ time period,
$\eta_{i,t}$ – residual factor,
$\alpha_1, \alpha_2, \alpha_3$ – regression equation parameters.

Set of control variables $X_{i,t-1}$ includes additional determinants of human capital inflow, such as:

$Dev_{i,t-1}$ – GDP per capita in *i*-country in $t-1$ time period,
$Edu_{i,t-1}$ – Stock of human capital in *i*-country in $t-1$ time period,
$Urban_{i,t-1}$ – share of urban population *i*-country in $t-1$ time period.

It is assumed that the effects of income inequality (and other variables) on human capital accumulation do not manifest year-to-year but over a longer period. Thus, the model is based on data divided into 5-year periods. The explanatory variables are delayed by one (5-year) period.

The independent variable in the model represents the inflow of human capital associated with the skills and competences of young generations. Modeling the inflow of human capital provides a way of omitting the issues related to changes in the stock of human capital associated with cohort differences and aging.

The model contains a set of control variables. Controlling the stock of human capital (i.e., aggregated human capital accumulated during previous periods) results from the recognition of positive externalities of human capital that facilitates further investment in this production factor (Barro, 1989; Azariadis and Drazen, 1990; Romer, 1993); meanwhile, controlling GDP per capita stems from theoretical findings that imply complementarities of human and physical capital and the importance of the demand for human capital that is greater in advanced economies (Caballé and Santos, 1993; Redding, 1996; Reinert, 2005, p. 7). Finally, including the urbanization variable in the model enables us to control the relatively high cost of education in countries that are sparsely populated. Including these control variables (next to the lagged dependent variable) increases the probability that the estimated coefficient of the inequality variable truly reflects the distributional effects and is not merely picking up another type of human capital determinant.

The specification of the regression equation is close to the related empirical research in this area. Perotti (Perotti, 1996), whose work is a pioneering attempt in this field, included among the control variables the level of economic development, the stock of human capital, and a dichotomous variable indicating poor countries. In turn, Battisti, Fioroni, and Lavezzi (Battisti et al., 2014) control only for the stock of human capital. In her attempt to estimate the impact of the inequality of education for human capital accumulation among the control variables, Castello-Climent (Castelló-Climent, 2010) included the stock of human capital, the level of economic development, the degree of urbanization, public educational expenditure, and a dichotomous variable indicating the least-developed countries. All of the above studies were based on cross-sectional data. The novelty of the present paper is, thus, the estimation of the income inequality – human capital relationship in the dynamic panel set.

4. Data sources

The present paper utilizes recent developments in human capital and income inequality indicators. First of all, the dependent variable is measured by the *average adjusted test scores* that were retrieved from the Global Education Achievement

World Bank Dataset (Angrist et al., 2013). Skills-test scores are believed to capture the human capital of young generations much better than purely quantitative measures such as enrollment rates. This is documented by, among others, a comparison of the growth regressions that use quantitative indicators of human capital with those using qualitative indicators. Such a comparison reveals that qualitative measurements of human capital are much better predictors of economic growth rates than measurements of school attainment (Hanushek, 2013, p. 8). Therefore, it is justified to believe that the use of *average adjusted test scores* reduces the measurement errors connected with the complex task of human-capital quantification.

Income inequality was measured by the Gini coefficient of net disposable income derived from the SWIID (Standardized World Income Inequality Database) developed by F. Solt (Solt, 2016). According to many authors, the SWIID provides the most-reliable data on income inequality (Ostry et al., 2014; Sequeira et al., 2017; Solt, 2015).

Measures representing other control variables include:

- the average number of years spent in formal education as a measurement of human capital stock (*Edu*), which was retrieved from the Barro and Lee dataset (Barro and Lee, 2013);
- the natural logarithm of GDP per capita in constant dollars from 2005 (*Dev*), retrieved from the World Bank dataset (World Bank, 2016);
- the percentage of the population living in cities as a measurement of urbanization (*Urban_pop*), retrieved from the World Bank (World Bank, 2016).

Due to data availability restrictions, the analysis was conducted for the time period of 1990–2010.

5. Estimation results

The estimation results suggest a statistically significant and negative impact of income inequalities on the accumulation of human capital (see Table 1 for the estimation results and robustness check). Estimate No. 1 shows that income inequalities help to explain the average tests scores even when controlling for these scores achieved in the previous period. These results are not sensitive to the inclusion of other control variables (Estimation 3). Adding variables representing the level of development (*Dev*), stock of human capital (*Edu*), and share of the urban population (*Urban_pop)* does not significantly alter the results. All others being equal, high income inequality was, on average, accompanied by a lower inflow of human capital. This result is statistically significant and the SGMM estimation seems to be consistent, as indicated by Hansen-Sargan and the AR(2) tests.

Table 1

System GMM estimates of model (1) with robustness check to choice of instruments and outlier exclusion

Sample	**OECD**	**OECD**	**OECD**	**OECD**	**OECD (excluding Mexico, Chile, and Turkey)**	**OECD (excluding Mexico, Chile, and Turkey)**	**OECD (excluding Mexico, Chile, and Turkey)**
Estimation	sGMM (1)	sGMM (2)	sGMM (3)	sGMM (4)	sGMM (5)	sGMM (6)	sGMM (7)
Ineq *t*–1	**–0.374*** (0.061)**	**–0.212** (0.098)**	**–0.268*** 0.100**	**–0.333*** (0.104)**	**–0.219* (0.118)**	**–0.159 (0.140)**	**–0.247* (0.134)**
H *t*–1	0.285 ** (0.112)	0.346*** (0.113)	0.285** (0.124)	0.291 ** (0.121)	0.321*** (0.114)	0.358*** (0.123)	0.291** (0.132)
Dev *t*–1	–	–	1.704* (0.924)	1.269 (0.9536)	–	–	0.855 (0.830)
Edu *t*–1	–	–	–0.373 (0.358)	–0.556 (0.389)	–	–	–0.636 (0.520)
Urban_pop *t*–1	–	–	0.004 (0.057)	–0.016 (0.069)	–	–	–0.003 (0.073)
Observations	181	181	179	179	168	168	166
Countries	34	34	34	34	31	31	31
Instruments collapsed	No	Yes	No	Yes	No	Yes	Yes
Hansen-Sargan	0.268	0.152	0.999	0.522	0.412	0.099	0.661
AR (2)	0.795	0.915	0.772	0.777	0.844	0.880	0.777

Source: Author's own research

Notes: *, **, and *** indicate statistical significance at the 10-, 5- and 1-percent levels, respectively. Robust standard errors in parentheses. Time dummies are included but not reported. Hansen-Sargan denotes the p-values of the Sargan-Hansen test of the over-identifying restrictions with the null hypothesis that the instruments are valid instruments. AR(2) denotes the p-values for second-order serial correlation with the null hypothesis that the error term is not second order serially correlated. Row 'Instruments collapsed' indicates whether horizontal squeezing of the instrument matrix was applied (see: [Roodman, 2009, p. 148]). All calculations made in R (R Core Team, 2015) with the use of the *plm* package (Croissant and Millo, 2008).

Estimations No. 2 and 4 provide a robustness check to the choice of instruments. As suggested in the econometric literature (Roodman, 2009) a large number of instruments may weaken the Sargan-Hansen test of instrument validity. This might especially be the case in Estimation 3, where adding a set of control variables increases the number of instruments and where the Sargan-Hansen test *p-value* is suspiciously high. Therefore, the instruments were collapsed (Roodman, 2009, p. 148), and the equation was re-estimated. As indicated in Columns 2 and 4, the results turned out to be insensitive to such a procedure; i.e., they suggest that income inequalities negatively influence human capital accumulation.

Among the OECD countries (which constitute the research sample of this paper), there are countries where income inequalities and educational test scores clearly stand out from the rest. In particular, Chile, Mexico, and Turkey are characterized by exceptionally high income inequalities (their Gini Indexes in 2005 amounted to 0.49, 0.46, and 0.40, respectively, while the average for the OECD was equal to 0.31). At the same time, these countries achieved the weakest educational test scores among all OECD countries (in 2010, Mexican students scored only 41.6 points, 42.3 points for students in Chile, and 47.7 points for those in Turkey, while the OECD average equaled 51.7 points). Therefore, one may suspect that the results of Estimations 1 through 4 were driven primarily by these countries. Thus, other estimations were conducted on a sample of OECD countries excluding Mexico, Chile, and Turkey. The results for the basic equation (Estimation 5) show that, although the estimated impact of income inequities on human capital accumulation is lower than in corresponding equation No. 1, it is still significant and negative. Similar conclusions can be derived from Estimation 7, where additional control variables are included. Only in Estimation 6 (where the instruments were collapsed) did the inequalities coefficient turn out to be statistically insignificant. It should be noted, therefore, that the sample restriction did not fundamentally determine the outcomes of the estimations; however, as it reduced cross-sectional variation in the data, it also weakened the results of the estimation.

6. Conclusions

Economic theory provides convincing arguments for the harmful effects of inequality in income distribution on human capital accumulation. The aim of the present paper is to verify these theoretical predictions in the sample of OECD countries during the years of 1990–2010.

Based on the research conducted in this paper, it can be concluded that the data confirms the theoretical findings and that income inequalities indeed constitute barriers for human capital accumulation. The estimation results show that, on average, high income inequalities precede a low inflow of human capital. The results do not change if the additional control variables that could potentially determine the pace of human capital accumulation are included. Income inequalities have proven to be better predictors of average adjusted test scores than the GDP per capita, average years of schooling, and share of urban population. These results are also robust with different instrument specifications. Through the use of the dynamic panel model, it was possible to mitigate the problems associated with the omitted variable bias and endogeneity of regressors. The results turned out to be modestly sensitive to the sample modifications. Exclusion from the sample of the most-unequal economies in the OECD (Chile, Mexico, and Turkey) did not change the direction of the estimated relationships between income inequalities and the inflow of human capital. Yet, these results tend to be weaker in such a limited sample size. On this basis, it is possible to indicate research areas for future work connected with further sample manipulation. In particular, it would be interesting to search for patterns of income inequalities, human capital, and economic growth relationships in groups of countries with inclusive and exclusive educational institutions, as this could possibly determine the direction and strength of these relationships.

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Importance of copyrights in online society

1. Introduction

Civilization history of the West is a history of a private ownership. This is unquestionably one of the most-important social "inventions" and a key institution of the market economy, an essence of capitalism, a source of effective managing, and a reason for conflicts. Irrespective of these considerations, private ownership constitutes one of the central elements of the order. In light of a social contract, private ownership is contrary to a natural situation which people give up in exchange for personal safety and things that people consider as theirs (cf. Golinowska 1994, p. 20). When considering the origin of private ownership, J.M. Buchanan (2000, pp. 12–15) mentions a universal need for the differentiation between things that are mine and those that are yours ("mine and thine"). Moreover, he states that setting out boundaries of ownership is a source that enables the primary definition of a particular person – a specified one, via the prism of his/her rights to things in relation to a society. In such a meaning, private ownership is one of the main foundations of a social contract; or in the meaning presented by J.M. Buchanan (2000, p. 69) – a constitutional contract. Among others, the legal setting up of a private ownership is an element leading from anarchy to a functioning society.

In the opinion of J. Rifkin (2016, p. 42), private ownership in the presently known form occurred during a period of plots fencing in England in the 17th and 19th centuries. And even if this is a period that is closer to contemporary times as compared to the social contract, ownership still mainly responds to tangible values. This remark has significant meaning, since civilization (or, in other words, the economy) was mainly based on tangible values before the turn 21st century. Obviously, this does not mean that intangible value had no importance, since it

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has always been important – however, it was treated differently than it is today. It should be mentioned that, at the turn of the 20th century, one considered goods only in the context of their tangible values; this is well-seen in case of the A. Marshall (1920, p. 54). This approach was preserved in economics theory for the entire 20th century. When referring to goods, O. Lange (1978, p. 15) and others defined them as tangible resources intended to satisfy human needs.

In the context of the considerations regarding ownership, materiality originated from a prehistoric period when primitive man (in touch with his/her natural environment) separated objects necessary to satisfy his/her needs. This process has been considered by J. Kurowicki (2010, p. 24–28) showing the conversion of a thing (an object separated from its environment), an object (a thing converted by means of work), and a product (an object being the result of socialized work). Considerations regarding the relationships between an object and a human conducted by J. Kurowicki stay within the tangible plane. This results from the fact that, at previous stages of civilization, the existence of development was so significant that the economy was based mainly on material flows.

Today, the matter is less important, but a larger and larger part of the economic mechanism is based on intangible values. The knowledge-based economy, information economy, or creative economy is a picture of weight transfer of values from material raw materials to intangible ones. In L.C. Thurow's opinion (2006, pp. 207–208, 215), growth of the production rate due to the application of more and more sophisticated know-how results in the replacement of matter with information – which is an immaterial factor. This is an essence of a contemporary change that has become more and more noticeable. Concentrating on a creative sector, one may not omit the growth of importance of this economic branch in developed countries. A creative sector is a source of values that, among others, take the form of content supplying the production of information goods (or simply, "works"). Obviously, the creative sector is much more than information goods (cf. Newbigin, 2010, pp. 16–21), but the creative-content industry (Florida 2012, p. 30) based on intellectual property in the form of copyrights (Howkins 2001, s. xii) constitutes its serious part with which the online society deals every day[1].

The creative-content industry products flow via the Internet in the form of digital information goods and satisfy the needs of a society. Internet websites, information news, movies, music, electronic books, and other digital types of information goods are converted by computers and smart phones responding to

[1] Generally, the creative-content industry includes the following activity areas: advertising, architecture, broadcast media, design – fashion design, graphic design, interior design, product design, gaming software, new media, film, the "finer" arts – literary, visual, and performance arts, libraries, museums, heritage, music, photography, print media, object d'art – glass, ceramics, cutlery, crafts, and jewelry (cf. Power, 2011, p. 31).

the growing demand produced by people who need regular contact via modern IT grids. The flow of digital information goods is regulated by means of copyrights, which are equivalent to ownership rights originating from the tangible economy. As private ownership regulates the ownership of a particular person in his/her relationship to society, copyrights regulate access of a particular person to intangible values. However, the relationships of access to content in information goods in the online society are different compared to relationships based on having an object. This results from the fact that the nature of copyrights themselves is different from private ownership. The differences result from (among others) the function copyrights were supposed to play in another social-economic reality – before the creative-content economy and the all-embracing Internet as well as from an abstractive nature of information goods.

This paper aims to determine the importance of copyrights in the field of relationships taking place in the online society. One needs to consider the bi-polarity of copyrights that protect authors from the one hand and prevent the occurrence of the so-called author's monopoly from the other. At the same time, one needs to deal with the validity of the copyright idea and the way it is perceived and observed by online society members. In the paper, a hypothesis is advanced that the bi-polarity of copyrights responds to the needs of the online society, but the formal copyright institution has no serious authority like the institution of ownership rights to tangible things has. The equity of such a hypothesis means that the online society treats the ownership of intangible value less radically as compared to tangible value. Consequently, in the online society, a dissonance takes place between the formal copyright institution and the informal norms regulating the flow of the content (which takes the form of digital information goods).

In this paper, a deductive approach was applied. Considerations were based on two basic pillars. The first is connected with the copyright institution and its bi-polar idea consisting of the reconciliation of the interests of the authors with public interest. The second pillar is the observation of size, extent, and content of the flows within the online society. Finding out the issues for which the pillars in question constitute a solid basis and (in the case of when they constitute a very doubtful basis) shall enable us to explain the general importance of copyrights in the relationships taking place in online societies and the verification of the advanced hypothesis.

2. Copyrights and their bi-polarity

The ownership right, in its varied form, is as old as Western civilization, but intellectual property rights are much-younger institution. In the context of this paper, copyrights must be separated from the group of legal monopolies that the intellectual property rights include. Hence, patents and trade signs, which became the subject of a legal monopoly later compared to intangible goods (works), shall be omitted. Copyrights are governed by a number of documents and acts. At the international level, the most-important of these are the Berne Convention, Rome Convention, TRIPS Agreement, and WIPO treaties (cf. Brata, Markiewicz, 2013, pp. 411–425). In the European Union, a common copyright law does not exist. Nevertheless, the issue of copyrights is established in Directive 2014/26/EU of the European Parliament and of the Council of 26 February 2014 on the collective management of copyright and related rights as well as the multi-territorial licensing of rights in musical works for online use on the internal market, which affects domestic law regulations in the member states.

The beginnings of copyrights are correlated directly with the occurrence and popularization of the printing press. The invention of the printing press was a direct reason for the implementation by rulers of legal solutions regarding copied content. However, the intent to implement an “ancestor” of the copyright institution was not to protect authors but to control the content and numbers of copies printed. Therefore, a direct impulse to establish the institution called copyrights today harkens back to the invention of the printing press. At times, when the only possibility of copying books was to rewrite them in scriptoriums, the problem of the non-controlled distribution of content (especially, not favorable for authorities – laic or sacral ones) did not exist. Hence, the first “copyrights” (more accurately considered printing privileges) aimed to impose some publishing limits on authors and, in practice, on printers (cf. Rose, 1993, pp. 9–11). A change in the approach came along with *Anne’s Law*, which came into existence in 1710. Commonly, it is recognized that this is the first document assigning rights to authors (Górnicki, 2013, p. 122). The rights awarded to authors by means of Anne’s Law are the basis of the contemporary idea of copyrights (Levinson, 2010, p. 128).

Anne’s Law awarded authors exclusive rights to making decisions on the printing of their works; hence, moving the weight of the copyright idea into tangible aspects, assuring authors the de facto financial profits originating from their works. However, an essence of copyrights is not only the protection of an author’s interest but also of social (public) interest. Hence, in the course of the development of copyrights, a limitation of the copyrights took place to the benefit of social profits originating from a greater access to works (Górnicki, 2013, p. 210). Therefore, along with internationalization of the copyrights, there occurred a bi-polarity of the relationships between the protection of the author’s interest and non-admission to occur an author’s monopoly. From one side, copyrights were intended to protect authors in the personal and property fields, and from the other, to prevent total exemption of a work from its access to society. The second aspect has a special meaning in the context of the diffusion of culture, knowledge, and idea in a society, as a consequence of which cultural, scientific, and political development takes place (Gienas, 2008, pp. 198–199).

The idea of copyright bipolarity is a sophisticated way to establish a relationship between an author and a society. This relationship consists in the mutual profits exchanged between the authors and a society. Authors gain resources from a society (which assure them a means of existence) and the society gains the mental (intellectual) profits. It should be mentioned here that the goals of an author and a society may differ. The author can work exclusively to make money; in such a situation, it is in his/her best interest to protect his/her ownership rights, or in order to distribute his/her ideas, opinions, talents, or images of himself/herself – his/her best interest needs protection. This first case may be a source of conflict between an author and a society. It is the effect of a situation when an author takes great strides to seriously limit access to his/her works. This intent is clearly contrary to society's interest, which is unlimited access to works – which is a result of a will to maximize consumption. In such a view, the interests of an author and a society are contrary. An author heads for limitation, and a society heads for no limits; the copyright institution balances on a thin line between these contrary interests.

For sure, the idea of copyright bi-polarity is right from point of view of the social norms accepted in the West. The provision of profits for an author originating from his/her work and, at the same time, the non-admission to exclude part of a society from the advantages originating from the works are right when it comes to civilization growth. However, the practical realization of bi-polarity may turn out to be a source of conflict itself, as well as misunderstandings and opportunistic behavior (Czetwertyński, 2016d, p. 68–69). Nevertheless, the bi-polarity of copyrights must be treated as the end of the evolution of this institution characterized by universality and timelessness.

3. Flows in online society

The growing meaning of copyrights (and, more universally, intellectual property) is an issue that emerged in the literature at the end of the 20th century. This issue was considered by L.C. Thurow (2006, pp. 142–155) and C. Shapiro and H. Varian (2007, pp. 97–116). Their considerations in this field are not surprising; in particular, in the context of growth of the importance of information in the economy. From the point of view of this paper, one needs to emphasize that the growth of content transfer in society is noticeable. This growth has never been seen before; not only has the scale changed, but also the roles of the entities taking place in it. A main motor of such changes is the Internet, which, in M. Castells' opinion (2003, p. 11), has become for the contemporary online society what the electric energy grid was for the industrial society.

The popularization of the Internet, development of miniaturization, and mobile technology made that a serious part of society in developed countries keeps permanently connected. Saying it in pop-culture slang: "they are online." The term "online society" is not generally recognized, and there is no single accepted definition. Contrary to such terms as information society or network society (cf. Czetwertyński and Mroczek-Czetwertyńska, 2012, pp. 118–120), the term "online society" is used by authors without deep thought, as it is a term that is generally easy to understand. Generally, one can state that the online society stays within designates of the definition of both an information society and a network society. Hence, one could limit himself/herself to one of two recognized terms. Nevertheless, one must not ignore the fact that, in the literature, references to the online society have appeared more and more frequently (cf. Herold and Marolt, 2011; 2015, Waldman, 2013). In the case of the series of collective works of D.K. Herold and P. Marolt, the adjective "online" aims to separate people having access to Internet from a set of designates of the term "society." In turn, A.E. Waldman considers the *online* society is a set of "virtual selves." For the needs of this paper (and to make it clear), the author has accepted the definition stating that the online society is the group of post-industrial society members who keep permanent relationships by means of regular access to the Internet. Designates of this definition will be such people who stay connected to the Internet irrespective of the time or place. As a consequence, the online society is not limited by country boundaries or timeframes.

The online society is characterized by the asynchronism of a place and a time described by P. Levinson (2006a, pp. 224; 2006b, pp. 25–26). The asynchronism of a place and time consists of the possibility of communication irrespective of place. Levinson presents it as a break of relationships between a user and a room that is an allegory of a place reserved for connection by means of a desktop computer, for example. De facto, it comes about a mobility, which Levinson presents in relationship to mobile phones, just mentioning personal digital assistant. In turn, the asynchronism of time consists of the possibility to record and play information on the Internet. Levinson's considerations regarded technological order before the popularization of smart-phones (which enhanced the asynchronism of place and time). Contemporarily, this asynchronism can be matched with the fact that people who want to exchange communications between them do not have to stay in the same place at the same time. The asynchronism of place and time is also associated by the asynchronism of social status (Brol and Czetwertyński, 2013a, pp. 314–317), consisting of the possibility to participate in a debate in a virtual public sphere, irrespective of social status and financial capabilities. As an effect, the actor in a virtual public zone of the online society can be each and every member.

The asynchronism of the online society is connected with the activity of its members, who play social roles previously reserved only for selected social groups. Generally, it comes about the capabilities to produce content and share it. A reader form a previous epoch in the online society can be an author (cf. Levinson, 2006a, pp. 233–234). As a result of this, there is still a growing blog zone and growing importance of social media (cf. Czetwertyński, 2013, pp. 7–14). As an effect, very serious quantities of information recorded is produced by means of text, sound, and pictures. Statistics of Internet traffic reveal a dramatic growth in the transfer rate. In 1992, the Internet transfer rate equaled 100 GB daily. In 2015, it was already at 20,000 GB per second, and it is estimated that this value will exceed 61,000 GB per second by 2020. This means that the online society will generate 21 GB of data annually *per capita* (Cisco Systems Inc., 2016b).

Statistics conducted by Cisco Systems Inc. in terms of the *Visual Networking Index* (VNI) include varied types of content flowing via the Internet. A general division is business data and consumer data. In the context of this paper, one may concentrate on the Internet traffic analysis generated by consumers. It is related with the fact that consumers are non-institutional Internet users whose activity means downloading, sending, or exchanging digital information goods. One should mention that the division proposed by Cisco System Inc. does not respond ideally to the considerations conducted here. However, the flows of content generated by consumers are closer to the issue of copyright importance when compared to business flows (which are usually connected with financial information, documents, or logistics, which means that they are not subject to copyright since they are not works).

In the framework of the VNI, four data segments were distinguished (Cisco System Inc., 2016a): (1) Internet video; (2) web, email, and data; (3) files sharing; (4) online gaming. In Figure 1, the Internet traffic is presented as divided into the aforementioned segments from 2015 to 2020 (forecast from 2017) in peta-bytes (one petabyte is 1 M GB). A deeper analysis points out that the main factor affecting the size of the transfer in recent years is Internet video transfer. The very dynamic growth of this type of data results from two basic reasons. The first one is related with the growing requirements of consumers regarding audio-video content quality. The second one – with data transfer technological capabilities. This means that the technological capability exists to meet growing needs of consumers. One should consider that providers of Internet video are two types of websites. The first one consists of commercial websites, including Netflix, that provide content in exchange for cash, and the second one consists of websites belonging to such social media as YouTube. The Netflix and YouTube examples are especially meaningful. The first one generated 34.7% of the total Internet traffic in fixed access in Northern America in 2015. The second one came second, generating nearly 17% of the Internet traffic in Northern America, and the first one in Europe, with a value exceeding 21% (Sandvine Inc., 2015a, p. 3; 2015c, p. 4). Taking into consideration the fact that YouTube is very popular in Northern America (16.88%), Latin America (30.11%), Europe (21.16%), Asia and the Pacific (24.64%), and Africa (14.05%), and Netflix operates mostly in Northern America, the main generator of Internet video in regular access is YouTube (cf. Sandvine Inc., 2015a, p. 3, 12,; 2015b, p. 8; 2015b, p. 4, 10).

The remaining values presented in Figure 1 are quite stable in relation to Internet video, which arises from the fact that content in the form of text needs a relatively small amount of space. It must by noted that the exchange of files drops; this is related with a decrease in the popularity of file-exchange system BitTorrent (cf. Sandvine Inc., 2015a, p. 3, 12; 2015b, p. 8; 2015b, p 4, 10), via which audio-video content is exchanged (cf. Czetwertyński, 2016e, p. 507). The BitTorrent network has been pushed out by Internet video, while a larger part of file exchange is balanced by the growing popularity of cloud technology. The last segment of Internet traffic, which is online games, has no special importance for considerations in this paper, mainly because the flowing content is data regarding a play instead of an author's works.

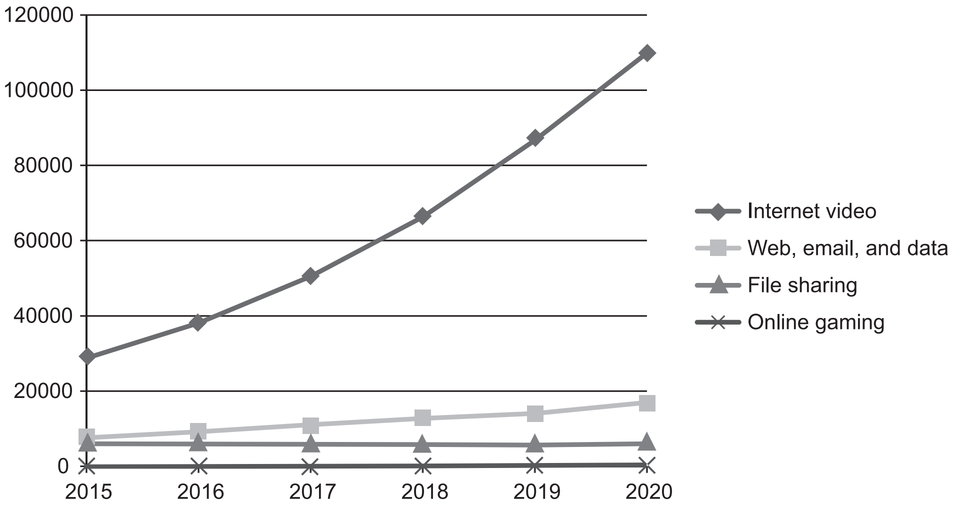

Figure 1. Internet traffic along with forecast, generated by consumers, divided into segments in 2015–2020 in peta-bytes

Source: Cisco Systems Inc. (2016a)

To sum up this short review of statistics of flows in the online society, one needs to pay attention to the meaning of User Generated Content (UGC). It can be absolutely by an author's content or compilations of somebody's quotes, referred to or edited, or just simply "pasted." Their form is free: hyper-text, e-mail, sub-cast, meme, etc. From the point of view of this paper, these are important since they are directly related to copyrights. Newly-established author content (formally called "works") cause the existence of other limits arising from copyrights; in turn, the use of somebody else's works can lead into a breach of the already-established copyrights.

4. Unauthorized turnover problem

The flow of content among Internet users consists of sending and receiving different types of digital information goods. Content generated by users can be an author's or based on somebody else's work. It is unquestionable that, during the constant "dialog" that takes place on the Internet, it is hard to avoid breaching copyrights. Differently from traditional dialogs taking place in a public zone or in a private one, an effect of which there are not established works, a discussion taking place in a virtual zone leaves a trace in the form of digital information goods. When generated content is recorded, one should recognize it to be work(s) (or post-work[s] if it is based on previously existing ones). In the case that one bases on previously existing works, a breach of copyright takes place that are regulated by the legal systems in varied countries in the same way. It comes about the so-called fair use, which enables use of other author's works in defined frameworks without consent of the author (Gienas, 2008, pp. 198–206). This institution (or the equivalent of it) is necessary since, in another case in practice, it would not be possible to consume information goods mutually during everyday life (cf. (Czetwertyński, 2016d, pp. 61–62).

Fair use in the Internet era enables us to distribute ideas relatively freely, to apply somebody else's works, and to comment on them without the necessity of getting permission from the authors and without fear of the legal consequences arising from a breach of copyright. In the framework of fair use on the Internet, unauthorized trade takes place, which means the occurrence of newer and newer digital copies of the information goods, and simultaneous legal breaches of the copyrights (Czetwertyński, 2015a, p. 67). Fair use establishes a thin line between legal and illegal actions. Among others, websites such as YouTube and Facebook can operate due to this fair use.

Even if unauthorized trade in the framework of fair use should be considered to be a necessary element of contemporary social contacts, the violation of copyrights resulting in legal consequences constitutes a serious problem of an economic, legal, and social nature. Online society, along with the development of ICT technology (Information and Communication Technology) gained the ability to trade works at a serious scale, extending the de facto extent of private copying to a global phenomenon (cf. Czetwertyński, 2015b, pp. 21–22). Private copying is a common practice, and it has occurred simultaneously to the development of information-goods-copying technology intended for the casual consumer. The meaning of this went up in the 80s when copying machines, recorders, and video-recorders became something common. This was the time when researchers started paying attention to this issue. S.M. Besen (1984), S.M. Besen and S.N. Kirby (1987), W.R. Johnson (1985) and S.J. Liebowitz (1985) considered the impact of private copying on the information goods market, pointing out the threats that this phenomenon could bring. However, the negative impact of private copying before the popularization of the Internet was incomparably less than it is today. Private copying, which means the practice of sharing information goods among small social groups characterized by direct social relationships (cf. Czetwertyński, 2016c, p. 460), usually stay within the fair use extent [Gienas 2008, pp. 199–203). A problem is the fact that, along with the popularization of the Internet, the extent of social groups and directness of social relationships have been re-defined. The so-called copy culture occurred, which is a "system of behaviors meaning non-market re-production of information goods, taking place acc. to patterns common for a particular society, created and purchased during a process of social interactions" (Czetwertyński, 2016c, p. 457).

The copying culture, common in the online society, leads to unauthorized trade that can fulfill fair use – both private and public (Gienas 2008, p. 203–204), or cause penal consequences arising mainly from the distribution of works without consent; e.g., by the publication of a movie or music video on one of the video-sharing websites.

As an informal institution, the copy culture originated from a time from before the popularization of the Internet. Therefore, it intakes from norms characteristics for the industrial society and previous stages of post-industrial society, but from before the Internet revolution. Hence, the standards of exchange, reproduction, and distribution of information goods arise more from an ownership-rights tradition to material things rather than copyrights. It can be explained on the basis of an analogy. Theft, which is socially unacceptable, consists of the embezzlement of somebody else's thing. But, if a thing is copied, it is not embezzled, so it is not associated with theft. If this example is transferred into information goods, copying them is not perceived as something wrong. It is the result of the fact that a tricky analogy is applied between having a thing on the grounds of ownership rights and just access to works awarded on the basis of copyrights (cf. Czetwertyński, 2016a, pp. 49–52).

The last issue related with the non-authorized digital information goods trade is the problem of the illegal distribution of works via the Internet, which is frequently called digital piracy (or Internet piracy, or sometimes media piracy), defined by P. Stryszowski and D. Scorpecci (2009, p. 7) as the infringement of copyrighted content (such as music, films, software, broadcasting, books etc.) where the end product does not involve the use of hard media such as CDs and DVDs. The previous definition is not very accurate since, as mentioned earlier, a breach of copyright may not cause penal consequences if it stays within the extent of fair use. Hence, designates of such a digital piracy definition are legal actions as well, and the "piracy" would point out illegal actions characterized by a criminal nature. In order to classify practices based on fair use for this extent, for needs of these considerations one should implement a more-accurate definition of the populist one – "digital piracy." This is just the illegal distribution of digital information goods with the intent to acquire financial gains. Utility of this action is also significant since, in this way, it is distinguished from the illegal trade taking place in the framework of the copy culture and which arises from accepted social norms instead of the intent to acquire financial gains originating from, de facto, an intentional crime.

The extent of the unauthorized trade is difficult to be determined, and the published data is frequently incomparable. It is also significant that, in a statistical test, it is difficult to determine which part of unauthorized trade is legal and which is illegal. Usually, the legality issue is neglected or the entire unauthorized trade is closed within the "digital piracy' term. To picture the phenomenon scale, one can quote the following statistics. D. Price (2013, p. 3) estimated that, in 2013, about 23% of the Internet traffic in Northern America, Europe, and Asia & the Pacific region was caused by a breach of copyrights. In turn, J. Karaganis and L. Renkema (2013, p. 5) pointed out that, in the USA and Germany in 2011, approx. 45% of the population copies information goods from each other, mostly via the Internet. Analyzing these values, one can advance the hypothesis that nearly half of the population generates the unauthorized digital information goods trade, which consumes nearly 1/4 of global Internet traffic. Even if this is just a hypothesis that needs to be verified by means of statistical tests, it brings a certain idea of the scale of the unauthorized digital information goods trade.

5. Consequences of copyrights – pros and cons

In the progress of previous considerations, four key issues were enumerated. The first one regarded the bi-polarity of copyrights that protects the author's interests from one side and protects the interest of a society by non-admission of the author's monopoly from the other. The second one was related with flows in the online society, which have gone up over the last decade. The specificity of the flows consisting in the asynchronism of place, time, and social status results in consequences in the context of the author's works and the use of already-existing works to establish after-works. The third one was the inadequate adoption of informal norms regarding the circulation of tangible goods to the digital information goods trade via the Internet. As an effect, a dissonance took place between the informal copy culture and the formal copyright institution. The fourth issue was the scale of the unauthorized digital information goods trade via the Internet. Since this scale is relatively related with the flows in the online society, then, along with the growth in its meaning from marginal one, it has become a first-class issue for industries that produce information goods and the creative-content industry.

The consequences caused by copyrights are a frequent reason for the discussion of their fairness, validity, and efficiency. In this field, the society is very divided; in extreme cases, it leads to a crisis in copyright authority (Czetwertyński, 2016a, pp. 48–49). Deprecating from populism and trying to stay objective, one needs to state that the online society must understand the idea of copyrights more deeply compared to the offline society that is in a society where the intangible value flow was not so large and the capability of copying works was limited.

The first issue that must be pointed out is the unintended effect of participation in a dialog in the virtual public zone (cf. Brol and Czetwertyński, 2013c, pp. 10–13) taking place via the Internet. The specificity of the dialog taking place, which means the production of content, in fact results in new works. Some of them take known and clear forms, such as papers in social media of other more-complicated areas like terms on Wikipedia.org. In both cases, a work is created, and it is subject to copyright. A problem is that it is not always justified to protect such content by means of copyright. In the case of a paper, this is understandable. and all references takes place pursuant to the copyright; but in the case of a term placed on Wikipedia.org, the reservation of copyrights would be a limitation for the idea of development and improvement of the Internet encyclopedia. Hence, there is a need for the awareness of consequences of the copyrights, which was totally neglected before the Internet era. A response to this need is an idea stream determined by the term "copyleft" (cf. Brol and Czetwertyński, 2013b, p. 141–143), which enables the application of copyrights in such a way as not to limit the development of an idea, knowledge, and (the primary reason) software (cf. Dixon, 2004, pp. 22–25). The copyleft concept is a certain type of copyright reverse – it is to prevent from reservation of rights to a work. A practical picture of this idea consists of licenses from the Creative Commons family or GNU (GNU's not Unix), which extensively determine "reservations" and "freedom." They are intended to provide unlimited development in terms of creative human operation. For example, the GNU Linux project has been developed thanks to the GNU General Public License and Wikipedia.org thanks to Creative Commons. Depending on the situation, copyleft licenses can partially or totally deprive the authors of their copyrights – which is desired in this case. Moreover, these licenses operate like viruses, which means that, once applied, they do not enable anyone to reserve any work based on licenses. In this way, a collection of works appears that belongs to everybody and with which everybody can use under the terms and conditions set out by means of the copyleft.

The second issue is related to the existence of the copyrights is the fact that flows in the online society can cause legal consequences. This is related to unauthorized trade that is illegal in certain cases, even if the goal of those generating the trade is not intended to acquire financial gains. An issue to be considered is not the issue of work reservation fairness but the fact that the scale of the illegal digital information goods trade is so large that the level of copyright enforcement is minimal. What is more, here is an area for opportunists; in particular, an area related to *copyright trolling*, which means the acquisition of financial gains due to a breach of copyrights by third persons who do not acquire financial gains from this action (cf. Czetwertyński, 2016d, pp. 59–61). Another form of gaining profits by third parties is the practices applied by certain websites that enable multimedia streaming. Individual users enter movies that are covered by copyrights, de facto committing illegal distribution while owners of the websites do not react until they receive a required demand. Therefore, they have become more and more popular. Such practices are frequently underestimated by the owners of the copyrights; this has been proven by the ease of access to such materials (among others). Moreover, representatives of the entertainment sector (e.g., J. Bewkes – General Director of Time Warner) say that the scale of the unauthorized trade of their productions is rather a form of nobility rather than something wrong (cf. Tassi 2014).

The last practice that hampers the interests of copyrights holders is a practice oriented to the acquisition of profits. In such cases, the owners of websites that enable multimedia streaming enter the works illegally, which is illegal and a punished practice by the system of justice. However, this procedure is profitable enough, and although many websites have been closed and charges have been raised against their owners, new ones still occur. They are more and more popular, among others, because they are sometimes payable and have a larger number of items (content) compared to their legal equivalents. (Czetwertyński, 2016b, pp. 11–12). One should also take into account that Internet users who watch digital information goods via the websites (usually movies) do not incur any responsibility, since the distribution is illegal but not watching. The practice of digital information goods illegal distribution significantly deepens the copyright institution crisis, since law enforcement authorities also seem to underestimate the problem as much as the copyrights holders.

6. Miscellaneous

Copyrights, even if in a populist way, are still criticized yet are still valid. Although they were developed at times when even futurists did not estimate such ICT technology growth, they still respond to the needs of the contemporary online society. What is more, their bi-polar essence has gained a new importance. Due to this, it is possible to keep an asynchronism of the relationships of places, time, and social status, since it protects part of the online society from exemption from a dialog taking place in the virtual public zone. Copyrights also provide the opportunity to assure the free development of digital information goods due to applying them in the copyleft concept, which is an image of another approach to the issue of "reservations" and "freedom" in the online society.

The problem is the constantly insufficient social awareness when it comes to their role, which consequently runs to a disharmony between casual norms and a formal institution. Despite the progress (which is the copyleft concept), copyrights are still not the subject of such authority as ownership rights to tangible things. It seems that the online society has adopted technological accomplishment quicker compared to the institutional one. Technological solutions resulted in the widely expression of the copy culture, signs of which are not compliant with the copyrights institution to some extent. Members of the online society treat copies of digital information goods (to which they have access under the terms and conditions of copyrights) as their own in the light of ownership rights. Consequently, they dispose of them as is common as disposing of any tangible thing that belongs to them. The problem is that, in the course of a transfer of tangible goods to a second person, ownership rights are also transferred to this person. However, when transferring copies of a digital information product, the rights to them are not automatically transferred. This results from the fact that copyrights specify the terms and conditions of the use of goods in relation to a particular person. It is unquestionable that the private ownership institution is much more deeply rooted in a society. This fact results from, among others, the fact that the rules of it have been promoted in the culture and law systems for ages. Suddenly, lasting just one generation jump of the society into the online stage is related to the ability to use new technological tools and simultaneously keep the standards of behavior from the previous period.

Summing up, one needs to state that copyrights are for the online society what the ownership rights to a tangible thing are for a widely recognized industrial society. Hence, as in the industrial society social relationships were shaped by ownership rights, the social relationships should be shaped by copyrights in the online society. However, this analogy is hampered; this is reflected by the commonness and extent of the unauthorized digital information goods trade via the Internet. The online society is still under the impact of the norms regulating exchange and access standards characteristic to previous civilization developmental stages. This is a reason for the dissonance between the copy culture and the formal copyright institution; as a consequence, relatively low copyright authority is present in the social consciousness. In their essence, copyrights do not require any changes. Their bi-polar idea is still the same. Certainly, some amendments must be implemented in order to enhance and adjust the law to the current requirements of the online society. This results from the fact that current regulations literally do not keep up with the Internet. Changes in copyright regulations should result in greater transparency, and they need to prevent ridiculous situations that are incomprehensible for the online society.

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MIDAS models in banking sector – systemic risk comparison

1. Introduction

With the elapse of time, financial markets have become more and more correlated. The respective literature presents different channels that have caused these interlinkages. Across financial markets, these mutual dependencies could reflect the similarities in industrial structure, monetary integration, bilateral trade, and geographical proximity. An empirical fact is that there is no unique economic determinant in supporting the integration of financial markets across different countries. However, from empirical observations, it follows that countries in close geographical proximity are more interlinked than countries in different regions

The empirical fact is that, after the introduction of the euro, the return correlations among the developed markets as well as European economic and monetary union (EMU) stock markets increased considerably. The empirical observations confirm that these higher dependencies have stabilized since the introduction of the euro.

During financial crises, losses tend to spread across financial institutions, thus affecting the financial system as a whole. Systemic risk measures capture the potential losses for the spreading of financial distress across institutions by capturing this increase in tail co-movement.

To present this concept, Adrian and Brunnermeier (2011) developed the CoVaR method. To emphasize the systemic nature of their risk measure, they add the measures the prefix Co to the existing risk (which stands for conditional, contagion, or co-movement).

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Dynamic factor models were developed in the eighties as a result of the needs by policy makers with respect to the forecasts of key macroeconomic variables; these models were based on small sets of time series, usually no more than ten enabled forecasts (especially in short-term situations). The quality of these forecasts was even better than the quality of forecasts by structural models or DSGE models. The most-important class of these models were those that allowed the processing of data exhibiting different frequency and time series with missing data. These models enabled us to reflect the dynamics and main dependencies among key macroeconomic variables.

Thus, these models were even used as reference models by central banks, international institutions, and state offices responsible for macro policies. In the current century, the researchers elaborated the new approach of modeling within one structure of time series collected with different frequency – the so-called regression models with mixed frequencies of sampling (MIDAS – Mixed Data Sampling Regressions). In the first step, these models were simple one-equation structures. However, further models captured multiple structures. They assured the modeling of unobservable components.

The main goal of this contribution is a comparison of the risk measures used in financial theory and practice and their applications to risk assessment in the banking sector.

The next section features an overview of the literature. The following chapter presents the methodology used in the empirical part of this contribution. In Section 4, the empirical results are reported. The last section concludes the paper.

2. Literature

In the financial literature, systemic risk measures are the subject of intensive research. Acharya et al. (2010) introduced the Systemic Expected Shortfall (SES) of a financial institution. This is its propensity to be undercapitalized when the system as a whole is undercapitalized. In the same paper, one of the most-widely-used systemic risk measures was introduced; i.e., Marginal Expected Shortfall (MES). This measure expected losses when a market declines beyond a given threshold. The application of this measure can be found in Banulescu and Dumitrescu (2015), Benoit et al. (2013), Popescu and Turcu (2014), and Brownless and Engle (2012), among others. CoVaR introduced by Adrian and Brunnermeier (2011) corresponds to the Value at Risk of the market return obtained conditionally on an event for a given institution. They defined the contribution of the institution to systemic risk as the difference of the two values of CoVaR. Benulescu and Dumitrescu (2015) proposed CES, a forward-looking method that encompasses MES. The empirical applications show that CES is relatively stable over time.

Popescu and Turcu (2014) transposed s systemic-risk approach to the Eurozone members by adapting those measures initially developed for the market risk to sovereign debt risk.

The proper forecast of future volatility is one of the main problems with respect to risk management and asset allocation. In the economic literature, it is well documented that volatility depends strongly on time and the different factors causing this time variation.

The MIDAS regression model was developed by Anderou and Ghysels (2004) and Ghysels et al. (2006a, 2006b). It allows data from different frequencies to be introduced into the same model. This approach enables a combination of high-frequency returns with macro-finance data that are only observed at lower frequencies (such as monthly or quarterly).

Engle and Rangel (2008) applied this technique to the GARCH framework to form the spline GARCH model. The GARCH-MIDAS modelis a combination of the spline GARCH framework and the volatility decomposing approach (comp. Ding and Granger, 1996; Engle and Lee, 1999; Bauwens and Storti, 2009; Amado and Teräsvirta, 2013) It was introduced by Engle et al. (2012). The advantage of this model is that it allows us to incorporate information on the macroeconomic environment into the long-run component.

Baele et al. (2010) and Colacito et al. (2011) used the MIDAS technique to the DCC model of Engle (2002). They decomposed the co-movement of stocks and bonds into short-run and long-run components.

The GARCH-MIDAS model is used in Conrad and Loch (2011) to investigate the relationships between long-term market risk (for US data) and the macroeconomic environment. They show that macro variables carry information on stock market risk and have a predictive ability for long-term volatility forecasting.

Asgharian et al. (2013) examined the information contained in large group of macroeconomic data. They showed that including low frequency macroeconomic data in the GARCH-MIDAS model improves the forecasting ability for the long-term variance component.

In a more-recent contribution, Conrad et al. (2014) use the GARCH-MIDAS model in order to decompose the stock returns into short-run and long-run components. They examined the long-run volatility component using economic factors. The DCC-MIDAS model is extended by allowing macro-finance variables to enter the long-run component of the correlation of crude oil and stock returns. They found that the behavior of the long-term correlation is counter cyclical.

The novelty of our contribution is the application of MIDAS models in the assessment of risk measures. To model the secular component, we used monthly realized volatility approximated as a sum of the squares of daily returns. Another possibility to model the long-run component is to use macroeconomic data; however, it was not available to the authors and may be a basis for future research.

In the next section, we describe the methodology used in risk measurement (MES and ΔCoVaR) and the GARCH-MIDAS and DCC-MIDAS models.

3. Methodology

MES and ΔCoVaR

We consider two popular measure of systemic risk. The first is defined in Acharya et al. (2010) and is based on the concept of Expected Shortfall. Consider the conditional Expected Shortfall computed at time t (given the information up to time $t-1$):

$$ES_{m,t}\left(C\right)=E_{t-1}\left(r_{mt}|r_{mt}<C\right)=\sum_{i=1}^{N}w_{it}E_{t-1}(r_{it}\,|\,r_{mt}<C)$$

where r_{mt} and r_{it} are the returns of the market and asset (bank), respectively. Threshold C defines the distress event, while w_{it} is the weight of Firm i in the financial system. Given the risk of system measured by $ES_{m,t}(C)$, its marginal contribution of Firm i is called the Marginal Expected Shortfall:

$$MES_{it}\left(C\right)=\frac{\partial ES_{mt}\left(C\right)}{\partial w_{it}}=E_{t-1}(r_{it}\,|\,r_{mt}<C)$$

and measures the increase in a system's risk resulting from a marginal increase in weight w_{it}. The second measure is ΔCoVaR, which is based on the concept of Value-at-Risk (Adrian and Brunnermeier, 2011). Suppose $\mathbb{C}(r_{it})$ is some event for Asset i. Then, CoVaR at confidence level α corresponds to conditional VaR of the market return:

$$P\left(r_{mt}\leq \text{CoVaR}_{t}^{m|\mathbb{C}(r_{it})}|\,\mathbb{C}\left(r_{it}\right)\right)=\alpha$$

The difference between the CoVaR at level alpha and CoVaR computed in the median state is denoted as ΔCoVaR (Benoit et al., 2013):

$$\Delta\text{CoVaR}_{it}(\alpha) = \text{CoVaR}_t^{m|r_{it}=VaR_{it}(\alpha)} - \text{CoVaR}_t^{m|r_{it}=Median(r_{it})}$$

MES and ΔCoVaR can be calculated with various approaches. In this paper, we consider the bivariate GARCH model of Brownless and Engle (2012):

$$r_t = H_t^{1/2}\epsilon_t \tag{1}$$

where $r_t = (r_{mt}, r_{it})'$ is the vector of demeaned returns and $\epsilon_{it} = (\varepsilon_{mt}, \xi_{it})'$ is the vector of *i.i.d.* shocks with zero means and an identity covariance matrix. The time varying covariance matrix is defined as:

$$H_t = \begin{pmatrix} \sigma_{mt}^2 & \sigma_{mt}\sigma_{it}\rho_{it} \\ \sigma_{mt}\sigma_{it}\rho_{it} & \sigma_{it}^2 \end{pmatrix} \tag{2}$$

where σ_{mt} and σ_{it} are conditional standard deviations of the market and asset, whereas ρ_{it} is the conditional correlation between r_{it} and r_{mt}.

Following (1) and (2), we can formulate the following equations:

$$r_{mt} = \sigma_{mt}\varepsilon_{mt},$$

$$r_{it} = \sigma_{it}\rho_{it}\varepsilon_{mt} + \sigma_{it}\sqrt{1-\rho_{it}^2}\,\xi_{it} \tag{3}$$

$$\epsilon_{it} = (\varepsilon_{mt}, \xi_{it})' \sim F$$

It is worth mentioning that the asset return can be described as:

$$r_{it} = \beta_{it} r_{mt} + \sigma_{it}\sqrt{1-\rho_{it}^2}\,\xi_{it}$$

where $\beta_{it} = \rho_{it}\frac{\sigma_{it}}{\sigma_{mt}}$. This is the formulation of one-factor CAMP with systematic risk measure β_{it}. From (3), we can express MES_{it} as:

$$MES_{it}(C) = E_{t-1}(r_{it}|r_{mt} < C) = \sigma_{it}E_{t-1}\left(\rho_{it}\varepsilon_{mt} + \sqrt{1-\rho_{it}^2}\,\xi_{it} \mid \varepsilon_{mt} < C/\sigma_{mt}\right) =$$
$$= \sigma_{it}\rho_{it}E_{t-1}\left(\varepsilon_{mt} \mid \varepsilon_{mt} < C/\sigma_{mt}\right) + \sigma_{it}\sqrt{1-\rho_{it}^2}\,E_{t-1}\left(\xi_{it} \mid \varepsilon_{mt} < C/\sigma_{mt}\right)$$

that is as a function weighted by the tail expectations of the standardized residuals of the market and asset, respectively. Similar to Benoit et al. (2013), we now set threshold C equal to the conditional Value-at-Risk of the market return (given information $\mathcal{F}_{t-1}$ available up to time $t-1$):

$$P\left(r_{mt} \langle \mathrm{VaR}_{mt}(\alpha) \middle| \mathcal{F}_{t-1}\right) = \alpha$$

In their paper, Benoit et al. (2013) showed that MES_{it} is proportional to the systemic risk measured by the time varying beta, where the proportionality coefficient is the expected shortfall of the market:

$$MES_{it}(\alpha) = \beta_{it} ES_{mt}(\alpha)$$

They showed that, given (3) and defining conditioning event $r_{it} = VaR_{it}(\alpha)$, ΔCoVaR can be expressed as follows:

$$\Delta\mathrm{CoVaR}_{it}(\alpha) = \gamma_{it}\left[VaR_{it}(\alpha) - VaR_{it}(0.5)\right]$$

with $\gamma_{it} = \rho_{it}\sigma_{mt}/\sigma_{it}$.

Both MES and ΔCoVaR require the estimation of the conditional standard deviations, conditional correlation, and tail expectations. For this purpose, Brownless and Engle (2012) use the TARCH and DCC models for modeling the standard deviations and correlation. Tail expectations $E_{t-1}(\varepsilon_{mt}|\varepsilon_{mt} < C/\sigma_{mt})$ and $E_{t-1}(\xi_{mt}|\varepsilon_{mt} < C/\sigma_{mt})$ are estimated with nonparametric estimators (Sciallet, 2005) with Gaussian kernel:

$$\hat{E}_{t-1}(\varepsilon_{mt} \mid \varepsilon_{mt} < c) = \frac{\sum_{t=1}^{T} \varepsilon_{mt} \Phi\left(\frac{c - \varepsilon_{mt}}{h}\right)}{\sum_{t=1}^{T} \Phi\left(\frac{c - \varepsilon_{mt}}{h}\right)}$$

$$\hat{E}_{t-1}(\xi_{it} \mid \varepsilon_{mt} < c) = \frac{\sum_{t=1}^{T} \xi_{it} \Phi\left(\frac{c - \varepsilon_{mt}}{h}\right)}{\sum_{t=1}^{T} \Phi\left(\frac{c - \varepsilon_{mt}}{h}\right)}$$

where $c = C/\sigma_{mt}$ and $h = T^{-1/5}$.

In order to model the standard deviations and correlations, Brownless and Engle (2012) use the TARCH and DCC models. In this paper, we use the GARCH-MIDAS and DCC-MIDAS models described in the next section.

GARCH-MIDAS and DCC-MIDAS models

Following Engle et al. (2013), we assume that univariate returns t_{jt} (on day j in period t) follows the GARCH-MIDAS process:

$$r_{j,t} = \mu + \sqrt{\tau_t g_{jt}}\,\varepsilon_{jt} \quad \forall i = 1,\ldots,N_t \tag{4}$$

where N_t is the number of days in period t and $\varepsilon_{jt}|\mathcal{F}_{i-1,t} \sim N(0, 1)$. Short-run volatility component g_{it} follows the mean-reverting GARCH(1,1) process:

$$g_{it} = (1-\alpha-\beta) + \alpha\frac{\left(r_{j-1,t}-\mu\right)^2}{\tau_t} + \beta g_{j-1,t} \tag{5}$$

whereas long-run volatility component τ_t is smoothed realized volatility:

$$\log(\tau_t) = m + \sum_{k=1}^{K}\varphi_k(w_1,w_2)\,RV_{t-k} \tag{6}$$

where realized volatility:

$$RV_t = \sum_{i=1}^{N_t} r_{j,t}^2$$

does not change within a time span (period, month), and the weighting shame is based on beta polynomials with weights w_1, w_2, and parameter K:

$$\varphi_k(w_1,w_2) = \frac{\left(\frac{k}{K}\right)^{w_1-1}\left(1-\frac{k}{K}\right)^{w_2-1}}{\sum_{j=1}^{K}\left(\frac{j}{K}\right)^{w_1-1}\left(1-\frac{j}{K}\right)^{w_2-1}}$$

We adopt the restricted beta weighting scheme. The weights are computed as:

$$\varphi_k(w) = \frac{\left(1-\frac{k}{K}\right)^{w-1}}{\sum_{j=1}^{K}\left(1-\frac{j}{K}\right)^{w-1}}$$

For $w > 1$, this guarantees a decaying pattern (slow or rapid) depending on the values of w (small or large).

The GARCH-MIDAS model is used to model the conditional deviations of r_{mt} and each asset return r_{it}. Natural extension is the DCC-MIDAS model of Colacito et al. (2011) in which as the input standardized residuals from the GARCH-MIDAS models are taken. The (i, j) element of quasi-correlation matrix Q_t has GARCH(1,1)-like dynamics:

$$q_{ijt} = (1 - a - b)\bar{\rho}_{ijt} + a\varepsilon_{i,t-1}\varepsilon_{j,t-1} + bq_{ij,t-1}$$

where $a > 0$, $b \geq 0$ and $a + b < 1$.

In the equation above, $\bar{\rho}_{i,j,t}$ represents element (i, j) of long-run quasi-correlation matrix ρ_t:

$$\rho_t = \sum_{k=1}^{K_c} \varphi_k(w) c_{t-k}$$

that is the weighted sum of sample correlation matrices c_{t-k}.

Finally, the correlation matrix (rescaled quasi-correlation matrix to obtain unity on the diagonal) is defined as follows:

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

4. Empirical results

We consider the prices (in euros) of the EURO STOXX BANKS index with 18 components of this index. Although the index contains 25 components, we excluded some of them (a list of the banks used in this paper is given in the appendix). First, we excluded the series due to the sample size. The second reason was the large number of zero returns (more than 10%). The dataset covers the period of January 2002 through June 2017. As usual, we computed the logarithmic return percentage as $r_t = 100 \cdot (\ln P_t - \ln P_{t-1})$ and descriptive statistics of returns. The mean of the return index is equal to -0.018 with a standard deviation of 2.000. The skewness equals to –0.032, and the kurtosis is 10.567. The high value of the kurtosis results in the non-normality formally confirmed with the Jarque-Bera test. As expected, we observed significant autocorrelation (from the Ljung-Box test with 15 lags). In Table 1, we present the statistics of all banks under study.

Table 1

Descriptive statistics

Statistics	Mean	Std	Skewness	Kurtosis	pLB	pJB
min	−0.08	1.83	−1.26	6.63	0.00	0.00
q1	−0.03	2.27	−0.19	10.33	0.00	0.00
med	−0.01	2.64	−0.07	10.67	0.00	0.00
q2	0.00	2.84	0.17	13.12	0.00	0.00
max	0.02	4.34	0.55	44.34	0.10	0.00

Source: own elaboration

The statistics are similar to those of the returns index. We observed a departure from normality for all banks and insignificant autocorrelation in only two cases.

Using the methodology presented in the previous sections, we estimated the models that were used to calculate the risk represented by MES and ΔCoVaR (during this estimation, we use the Midas Matlab Toolbox by Hang Qian). We used periods of 22 days to compute the monthly realized volatility and 36 lags in Equation (3). The conditional Value-at-Risk of the market return (threshold or conditioning event) is computed with a 95% confidence level. In Figure 1, we present VaR for the bank BAMI (top) and index (bottom) along with the returns.

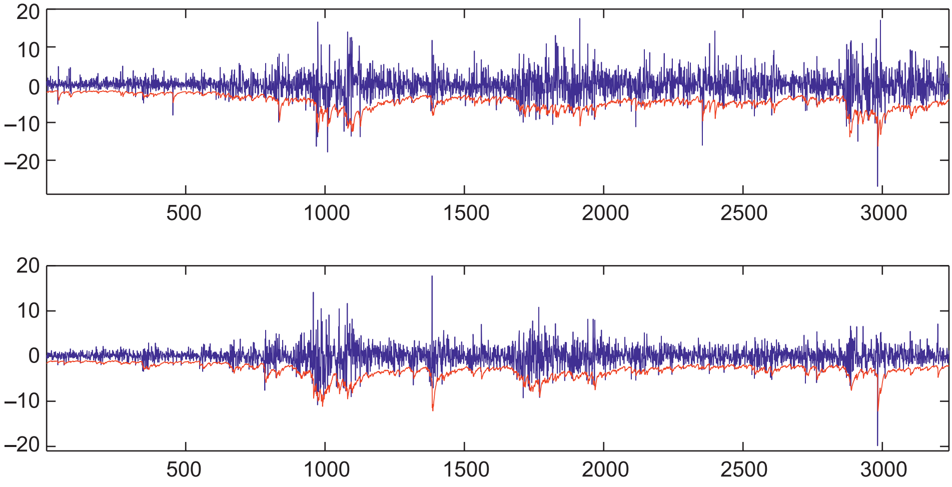

Figure 1. Value at Risk for BAMI and index

Source: own elaboration

In the Table 2, we present a ranking of banks according to the systemic risk measures from the Midas-type models (to save space, we omitted the tables with parameter estimates; details are available from the authors upon request).

The ranks (in descending order) refer to the last values of these measures in our sample (columns on the left) and mean values for year 2017 (two columns on the right). We consider the absolute values of MES and ΔCoVaR (these measures are typically negative). The higher values of these measures, the higher the individual contribution of the bank to the risk of the financial system.

Table 2

Ranking of banks according to systemic risk measures from Midas-type models

Rank	**MES**	**ΔCoVaR**	**MES**	**ΔCoVaR**
1	BAMI	ING	BAMI	SAN
2	UCG	BNP	UCG	BNP
3	KN	DBK	DBK	ING
4	SAN	BBVA	GLE	GLE
5	DBK	GLE	CBK	BBVA
6	GLE	SAN	BIRG	DBK
7	ACA	ACA	MB	ISP
8	CBK	UCG	ISP	CBK
9	BNP	MB	ACA	MB
10	MB	BKT	BNP	ACA
11	BBVA	CBK	SAN	UCG
12	EBS	ISP	KN	BKT
13	SAB	KN	SAB	KBC
14	ING	KBC	BBVA	SAB
15	ISP	BAMI	ING	KN
16	BIRG	SAB	EBS	BAMI
17	KBC	EBS	KBC	EBS
18	BKT	BIRG	BKT	BIRG

Source: own elaboration

The rankings resulting from both measures are different. In the top-five-riskiest banks, we can find only Deutsche Bank in both cases. BAMI is at the top of the table according to MES and is in 15^{th} place in the ΔCoVaR ranking. A similar conclusion can be made for ING. Regarding first five places, only DBK can be found in both columns. In the case of banks from the bottom of Table 2, we observe that BIRG and KBC are together in the last five places. When regarding the mean values, we observe some degree of similarity especially for the bank from the bottom of the table and from the top for the MES column. In Figures 2 and 3, we present the computed values of both measures for bank BAMI.

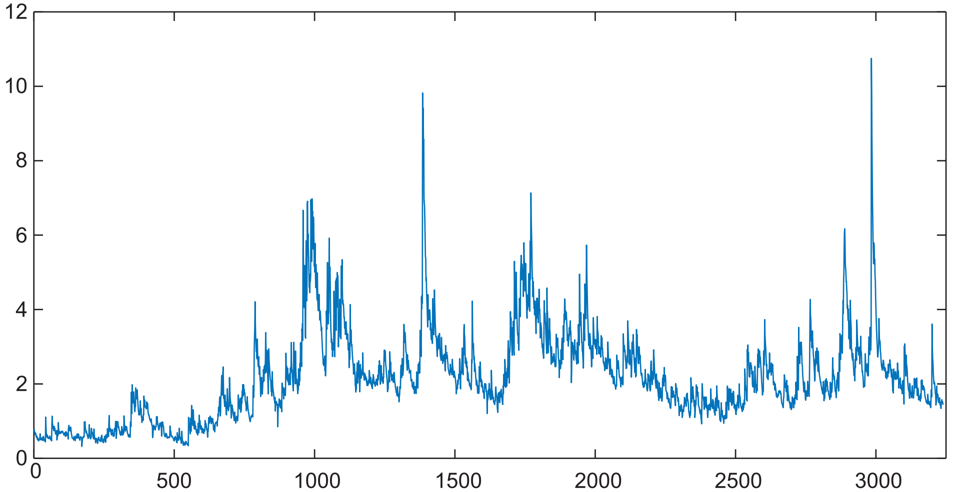

Figure 2. ΔCoVaR for BAMI from Midas-type models

Source: own elaboration

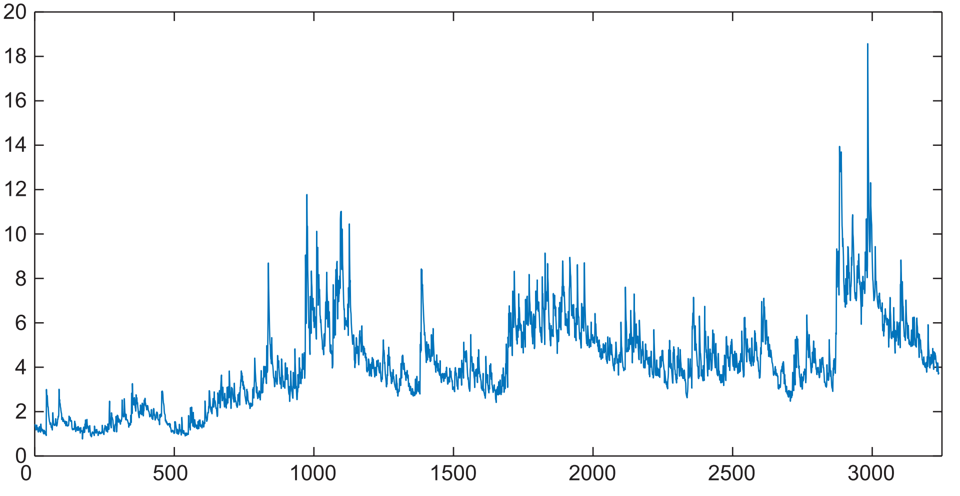

Figure 3. MES for BAMI from Midas-type models

Source: own elaboration

Additionally, we estimated the models used in Benoit et al. (2013), which are the GJR(1,1) models for conditional volatilities and standard DCC(1,1) with the bivariate normal distribution model for conditional correlation. In the Table 3, we present the rankings from these models (according to last values in the time series of systemic risk).

Table 3

Ranking of banks according to systemic risk measures from GJR-DCC models

Rank	MES	ΔCoVaR	MES	ΔCoVaR
1	BAMI	BBVA	BAMI	SAN
2	KN	BNP	UCG	BNP
3	DBK	DBK	DBK	GLE
4	UCG	SAN	GLE	BBVA
5	GLE	UCG	BIRG	ING
6	BNP	GLE	CBK	UCG
7	ACA	ING	BNP	DBK
8	SAN	CBK	ACA	ISP
9	CBK	ISP	KN	CBK
10	BBVA	BKT	ISP	ACA
11	ISP	ACA	MB	MB
12	ING	MB	SAN	KBC
13	EBS	KN	ING	SAB
14	BIRG	BAMI	BBVA	BKT
15	KBC	KBC	SAB	KN
16	MB	SAB	KBC	BAMI
17	BKT	EBS	EBS	EBS
18	SAB	BIRG	BKT	BIRG

Source: own elaboration

The conclusions about the congruence of ranks is similar when standard models are applied. The bank from the top according to ΔCoVaR (BBVA) is tenth according to MES, but DBK and KBC take the same places in both columns (regarding the values from the end of the sample). For the mean values of measures, we can identify a coincidence of ranks (BAMI and DBK for MES and BNP for ΔCoVaR) and banks (KN) that are placed in different rows.

From Tables 2 and 3, we can identify the most- and least-systemically-important banks. These banks can be found in the first few and last few rows of both tables, respectively. Banks BAMI, SAN, UCG, and BNP are simultaneously at the top of the table, and BKT, BIRG, and EBS are at the bottom. The results from both models are the same if we consider the highest values of the measures. In Tables 4 and 5, we present the highest and lowest mean values (respectively) of the systemic risk measures for the last ten years.

Table 4

Banks with highest mean values of MES and ΔCoVaR during years of 2007–2017

Model	**MIDAS**		**GJR-DCC**	
year	**MES**	**ΔCoVaR**	**MES**	**ΔCoVaR**
2007	BNP	DBK	KN	BNP
2008	ING	DBK	ING	SAN
2009	BIRG	SAN	BIRG	SAN
2010	BIRG	SAN	BIRG	SAN
2011	ISP	BBVA	ISP	SAN
2012	UCG	BBVA	UCG	SAN
2013	BAMI	BBVA	BAMI	SAN
2014	BAMI	BBVA	BAMI	SAN
2015	BAMI	BBVA	UCG	BBVA
2016	BAMI	BNP	BAMI	SAN
2017	BAMI	SAN	BAMI	SAN

Source: own elaboration

Table 5

Banks with lowest mean values of MES and ΔCoVaR during years of 2007–2017

Model	**MIDAS**		**GJR-DCC**	
year	**MES**	**ΔCoVaR**	**MES**	**ΔCoVaR**
2007	SAB	KN	SAB	BIRG
2008	MB	BIRG	MB	BIRG
2009	SAB	BIRG	SAB	BIRG
2010	SAB	BIRG	SAB	BIRG
2011	SAB	BIRG	SAB	BIRG

Table 5 cont.

Model	MIDAS		GJR-DCC	
year	MES	ΔCoVaR	MES	ΔCoVaR
2012	SAB	BIRG	SAB	BIRG
2013	BIRG	BIRG	KN	BIRG
2014	DBK	BIRG	DBK	BIRG
2015	KBC	BIRG	KBC	BIRG
2016	BKT	BIRG	BKT	BIRG
2017	BKT	BIRG	BKT	BIRG

Source: own elaboration

We observe that, according to MES (with one exception – year 2015), BAMI refers to the highest values over the last five years. The information from ΔCoVaR is not as clear. Actually, two banks represent the highest values; those are BBVA and SAN from 2009 (with one exception). Regarding the lowest values of risk measures, we observe a coincidence of bank rankings between two models over the last ten years (with only two exceptions). For the last two years, BKT and BIRG are simultaneously at the bottom of the table. From Proposition 1 in Benoit et. Al (2013), we know that identifying SIFIs using MES is equivalent to comparing the betas of banks. In Figure 4, we present the estimated values of the betas for banks BKT and BAMI.

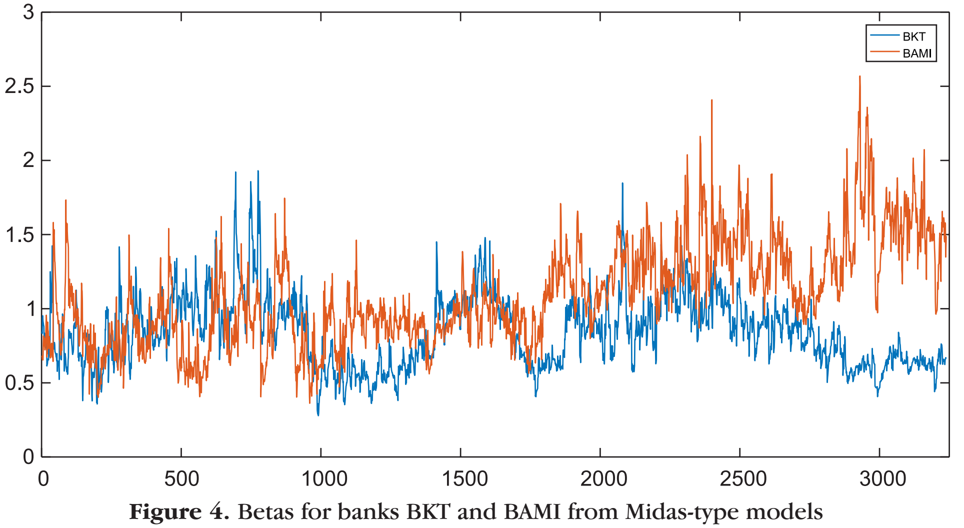

Figure 4. Betas for banks BKT and BAMI from Midas-type models

Source: own elaboration

5. Conclusions

The aim of this contribution is to apply MIDAS models in the assessment of risk measures in the banking sector. The modeling of systemic risk is an important issue in the financial literature. The successful use of MIDAS models in risk determination is value added of this contribution. The authors modeled the secular component by using monthly realized volatility calculated as a sum of squares of the daily returns. The promising option in modeling the long-run component of the risk and correlation is the application of macro-finance factors. Unfortunately, the necessary macroeconomic data with respect to volatility and correlation modeling was not available to the authors. Further research should be directed at finding the most-appropriate macro-finance factors with respect to volatility and correlation modeling that can influence systemic risk assessment.

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Appendix

Bank	Symbol
BANCO SANTANDER	SAN
BNP PARIBAS	BNP
ING GROEP	ING
BBV.ARGENTARIA	BBVA
INTESA SANPAOLO	ISP
CREDIT AGRICOLE	ACA
SOCIETE GENERALE	GLE
UNICREDIT	UCG
DEUTSCHE BANK (XET)	DBK
KBC GROUP	KBC
NATIXIS	KN
ERSTE GROUP BANK	EBS
BANCO DE SABADELL	SAB
COMMERZBANK (XET)	CBK
BANK OF IRELAND	BIRG
BANKINTER ,'R''	BKT
MEDIOBANCA BC.FIN	MB
BANCO BPM	BAMI

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Exploring relative instances of exposure in equilibrium of migration processes based on population characteristics

1. Introduction

Unfortunately, migration is a relevant topic in the global economy even now, resulting, for example in intercultural and religious conflicts, social pressure, and the structural change of labor markets, because relevant decision makers do not practice – parallel to the classic intuitive approaches – the principles of data-driven policy making. Big Data-like information is supplied, and sophisticated analytical methods are also accessible.

From another perspective, migration could be a source of economic growth, because the modern global economy depends on the production and dissemination of knowledge (if rational constellations can be ensured for the goal of integration). Randomized mixed teams are less effective and less efficient than optimal mixed teams/populations in general, where ideal teams involve members with different characteristics, ensuring that the catalytic effects affect each other. The more the variability of the potential team member is, the greater chance there is to increase the value of the objective function in the frame of an optimization process about team building.

It can be assumed that the relocation of highly skilled people is an opportunity to absorb the most-valuable workforce, enhancing idea generation or intensifying cross-cultural cooperation. However, if elderly women are needed in a highly qualified region, then this sort of person can't be found in each population/culture

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with the same probability. This example increases the necessity of well-prepared optimization applicable to migration processes.

Migration can be both a continuous supply of new knowledge (which is a condition for economic renewal) and a continuous source of problems between unbalanced force fields. It should also be repeated: The ideal population (or an ideal team) should have specific characteristics in specific ratios.

The aim of this article is to advance our understanding of knowledge-based issues of migratory flows in the frame of equilibrium-oriented modeling for estimating a rational level of the "cybernetic state of law" idea; in other words, the creation of a new case for socio-cybernetics (Raven, 2015). If migration policy should change to absorb a more-valuable workforce, then the models should be capable of deriving potentials in each aspect that have a real influence towards success. If the labor market should change by highly skilled human resources, constellations should be identified where even highly educated people are really needed. Average-oriented declarative rules can't cover the complexity of the related phenomena. It is important to be able to derive non-declarative rules (dynamic norms) based on all of the force fields of compared objects (like countries) in a parallel and consistent way in order to respond to the emergence of new cultures and intercultural issues in an optimal way through the educational system. It is also important to implement the future society based on our knowledge about quasi-ideally designed migration processes, because the randomized distribution of people in a given dynamic system can't lead to the optimal solution in an automated way.

This article tries to demonstrate two layers of similarity-oriented principles (in the frame of the MY-X FREE TOOL) about sustainability with the trivial operationalization of these principles even through simulated "Robot-Politicians." The article shows the connection of migration and innovation based on the methodological level in order to be able to derive immigration policies from knowledge transfer perspectives like Big Data and artificial intelligence-oriented modeling. This is done in order to ensure that placing highly skilled immigrants in labor markets leads to a real increase in efficiency instead of a clash between intercultural force fields. In order to ensure a dynamic framework for knowledge-based entrepreneurial ecosystems through optimized intercultural collaboration and improve the education system in a multicultural society, the implementation of the above-mentioned modeling possibilities can be interpreted at the micro-, mezzo-, and macro-levels, locally, regionally, and globally – where matured statistical systems are available.

This article tries to operationalize the artistic principles of Kazohinia by Szathmáry (1941) based on multi-layered artificial intelligence solutions, which were developed to increase the objectivity of human decision-making processes.

2. Basic information before modeling

The following modeling steps are built on a trivial basic decision: each human individual has an unlimited human right to exist. Therefore, segregation/discrimination can't be accepted as a solution for migration problems in general. Parallel to this, it should be assumed that each potential phenomenon can have a solid impact towards migration processes, but a cybernetic force field (a state of law) can only handle existing statistics during the planning phase in order to ensure the highest level of objectivity. An information society has to manage a statistical system where each rational measurable phenomenon will be measured and evaluated in an effective and efficient way. Therefore – based on each set of existing data assets – models can be built without limits. The hermeneutics for the models handling more or less data (phenomena) should try to manage the risks originating from a lack of information. Methodologies can support the maximization of consistency in multi-layered modeling. Models always have a competitive connection to each other. Models with less data can never be seen as better when compared to models handling more data (as long as the modeling approaches are rational and flexible). Model-evaluation can define a set of quasi-unlimited evaluation indicators; therefore, the best model should be derived from each potential fitting value (c.f. Occam's razor). Partial results can only be substituted with more-complex results. The following analyses try to demonstrate a trivial way to robotize the preparations of complex (political) decisions based on a limited set of phenomena.

3. Data asset and analytical steps

As mentioned above, each phenomenon can have an impact on another phenomenon (like migration). The article involved a minimal set of statistical data in order to be capable of interpreting both content and methodology according to the sustainability of migration processes.

3.1. Data assets

The selection of phenomena tries to follow the most-trivial (c.f. Maslow-pyramid) logic: to live in a sustainable way, it is necessary to have land, water, and motivation to work effectively/efficiently, and the population needs to be fertile (see the latter attributes). The depth-level of the analyses became defined via countries and years (see the objects below). The permanently limited number of phenomena is in character for the human intuition processes, where this process is very effective but not risk-free (c.f. demagogy).

3.1.1. Objects

Processes should be analyzed in space and time dimensions. Space is interpreted through countries, because the country profiles are the most-frequently-reported statistics. Time is presented through years (especially 5-year intervals – like 1990–1995, 2000–2005, 2010–2014) because the annual reports are the most-used process in the international statistics system. Though the space and time raster got chosen rationally, the volume of the lack of data couldn't be limited arbitrarily. The ratio of the lack is ca. 10%: Countries with an acceptable volume of data are as follows: HUN / ISL / EST / CAN / CZE / ESP / SWE / FRA / NOR / SVK / JPN / PRT / FIN / POL / DNK / ITA / LUX / DEU / GBR / AUS / BEL / NZL / NLD / AUT / KOR / SVN / USA / IRL / CHL / TUR / ISR / MEX / CHE + an artificial average object supporting calibration processes or sensitivity analyses. The number of countries is 33+1. The number of year-intervals is 6. The number of objects is about 204.

3.1.2. Attributes

The so-called 'independent' attributes as such are freshwater/capita, cropland/capita, grassland/capita, pasture/capita, child/woman, wage/capita, ratio of working population, and (as a dependent variable) the annual growth rate:

- https://data.oecd.org/lprdty/gdp-per-hour-worked.htm,
- https://data.oecd.org/pop/fertility-rates.htm,
- https://data.oecd.org/pop/population.htm,
- https://data.oecd.org/pop/working-age-population.htm,
- https://data.oecd.org/popregion/national-population-distribution.htm,
- https://data.oecd.org/agrland/agricultural-land.htm,
- http://stats.oecd.org/viewhtml.aspx?datasetcode=WATER_RESOURCES,
- http://stats.oecd.org/viewhtml.aspx?datasetcode=WATER_TREAT.

The directions for the independent variables are as follows: the more resources (water, land, wages/money) are available in a given region during a given time interval, the more the annual growth rate should be (c.f. absorption potential concerning migration). Parallel to this, the lower the fertility rate and ratio of the working population, the more the annual growth rate should be.

Directions can be proven through an inverse logic: without resources, it is hardly possible to live in a given small area without water; and where the fertility is high and a high ratio is currently working, it is hardly possible/necessary for more people to integrate.

3.1.3. Lack of data

As we have already declared, the raw data produced volumes of the lack of data, a total of ca. 10%. Parallel to this, the validity rate of the estimations is ca. 50% concerning the space-time objects. The lack of raw data became filled through the value of the previous given time period for the same spot. In the case of invalid estimations, the lack of data became substituted through the average estimation errors for each country.

3.1.4. Standardization

At first, the raw data became standardized via the creation of relative attributes (like resources/capita). Before modeling, each relative attribute was ranked for similarity analyses, where the potential information lost through ranking can be compensated with the flexible staircase functions of the attributes.

3.2. Models

To be able to derive the migration potentials for countries, it is necessary to create models like production functions where well-known values of the dependent variables should be reproduced based on independent variables. The hermeneutics of estimation errors can be defined as follows: if the estimation is higher than the fact of the given object, then the dependent variable should be higher in the case of the given object (and vice-versa). Of course, it was noted that the correlation between the estimated values and the given facts of the dependent variable should be as high as possible. It is always necessary to derive estimations that are valid.

After producing the raw estimations for the space and time objects, it is necessary to create a second modeling layer where the objects are limited to the countries and the attributes are the selected time periods and their statistics (like average and trend). The model should search for those objects where estimation errors (derived as the difference in % between fact and estimation) are relatively high in the negative interval (which means the dependent variable, like the annual growth rate, could be higher). Parallel to this, the trend of the estimation error of a country should also be minimal (which means the tendency of overestimation is increasing).

3.3. Detailed steps of models

In this complex analysis, there are two model-chains. The first chain produced estimated ranks of countries concerning absorption potential based on valid and invalid estimations and the parallel chain count potential in necessity of educated people The next chapters detail what kind of elementary steps were necessary to produce the above-mentioned figures as final results.

For both chains of the model phases, it was inevitable to identify data sources (URLs) via Google searches. The explored data in diverse tables can have special meta-information sets (like a country name with code or text); therefore, a kind of consolidation of the used terms is always necessary, even if it's just a step in the general quality management process of modeling.

3.3.1. General pressure index of the variable "annual growth rate"

To derive the pressure index of the variable "annual growth rate," the basic data from the OECD adopted the structure shown in the chart below (Tab. 1):

Table 1

Structure of raw data from OECD

Location	Indicator	Subject	Measure	Frequency	Time	Value
Aus	Fertility	Tot	chd_woman	A	1960	3.45
Aus	Fertility	Tot	chd_woman	A	1961	3.55
Aus	Fertility	Tot	chd_woman	A	1962	3.43
Aus	Fertility	Tot	chd_woman	A	1963	3.34
Aus	Fertility	Tot	chd_woman	A	1964	3.15
Aus	Fertility	Tot	chd_woman	A	1965	2.97
Aus	Fertility	Tot	chd_woman	A	1966	2.89

Source: OECD, own presentation – demo view

The next preparation step in the chain is producing the amount-chart based on pivot-services (amount of data per year and country).

The maximum available data for each country is 14 (see Tab. 2), and the minimum value is 2. The rational set of variables is 7 independent variables, and the annual growth rate was a dependent variable for 6 time intervals (incl. lack of data [see red marks] substituted with the previous existing data [see Tables 3, 4, 5]):

Table 2

Number of attributes according to years and countries

Location	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total
AUS	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	6	7	6	5	276
AUT	11	10	10	10	10	8	7	7	8	12	13	13	13	13	13	12	9	12	13	12	7	6	8	6	2	245
BEL	12	12	12	12	12	13	13	13	13	13	13	13	13	13	13	12	12	12	12	12	12	6	7	6	5	286
CAN	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	13	12	12	13	6	6	7	6	5	272
CHE	12	7	7	6	6	7	12	13	13	13	13	13	13	12	12	13	12	12	12	12	13	6	7	7	2	255
CHL	12	12	12	12	12	12	12	10	12	12	12	12	12	12	13	12	13	12	12	7	6	6	7	6	5	265
CZE	11	11	11	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	7	7	6	5	292

Source: own calculation – demo view

Table 3

Raw data in object-attribute-matrix

Location	Time	Fresh water	Cropland/ capita	Grasland/ capita	Pasture/ capita	Child/ woman	Wage/capita	WKGPOP	Annual growth rate
AUS	1990	16738	2801033	0	24406494	1.9	35	66.90107	1491
AUS	1995	16738	2949181	0	22782560	1.82	38	66.5704	1123
AUS	2000	16738	2500552	0	21437438	1.76	43	66.85059	1153
AUS	2005	16738	1324527	0	20737672	1.85	47	67.31427	1224
AUS	2010	16738	1178649	0	16912309	1.95	49	67.3838	1567
AUS	2014	16738	1178649	0	16912309	1.95	53	66.4595	1578

Source: own presentation – demo view

The 204 objects (33 countries + an average of them) for the 6 time periods with 7 input variables (incl. additional water information) and 1 output variable made it possible to derive a production function (simulator) for the annual growth rate based on layers of similarity analyses with 35 stairs in the framework of 204 objects. The model has 101 invalid positions where the inverse staircase function and the direct staircase function didn't deliver a symmetric estimation-pair for the annual growth rate per year and country. The estimations and facts produced a correlation value of 0.4.

The valid estimations make it possible to derive a cross-chart for countries and time periods with further characteristics (like the trend of differences between facts and estimation [called delta] concerning annual growth rate).

Table 4

Valid differences between facts and estimation according to years and countries

Location	Time						Average
	1990	1995	2000	2005	2010	2014	
AUS	–	–	–2.66	–	–	–0.88	–1.77
AUT	–11.06	7.55	–8.13	–2	–	–	–3.41
BEL	4	–	–	–	–	0.1	2.05
CAN	–0.8	–4.82	–5.67	–5.52	–3.67	–5	–4.25
CHE	7.45	–	–	–	–	–	7.45
CHL	2.09	–5.97	–	1.77	2.52	1.74	0.43

Source: own calculation – demo view

Table 5

Substitutions and trend values for anti-discriminative modeling

Location	Time						Average	Trend
	1990	1995	2000	2005	2010	2014		
AUS	–1.77	–1.77	–2.66	–1.77	–1.77	–0.88	–1.77	0.03
AUT	–11.06	7.55	–8.13	–2	–3.41	–3.41	–3.41	0.07
BEL	4	2.05	2.05	2.05	2.05	0.1	2.05	–0.11
CAN	–0.8	–4.82	–5.67	–5.52	–3.67	–5	–4.25	–0.10
CHE	7.45	7.45	7.45	7.45	7.45	7.45	7.45	0.00
CHL	2.09	–5.97	0.43	1.77	2.52	1.74	0.43	0.15

Source: own calculation – demo view

The similarity analysis only needs the ranked view of the raw data for each attribute, where the lack of data for the time series was substituted with the rank value of the average field. Rank values can be seen on table 6.

Table 6

Ranked inputs for anti-discriminative modeling

Location	1990	1995	2000	2005	2010	2014	Average	Trend	Y
AUS	15	18	15	18	17	22	18	25	1000000
AUT	2	31	4	15	9	13	10	28	1000000
BEL	25	23	26	27	25	24	25	8	1000000
CAN	16	7	5	5	8	8	6	9	1000000
CHE	32	30	32	33	32	32	33	16	1000000
CHL	21	5	21	26	27	27	22	30	1000000

Source: own calculations – demo view

In the case of massive lacks in the time series, the trend value could not be derived (See Table 5 for CHE = Swiss). The estimated trend was 0. The ranked inputs in this second model layer lead to an anti-discrimination model where the dependent variable was an artificial variable consisting of a constant value for each object (country) used for the ability to derive whether each country can be seen as the same object concerning the exposure index of migration pressure.

The second model layer delivered estimations for norm-like behavior, high-exposure, and low-exposure situations as a kind of risk simulation according to migration pressure. The time-period-oriented delta values and their averages have a direct interpretation in the case of the direction of the variables. The trend values (based on the time periods) make the risk of exposure higher in the case of lower values (which means in the case of more and higher differences from the norm values). The know-how in the aggregation of arbitrary risk layers delivers the anti-discrimination model logic, because ranked model inputs will be re-weighted in the frame of an optimization process where the aim is to approximate the same risk potential for each object (each constellation).

Invalid estimations are available for 8 countries from 34 objects (CAN, CZE, LUX, SWE, EST, PRT, KOR, CHE). For anti-discrimination, the models' correlation cannot be calculated.

3.3.2. Detailed indexes for educated human resources

The preparation steps for these models are the same as before until the input sides of the object-attribute-matrixes are created. Only the dependent variables were substituted: first with the HR-ratios for the male population, and later for the female population.

The adapted OAMs were processed using the same logic as before: first, for each question (male/female), a classic production function was generated. These models have only 25 countries with 3 time periods (2005, 2010, 2014) because the data was available only in this volume.

The correlation in the model for males is 0.9. The invalidity rate is 39/75. The correlation in the model for females is 0.86. The invalidity rate is 33/75.

The second model layer (anti-discrimination models) produced only valid estimations for both models.

Further layers for arbitrary detail indexes can be calculated in the same way for completing the analysis and for ensuring consistent control steps between the dependent layers and the general risk values – especially in the case of the estimations for people volumes in capita.

3.3.3. Estimation of annual growth rates

The first model is a standard estimation model where the dependent variable (annual growth rate) in the case of the 204 objects should be derived based on the 7 independent variables. The sum of estimations should be the sum of the values of the dependent variable. The estimation and facts deliver a correlation of 0.4. It's important to note that the inverse model with inverted directions delivers a correlation between estimations and facts at ca. 0.7. This shows that the logic behind the annual growth rate is partially irrational. The lower the volume of the necessary force fields, the more the annual growth rate will be. The amount of invalid estimations can be derived through inverse modeling. Ca. 50% of the objects are invalid. One country (GRC) could not produce valid estimations for the six time periods due to the statistical system of Greece (c.f. OECD, 2011)

The second model-layer expects a new OAM, where the objects are the countries and the attributes are estimation errors of the time intervals and their trends.

3.3.4. Estimation of required education levels

The education levels for male and female (c.f. human resources in science and technology (HRST) – % of active population [source: Eurostat – 2003–2014]) can also be modeled in the same way as before.

The basic idea is that the same independent variables as those of the estimation of the annual growth rate allow us to derive models for the ratio of educated males and females, because the potential of population density runs parallel to the rational portion of potential leaders.

Therefore, the first models (for the male as well as the female population) try to derive a production function where the ratio of the educated population in the case of males and females (Y) should be reflected based on the already-introduced independent variables. The OAMs in these cases consist of 25 EU Member States in 3 time periods (like 2005, 2010, and 2014) – this means 75 space-time objects and the well-known (7) independent variables as attributes.

The second models create a new OAM where the objects were the 25 countries (+ a so called average object for control purposes). The attributes were the three time-intervals, their average, and the trend based on them. Each attribute consists of the values of estimation errors where the negative values show that the ratio of the educated (fe)male population could be higher. The direction (for each time-interval, and their average) is "the less, the more". The same direction is valid for the trends of estimation errors. Summa summarum (see Table 9), this means the country where the estimated ratio for educated people is higher than the facts needs the highest number of educated people, and the trend of these errors shows an increasing necessity.

4. Results

4.1. Annual growth rate

Compared to Table 8, Table 7 allows us to interpret a kind of sensibility for each country. The more characteristic the color scheme for a country is, the more robust the assumption about the exposure potential.

Table 7

Estimated ranks of countries concerning absorption potential based on valid and invalid estimations

Location	Estimation	Location	Estimation	Location	Estimation
AUT	1000094	SVN	1000037	NLD	999966.1
EST	1000093	FRA	1000025	LUX	999964.6
CAN	1000086	GRC	1000017	CHE	999951.1
SVK	1000083	NOR	1000016	JPN	999949.6
HUN	1000080	Average	1000011	NZL	999949.1
DEU	1000065	PRT	1000009	BEL	999937.1
ESP	1000060	ITA	999997.6	MEX	999929.1
POL	1000056	DNK	999990.1	TUR	999912.6
IRL	1000047	SWE	999985.6	GBR	999902.6
FIN	1000046	AUS	999979.1	KOR	999875.1
USA	1000046	CHL	999975.6	ISR	999862.6
CZE	1000040	ISL	999966.1		

Source: self-made calculation

Table 8

Estimated ranks of countries concerning absorption potential, based only on valid estimations

Location	Estimation	Location	Estimation	Location	Estimation
HUN	1000097	LUX	1000028	NLD	999963.1
SVK	1000087	POL	1000028	SVN	999961.1
IRL	1000083	NOR	1000014	CHL	999944.1

Table 8 cont.

CAN	1000082	AUT	1000008	NZL	999940.1
ESP	1000077	PRT	1000008	KOR	999930.1
CZE	1000068	ITA	999997.1	TUR	999908.1
USA	1000067	FRA	999994.1	MEX	999892.1
SWE	1000060	BEL	999989.1	CHE	999889.1
EST	1000058	DNK	999985.1	GBR	999885.1
ISL	1000058	Average	999982.1	ISR	999872.1
DEU	1000051	JPN	999981.1		
FIN	1000040	AUS	999972.1		

Source: self-made calculation

The 'annual growth rate'-oriented analyses based on valid and invalid estimations show that countries like DEU and AUT (as potential targeted countries by migrants) probably see their own positions rationally. SWE gave signs of a relative rush concerning the saturation effects. HUN and SVK try to fight against the given circumstances, because it seemingly could not be understood what the real force fields are, and more notably because the way to accept it can be interpreted in the EU legal system in different approximations. The so-called average-object (average of all countries) has a relatively robust position almost in the center of the estimation values (near the arbitrarily chosen norm value of 1000000). The southern region (GRC, ITA) is already full (like TUR and ISR). This can be seen as a rational force field for migration in general.

Based on only the valid estimations, the interpretation is hard to change. The position of AUT seems to be weaker, and the HUN-SVK positions are more robust. Model-average as such is consolidated to relatively near the norm value of 1000000. SWE has a higher force field than before. On the one hand, the differences of the valid and invalid positions show the impact of a lack of data. On the other hand, the two views make it possible to interpret a kind of sensibility of the modeling, based on multi-layered and consistence-oriented similarity analyses.

4.2. Required education level

Table 9 shows potential in necessity of educated people in case of males and females.

Table 9

Potential in necessity of educated people
(parallel based on valid and invalid estimations)

Human resources in science and technology (HRST) – percent of active population (MALE)						**Human resources in science and technology (HRST) – percent of active population (FEMALE)**					
Location	**Estimation**	**Location**	**Estimation**	**Location**	**Estimation**	**Location**	**Estimation**	**Location**	**Estimation**	**Location**	**Estimation**
SVK	1000047	EST	1000003	TUR	999980.3	PRT	1000032	FIN	1000010	GRC	999988.3
AUT	1000044	ISL	1000002	SVN	999971.8	FRA	1000031	DEU	1000010	BEL	999981.8
HUN	1000035	DNK	1000001	LUX	999970.3	ESP	1000030	HUN	1000009	TUR	999979.8
PRT	1000035	FIN	999997.8	BEL	999965.8	IRL	1000028	DNK	1000003	NOR	999979.3
ESP	1000029	SWE	999997.8	NLD	999962.8	ITA	1000026	SWE	999995.8	LUX	999964.8
FRA	1000029	IRL	999997.3	CHE	999962.3	AUT	1000022	CZE	999994.3	CHE	999963.3
DEU	1000027	GRC	999994.8	CZE	999960.3	SVK	1000021	EST	999994.3	GBR	999958.8
POL	1000021	NOR	999994.8	GBR	999958.8	ISL	1000020	POL	999994.3	SVN	999956.3
ITA	1000017	average	999994.8			average	1000013	NLD	999993.8		

Source: self-made calculation

DEU, in fact, needs educated people (more males than females). AUT's need level is higher for both genders. HUN needs educated males and seemingly few females. SVK, compared to HUN, has the same position as AUT compared to DEU. ITA needs more females than males. The average objects have a semi-robust position according to the norm value of 1000000 and the estimations as such. GBR, CHE, SVN, BEL, LUX, NDL, TUR, and GRC are full.

Especially in the case of ITA (but also in the cases of countries needing educated people in general), a critical situation is given: whether the expectation of educated people (especially females) can be covered through the recent structure of migrants.

Fortunately, people can be educated (c.f. LLL). The question is this: How many years on average will be necessary until arbitrary migrants will be able to work as preferred?

4.3. Estimation of absorption potentials

Table 10

Estimation errors for all countries

Estimation errors [%]			
average	**invalid**	**valid**	**average**
female	–3.6	0.9	–1.1
male	–3.3	0.2	–1.6
average	–3.4	0.6	–1.3
AGR	–3.8	0.4	–0.1
max	**invalid**	**valid**	**average**
female	23.4	25.5	25.5
male	17.9	19.5	19.5
average	23.4	25.5	25.5
AGR	4.7	10.3	10.3
min	**invalid**	**valid**	**average**
female	–41.9	–25.6	–41.9
male	–41.9	–26.5	–41.9
average	–41.9	–26.5	–41.9
AGR	–18.8	–11.8	–18.8

Source: own calculations

The estimation of the real amount of absorption concerning people in general (or especially educated people) can be approximated through the estimation errors (see Table 10). The number of (educated) people being absorbable in countries with the given statistics for AGR and for the ratios of educated people can be calculated in a way that the estimation errors will be converted into real values in capita.

In the case of DEU, the lack of educated females in 2014 was ca. 1% (c.f. the last value of the estimation errors), but the spontaneous saturation is 0.23%/year, based on the experiences of the time periods of 2005–2014. This means that the saturation has been relatively fast. Assuming that DEU has 80,000,000 people and the active population is ca. 50% (40,000,000), where the ratio of females is also 50% (20,000,000), and the education rate for females is 50% as well (10,000,000), an estimation error of 1% leads to 100,000 capita as required educated females.

The same calculation process for male delivers the following result: 200,000 educated males (based on the double rate of the last lack-value).

If we look at Figure 1 we can note that DEU (blue = fact; red = estimation) should have grown (AGR) massively in general since 2000. The ca. 1% average lack of growth rate makes 800,000 people; among them, ca. 100,000 females are well-educated, and 200,000 males are also well-educated. The 200,000 families may have 4 members, which means 2 children. This estimation may hold a kind of evidence for 2015. And reality seems to deliver the estimated values for DEU in general, but hardly in detail.

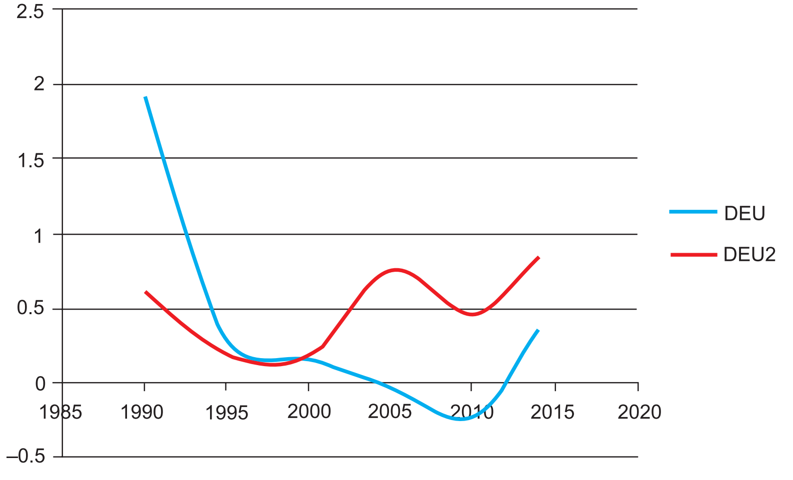

Figure 1. Annual growth rate for DEU – facts and estimations

Source: own calculation

5. Conclusion

We must emphasize that the goal of this article is not to heat the political atmosphere. In this topic, we have presented the facts through data. We have to stress that the logic of this objective and highly operationalized method allows us to analyze any variables if the consistency and concordance of the list of attributes is assured. In this case, we have investigated the question from the perspective of sustainability instead of culture. The analysis confines oneself to "trivial" variables. If the data has a reference to variables like religion, habits, culture, behavior, etc. with which to estimate "annual growth rate" or "population density," these also can be included. This article wants to present the opportunity of data-driven decision making.

The UNO could be seen as an organization with the appropriate potential and legitimacy to be responsible for data-driven policy-making actions, where each member should deliver statistics with high quality, and the robot-politician should be re-run in order to calculate new exposure values for each country.

The same process could be driven in the case of validating the credibility of countries, cities, concerns, etc. (like the services of Moody's, Fitch Ratings, or Standard and Poor's, etc.) in order to generate and publish ranking values as well as their changes in an entirely automated way.

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Price reversal as potential expiration day effect of stock and index futures: evidence from Warsaw Stock Exchange

1. Introduction

Since 1986, when Stoll and Whaley published their first article about expiration day effects of index options and futures on the US market, many authors have researched the anomalies observable on different equity markets on days of derivatives' expirations. Such undesirable effects can be especially strong on days when several derivatives expire. Stoll and Whaley (1990) researched the effects of the so-called "triple witching days" when index futures, index options, and options on index futures expired simultaneously. In the literature, potential anomalies of expiration days on the main market are divided into price effects and volume effects. Alkebäck and Hagelin (2004) described the possible sources of these effects. The first one is the activity of arbitragers who unwind their positions on the stock market. If, during a contracts' life, the difference between the contract price and its theoretical value (basis) is non-zero, arbitrage transactions can be conducted only if the difference is great enough to exceed the required transaction costs. Arbitragers open opposite positions on the equity market and the derivative market. Unwinding positions on the equity market is always connected with buying or selling shares, while on the derivative market, only unwinding before the expiration demands trading. Thereupon, as Stoll and Whaley wrote (1987), it is useful for arbitragers to keep their positions until a derivative's expiration, as (in this case) the liquidation does not require any activity on the derivative market and thereby does not involve unnecessary transaction costs. If there are many arbitragers unwinding their positions in the same direction, price effects are possible.

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The second source of expiration effects specified by Alkebäck and Hagelin (2004) arises from the activity of speculators. Investors who have naked positions in expiring contracts can try to manipulate its settlement price by the appropriate transactions on the equity market. Affecting the underlying asset price, they simultaneously affect the settlement price of the contract.

Such increased activity of investors on an expiration day should be reflected in increased price volatility. Furthermore, if the price effect is drawn mostly by arbitragers unwinding in the same direction, abnormal price changes can be observed. Intensified activity of speculators can also abnormally lower or raise the underlying assets' price upon expiration. After the expiration, however, prices should return to a "normal" level. Stoll and Whaley (1986) wrote about price reversal after expiration as a second potential price effect. Beyond these, trading volume that was significantly higher than on non-expiration days has been reported by many researchers as an effect of expiration day. On the markets where the settlement price is determined on the basis of stock prices from a certain time interval (usually from the last trading hour or the last 30 minutes of trading), the trading volume is especially high during this time span.

Most researchers study the expiration day effects of index futures and index options. Derivatives on individual stocks are less common; for this reason, they rarely form a subject of research. Results of the studies of expiration day effects vary depending on the research method, market under study, and period of time from which the data originates. Stoll and Whaley (1986) proposed a comparison of returns and trading volume of an underlying asset on expiration days to the corresponding returns and volume on control days by using some statistical tests. Significant differences between these variables on expiration and non-expiration days are evidence of the influence that the derivatives' expiration has on the equity market. Most other researchers have based their findings on this method, employing it in sundry variations to daily or intraday data.

The existence of a volume effect of an index futures and index options expiration days was first confirmed for the US market (Stoll and Whaley [1986, 1987]; Chen and Williams [1994]). Since then, research on expiration effects has been extended to other markets. As a result, the increased trading volume of underlying assets on the day of a derivative's expiration was detected on the markets of Japan (Karolyi [1996]), Germany (Schlag [1996]), Australia (Stoll and Whaley [1997]), Sweden (Alkebäck and Hagelin [2004]), Poland (Morawska [2007]), China (Fung and Jung [2009]), Spain (Illueca and Lafuente [2006]), and India (Narang and Vij [2013]), among others.

While the existence of the volume effect of an expiration day seems to be widespread, researchers are not unanimous about the price effects. Increased volatility around the expiration has been reported, for example, by Stoll and

Whaley (1987, 1997), Day and Lewis (1988), Chamberlain et al. (1989), Diz and Finucane (1998), Alkebäck and Hagelin (2004) (for the earlier of two sub-periods under study), Chow et al. (2003), Lien and Li (2005), Illueca and Lafuente (2006), Morawska (2007), and Narang and Vij (2013). Other authors did not find evidence of a volatility effect (see Chen and Williams [1994], Karolyi [1996], Bollen and Whaley [1999]). This ambiguity in the results surely indicates differences between the markets on that score, but this can also come from that facts that researchers use various volatility measurements for data on different frequencies and that they study the expiration of different derivatives.

The occurrence of the phenomenon of price reversal after expiration was identified, for example, by Stoll and Whaley (1987) and Chamberlain et al. (1989). Definitely more researches report no price reversal effect (see, e.g., Karolyi [1996], Stoll and Whaley [1997], Alkebäck and Hagelin [2004], Chow et al. [2003], Morawska [2007], Fung and Jung [2009], and Narang and Vij [2013]). Schlag (1996) found reversal only in case of futures that expire at the open. For options expiring at the close, no price reversal was found. Stoll and Whaley (1986, 1987) defined a few ways of calculating the reversal based on the comparison between signs of an underlying asset return on the expiration day and the return on the next day. These definitions were then used by others (e.g., Bollen and Whaley [1999], Chamberlain et al. [1989], Alkebäck and Hagelin [2004], Chow et al. [2003], and Morawska [2007]) to variously defined returns.

The above-mentioned authors studied either futures or options (or both) expiring simultaneously. This research only studies futures, as options are still not very popular derivatives on the Polish terminal market. According to the author's knowledge, the only research about futures' expiration day effects on the Polish equity market was conducted by Morawska (2004, 2007). Unfortunately, the full text of the first article (2004) is not available to the author. In (2007), Morawska studies 15 futures on WIG20 expirations between the first of January 2002 and 30th of June 2006. These contracts expired each year on the third Friday of March, June, September, and December. Each expiration date was researched separately. Following Stoll and Whaley (1986), the WIG20 Index returns and volume is studied by comparing the expiration days with control days. Control days are defined as the first and second Friday of the expiration month.

As a measurement of abnormal trading volume, Morawska (2007) took the relative trading volume at the close – the ratio of the volume values of particular stocks in the index from the last hour of the trading day to their volume values from the whole day. On 7 out of 15 events, she found a significantly higher average relative trading volume on expiration days than on control days. The volatility effect is measured by the variance of one-minute intraday WIG20 returns. To check if an index price reversal after expiration can be observed, Morawska (2007) compares the sign of the index return from the last 30 minutes on the expiration day with the sign of the return after the close (defined as a return calculated from the opening rate on the day after expiration and the rate of the index at the close of expiration day). The volatility effect and price reversal are also measured by a comparison with the control group. In 14 out of 15 events, abnormal volatility was detected. Price reversal, on the other hand, occurred only once.

The first futures contract on the WIG20 Index was introduced in 1998. This was also the first derivative on the Polish market (which has remained the most-liquid one to this day). Since 1998, more and more futures have been introduced; however, some of them have already been withdrawn from the market. Currently, two types of index futures are being traded: futures on the WIG20 Index and futures on the mWIG40 Index. Since 2001, futures on individual stocks have also been introduced to the Polish derivative market. Since the research conducted by Morawska (2007) covers only a period of six years (when the derivative market was relatively young) and only studies futures on the WIG20 Index, it seems to be desirable to extend the research of expiration day effects on the Polish equity market by taking into account more types of derivatives and expanding the time span of a study.

In this paper, we focus only on the price reversal effect of futures' expirations and check, if the effect is observable on the Warsaw Stock Exchange. Studies from other markets are not unequivocal about this effect, so an in-depth analysis of this phenomenon is desirable. Concededly, Morawska (2007) wrote that this effect does not exist on the Warsaw Stock Exchange, but this study broadens her research in several ways. First of all, beyond futures on the WIG20 Index, futures on the mWIG40 Index and futures on individual stocks are also studied. What is more, the derivative market today is more developed and liquid, so there are probably better conditions for speculations and arbitrage that can result in expiration day effects. The research covers a much-longer time span that was considered by Morawska (2007). The occurrence of a potential price reversal effect is also tested in different ways. First, an appropriate regression model is used to determine an underlying asset's returns. Second, the measures of reversal proposed by Stoll and Whaley (1986, 1987) are calculated. Finally, abnormal price changes around expiration are tested with the use of event study methodology, which has not been employed to the analysis of expiration day effects so far (according to this author's knowledge).

The structure of the paper is as follows: Section 2 describes the data and methodology; empirical results of the research are demonstrated and discussed in Section 3; and Section 4 concludes the paper. A list of futures along with their underlying assets used in this study is presented in the appendix.

2. Data and methodology

The dataset contains the daily markings of futures on individual stocks and futures on the indexes (WIG20 and mWIG40) as well as the markings on their underlying assets within a period from the first of January 2001 to the 31st of December 2016. The choice of such a time span was dictated by the availability of data at www.gpwinfostrefa.pl. During this period, there were 64 expiration days of futures on the WIG20 Index. Futures on the individual stocks were researched over a somewhat shorter time span (starting from 2003). During the early years of the markings, the frequency of the expiration of some futures on stocks changed (for example, in 2001 and 2002, futures on the PKN expired every month); therefore, the time horizon of the research is chosen so as to contain only futures with the same characteristics in the sample. The first futures contract on the mWIG4o Index expired in May 2007, so there are 39 days of this contract's expiration in the dataset.

Except for index futures and stock futures, European put and call options on the WIG20 Index (which expire on the third Friday of each month) are also available on the Polish derivative market. However, options have only started to become more popular over the last few years, and there is still much-lower interest in these instruments than in futures (in 2016, 95.4% of the total volume value on the derivative market came from futures). For this reason, the author only takes futures into consideration, bearing in mind that their expiration occurs simultaneously with the expiration of WIG20 options.

All of the contracts that are the subject of this study have some common characteristics. The value of each contract is equal to its rate multiplied by a given number. Futures on the individual stocks have a multiplier of 100 or 1000. Futures on the mWIG40 (as well as futures on the WIG20 through 2013) have a multiplier of 10. In September 2013, futures on the WIG20 with a multiplier of 20 were put on the market. The contracts expire simultaneously (four times a year – namely, on the third Friday of each March, June, September, and December) and are listed for nine months. The contracts are cash settled. Every day, the settlement price of the contract is defined as its closing price. The final settlement rates for index futures are calculated as the arithmetic mean of all index values of a continuous quotation during the last hour of trading on the expiration day and its value at the close (after eliminating the five highest and five lowest values). In the case of futures on the individual stocks, the final settlement price is equal to the rate of the underlying asset used in the last transaction made on the equity market on the expiration day. The list of futures used in the research (as well as the names of their underlying assets and their multipliers) are presented in Table 6 in the appendix. In the table, the first expiration means the first one included in the research. If some contract was introduced before the period under study, it is not its first expiration at all.

In this article, the effect of price reversal after expiration is explored. The existence of this effect is researched in three different ways. The results from the analysis of expiration days are compared with the analogous results from control days. To obtain the control group (equinumerous to the research group), control days are defined as the third Friday of January, April, July, and October. First, a simple regression model is employed to the returns of the futures' underlying assets:

$$R_{i,1} = \alpha + \beta R_{i,0} + \varepsilon_i$$

where $R_{i,0}$ represents the return on the expiration or control day, respectively, while $R_{i,1}$ represents the return on the day following the expiration day or control day, respectively. Two regression models are checked. In both, independent variable $R_{i,0}$ is defined as the daily logarithmic rate of the return of an underlying asset, but the dependent variable changes. In the first model, this is represented by the logarithmic rate of return on the day following the event day, while in the second model, $R_{i,1}$ is defined as the overnight return; that is, the natural logarithm of the ratio of return on the opening on the day after the expiration (or control) day to return at the close on the event day.

Second, the three measures of price reversal used by Alkebäck and Hagelin (2004) and taken from Stoll and Whaley (1987) and Chamberlain et al. (1989) are calculated for the expiration and control days.

Type 0 reversal:

$$REV_{i,0} = \begin{cases} R_{i,1} & if \quad R_{i,0} < 0 \\ -R_{i,1} & if \quad R_{i,0} \geq 0 \end{cases}$$

has a positive value in the case of price reversal and a negative value in the case of continuation. The average $REV_{i,0}$ is calculated in the group of expiration days and control days, respectively, and the *t*-test is used to check if the difference between them is significant.

Type 1 reversal:

$$REV_{i,1} = \begin{cases} |R_{i,1}| & if \;\; sign(R_{i,1}) \neq sign(R_{i,0}) \\ 0 & \text{otherwise} \end{cases}$$

and Type 2 reversal:

$$REV_{i,2} = \begin{cases} |R_{i,0}| & if \;\; sign(R_{i,1}) \neq sign(R_{i,0}) \\ 0 & \text{otherwise} \end{cases}$$

have only nonnegative values. In contrast to the Type 0 reversal, these measures are only descriptive, as the above-mentioned authors do not give any tests that could determine whether the reversal is significant. The average $REV_{i,1}$ and $REV_{i,2}$ are calculated in the group of expiration days and control days, respectively. The greater the value of the average measure, the stronger the phenomenon of price reversal. As in the case of the regression models, these measures are defined in two ways (depending on the definition of $R_{i,1}$).

Finally, the event study methodology is used to more-deeply explore the phenomenon of abnormal price changes around the expiration of the futures. This methodology is usually used to check the impact of different unexpected events on the equity market (see, for example, Gurgul [2006]). According to the author's knowledge, it has yet to be employed to the analysis of expiration day effects. Although future expiration cannot be perceived as an unexpected event in terms of the expiration date (which is preconceived), the impact of this event on the stock returns is unforeseeable (as it depends on the investors' activity on this day). In the author's opinion, event study analysis applied in an appropriate manner should be able to detect price reversal after expiration. However, as it is usually employed for abnormal returns, the reversal has a slightly different definition in this case than in the previously mentioned measures.

The analysis is used separately for expiration days and control days, and the results are compared. The event day (expiration day and control day, respectively) is designated by $t = 0$. The pre-event window covers 45 days from $t = -50$ to $t = -6$. It is as wide as possible to avoid an overlap with the previous event window. The event window contains 11 days around the date of the event; it starts 5 days before the expiration day or control day, respectively ($t = -5$), and ends 5 days after it ($t = 5$).

Abnormal returns for each day in the pre-event and event windows are defined as the difference between the actual rate of return and its expected value:

$$AR_{i,t} = R_{i,t} - E\left(R_{i,t}\right)$$

is the logarithmic rate of return of the shares or index on day t. For the individual stocks, the expected returns are calculated with the classical market model from the estimation window:

$$R_{i,t} = \alpha + \beta R_{m,t} + \varepsilon_{i,t}$$

where $R_{m,t}$ is the logarithmic rate of the WIG20 return and $\varepsilon_{i,t}$ is the error on a given day. For the WIG20 and mWIG40 indexes, the expected returns are equal to the mean of returns in the estimation window, as the market model cannot be applied in this case. The use of parametric tests in the event study requires the normal distribution of residuals, a lack of autocorrelation, and homoskedasticity. Most of the data fails to satisfy at least one of these assumptions. For this reason, the non-parametric generalized rank test proposed by Kolari and Pynnönen (2001) is applied. As the authors explain, the test is robust for event-induced volatility and to a certain degree of cross-correlation caused by event day clustering. Moreover, it is reasonably robust to the autocorrelation of abnormal returns. Finally, it does not require an assumption about the normality of abnormal returns, and its power dominates the power of popular tests used in the event studies.

To construct the test statistic, abnormal returns for each event are standardized; that is, they are divided by the standard deviation of abnormal returns from pre-event window:

$$SAR_{i,t} = AR_{i,t} / S\left(AR_i\right)$$

Thereafter, adjusted standardized abnormal returns are computed in order to account for any event-induced increase in volatility:

$$SAR'_{i,t} = \begin{cases} SAR_{i,t} & t = -50,\ldots,-6 \\ SAR_{i,t} / S\left(SAR_t\right) & t = -5,\ldots,5 \end{cases}$$

where $S(SAR_t)$ is a cross-sectional standard deviation of standardized abnormal returns defined as:

$$S\left(SAR_t\right) = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}\left(SAR_{i,t} - \overline{SAR_t}\right)^2}$$

and N is the number of events in the sample. $SAR'_{i,t}$ are random variables with an expected value of zero and a unit variance under the null hypothesis of no event effect. Abnormal returns on each day t_0 in the event window are tested separately. For this reason, the demeaned standardized abnormal ranks are defined as:

$$U_{i,t} = \frac{rank\left(SAR'_{i,t}\right)}{T+1} - \frac{1}{2}$$

for $i = 1,\ldots, N$, and $t \in \Omega = \{-50, \ldots, -6, t_0\}$. $T - 1$ is the length of the pre-event window, and $rank(SAR'_{i,t})$ is the rank of $SAR'_{i,t}$ within the group of adjusted standardized abnormal returns from the pre-event window and SAR'_{i,t_0}. The null hypothesis about the no event effect is, thus, equivalent to the hypothesis that:

$$E\left(U_{i,t_0}\right) = 0$$

This hypothesis is tested with the use of generalized rank test statistic τ_{grank} defined by Kolari and Pynnönen (2001) as:

$$\tau_{grank} = Z\sqrt{\frac{T-2}{T-1-Z^2}}$$

where:

$$Z = \frac{\overline{U_{t_0}}}{S_{\bar{U}}}, \quad \overline{U_t} = \frac{1}{N}\sum_{i=1}^{N} U_{i,t}, \quad S_{\bar{U}} = \sqrt{\frac{1}{T}\sum_{t\in\Omega}\bar{U}_t^2}$$

Under the null hypothesis of the no event effect, the distribution of the τ_{grank} statistic converges to *t*-student distribution with $T-2$ degrees of freedom when sample size N increases.

Normally, an event study analysis is based on abnormal returns, which are defined as the difference between actual returns and their expected values. For an individual stock, the expected value is usually received from an appropriate model that describes the relationship between the return of the stock and the market rate of the return (see Gurgul [2006], page 41). Thus, the event study is able to detect price changes that are inconsistent with expectations. For example, a positive abnormal return on an expiration is a sign that the price on this day was higher than expected. The study is conducted it two clusters of events: expiration (or control) days with positive abnormal returns and expiration (or control) days with negative abnormal returns. In each of the clusters, the attention is focused on the day after the expiration. If the test statistic on day $t = 1$ is significantly different from zero and has an opposite sign to the sign of abnormal returns on the event day, this is a signal that an unexpected change in price has taken place and that the change went the opposite direction of the change from the day before. This is not tantamount to saying that the price has changed in the opposite direction than the day before, so this conception of price reversal is slightly different than the one proposed by Stoll and Whaley (1986) and employed by other research. For example, if there is a rapidly growing trend in prices and an abnormal return is positive on the day of expiration, this means that the price rose even more than was expected. If, on the next day, the abnormal return is negative, this does not necessarily mean that the price dropped, but it is a signal that the trend was disturbed in the opposite direction than the day before (the trend was constricted). When a price reversal is defined as the change of the return's sign, the above-mentioned situation appearing as an effect of expiration is not taken into account. Thus, it is desirable to check whether the effect of a future's expiration day is reflected in the abnormal returns.

To avoid making the article too weighty, the results of the event study analysis conducted on the control groups are only briefly described, but they are not presented in the tables. However, these can be provided by the author upon request.

3. Empirical results

3.1. Results from analysis of regression models

As an initial study of the price reversal effect of expiration, two regression models are matched to the returns of the futures' underlying assets. In the models, an independent variable represents the daily logarithmic rate of return on the expiration day (or control day), while the dependent variables are defined in two different ways and describe the returns on the day following the expiration day (or control day). In the case of a price reversal, the coefficient corresponding to the explanatory variable should be negative. Results from the analysis are presented in Table 1. Panel A presents the results from the model with the dependent variable defined as the logarithmic rate of return on the day following the event day. In Panel B, results from the model with the dependent variable defined as the overnight return (that is, the logarithm of the ratio of the return on the opening on the day after expiration or the control day to return at the close on the event day) are presented. The expiration and the control group each have 64 observations for WIG20, 39 observations for mWIG40, and 591 observations for the individual stocks.

Table 1

Results from regression models employed to returns of futures' underlying assets

PANEL A						
Underlying asset	**Expiration days**			**Control days**		
	coefficient	**estimate**	**p-value**	**coefficient**	**estimate**	**p-value**
WIG20	α (intercept)	0.000	0.986	α (intercept)	−0.002	0.377
	$\beta(R_{i,0})$	−0.128	0.376	$\beta(R_{i,0})$	0.048	0.744
	Multiple R^2: 0.013			Multiple R^2: 0.002		
PANEL A						
Underlying asset	**Expiration days**			**Control days**		
	coefficient	**estimate**	**p-value**	**coefficient**	**estimate**	**p-value**
mWIG40	α (intercept)	0.000	0.854	α (intercept)	−0.002	0.307
	$\beta(R_{i,0})$	−0.136	0.400	$\beta(R_{i,0})$	0.084	0.753
	Multiple R^2: 0,019			Multiple R^2: 0.003		

Table 1 cont.

individual stocks	α (intercept)	0.002	**0,023**	α (intercept)	0.000	0.747
	$\beta(R_{i,0})$	−0.049	0,213	$\beta(R_{i,0})$	0.252	**0.000**
	Multiple R^2: 0.003			Multiple R^2: 0.040		
PANEL B						
Underlying asset	**Expiration days**			**Control days**		
	coefficient	**estimate**	**p-value**	**coefficient**	**estimate**	**p-value**
WIG20	α (intercept)	0.002	0.061	α (intercept)	−0.002	0.077
	$\beta(R_{i,0})$	−0.094	0.181	$\beta(R_{i,0})$	−0.050	0.502
	Multiple R^2: 0,029			Multiple R^2: 0,007		
mWIG40	α (intercept)	0.001	**0.050**	α (intercept)	0.001	0.743
	$\beta(R_{i,0})$	0.034	0.550	$\beta(R_{i,0})$	0.249	0.977
	Multiple R^2:	0.010		Multiple R^2:	0.083	
individual stocks	α (intercept)	0.001	**0.037**	α (intercept)	−0.002	**0.002**
	$\beta(R_{i,0})$	−0.535	**0.007**	$\beta(R_{i,0})$	0.017	0.581
	Multiple R^2: 0.012			Multiple R^2: 0.001		

Source: own calculations

In each of the three models from Panel A (for WIG20, mWIG40, and the individual stocks), the coefficient corresponding to the explanatory variable is negative in the group of expiration days, suggesting that the higher the rate of return on the event day, the lower the rate on the following day, and (conversely) a negative rate of return on the expiration day has a positive impact on the rate of return on the next day. Unfortunately, the coefficients are not statistically significant from zero, so this impact is not strong enough to be a convincing sign of a price reversal. In the control group, coefficient β is positive in each of the models, but it is only statistically significant (at a 1% level) in the case of an individual stock's returns. This is a confirmation that, on days without a futures' expiration, returns of the stocks tend to follow the trend. This feature seems to be disturbed by the expiration. In the WIG20 and mWIG40 index returns, there are no significant differences on the days with and without an expiration. The daily rate of return, employed as a dependent variable in the first model, contains information about the change in price during the whole day following the expiration. Thereby, many different events on this day can have an impact on it, disturbing its possibility to reflect the price reversal. As the models in Panel A do not provide satisfying clear-cut results, a second model is employed to check if it is possible that the price reversal after expiration is immediate and can be reflected in the overnight rather than daily returns. Thus, in the second model, the dependent variable is defined as the logarithm of the ratio of the price on the opening of the day after the expiration (or control) day to the price at the close of the event day.

In all of the models constructed for the indexes, coefficient β does not differ significantly from zero. For the mWIG40 returns, this coefficient is even positive (but insignificant) in the group of expiration days. However, the results obtained for the individual stocks are interesting. Coefficient β is negative and significant on expiration days yet positive (but not significant) on control says. This suggests that the price reversal appears directly after a future's expiration, while the continuation of the trend on ordinary days is connected with investor activities during the day and is reflected in the daily rather than overnight returns.

A slightly different regression model (but one that also describes the relationship between the returns on the expiration day and on the following day) was employed by Alkebäck and Hagelin (2004). They study futures on the OMX index and do not find a statistically significant reversal of the index returns after expiration. Narang and Vij (2013) also use some regression model (but definitely more complicated) for the daily data to evaluate the price and volume effects of an index derivative's expiration, and their results also indicate that there is no price reversal.

This preliminary research of regression models suggests that the expiration day effect may not be reflected in the index returns but might be visible in the prices of these stocks that set an underlying asset of a contract. In this case, an abnormal change in price on the expiration day may be immediately rectified after expiration and be reflected in the overnight stock returns. Further research will be conducted to support this thesis.

3.2. Results from analysis of reversal measures

Three measures of price reversal used in foregoing studies of futures' expiration effects (see, e.g., Stoll and Whaley [1987], Chamberlain et al. [1989], Alkebäck and Hagelin [2004]) are constructed for the returns of the WIG20 and mWIG40 indexes as well as for the individual stocks on the expiration and control days. As in the case of the regression models, the measures are defined in two different ways depending on the definition of the returns after expiration. These results are presented in Table 2. The expiration and control groups each have 64 observations for WIG20, 39 observations for mWIG40, and 591 observations for the individual stocks.

Table 2

Average price reversal measures in percentages as well as percentages of number of days with reversals

Panel A				
Underlying asset	**Type of reversal**	**Expiration days [%]**	**Control days [%]**	**p-value of t-test**
WIG20	Type O reversal	0.036	0.091	0.858
	Type 1 reversal	0.582	0.673	–
	Type 2 reversal	0.543	0.587	–
	Percentage of reversals	48%	56%	–
mWIG40	Type O reversal	0.096	−0.176	0.343
	Type 1 reversal	0.431	0.467	–
	Type 2 reversal	0.479	0.280	–
	Percentage of reversals	64%	38%	–
individual stocks	Type O reversal	0.164	−0.195	**0.009**
	Type 1 reversal	0.899	0.822	–
	Type 2 reversal	0.864	0.626	–
	Percentage of reversals	53%	46%	–
Panel B				
Underlying asset	**Type of reversal**	**Expiration days [%]**	**Control days [%]**	**p-value of t-test**
WIG20	Type O reversal	0.050	–0.035	0.587
	Type 1 reversal	0.027	0.289	–
	Type 2 reversal	0.451	0.599	–
	Percentage of reversals	50%	42%	–
mWIG40	Type O reversal	0.022	–0.077	0.474
	Type 1 reversal	0.164	0.233	–
	Type 2 reversal	0.322	0.310	–
	Percentage of reversals	59%	44%	–
individual stocks	Type O reversal	0.065	–0.069	0,078
	Type 1 reversal	0.417	0.407	–
	Type 2 reversal	1.044	0.809	–
	Percentage of reversals	47%	39%	–

Source: own calculations

Panel A includes measures drawn by comparing the daily logarithmic rate of a return on the day of expiration (or on the control day) to the daily logarithmic rate of return on the following day. The average Type 0 reversal for mWIG40 as well as for the individual stocks is positive on expiration days and negative on control days. This measure takes a positive value in the case of price reversal and negative otherwise, so the results are consistent with the assumption of reversal after the expiration and continuation in prices when no contract expires. However, the test statistic of the differences in means indicates that the difference between average Type 0 reversal on the expiration and control days is significant only in the group of individual stock prices. For the WIG20 index, the Type 0 reversal is positive both on expiration and control days, suggesting no reversal. The Type 1 and Type 2 reversals take strictly nonnegative values. These measures are only descriptive. The higher the value of the average measure, the stronger the phenomenon of price reversal. It can be noticed that the means of both measures are higher on expiration days than on control days only in the case of individual stocks; however, the differences are not substantial. In the table, the percentages of the number of days with reversals is presented (calculated as the percentage of the number of days with a positive Type 0 reversal). For the mWIG40 index as well as the individual stocks, this is higher on expiration days than on control days; but again, the differences are moderate.

The averaged measures presented in Panel B were calculated with the use of the daily logarithmic rate of return on the event day and the overnight return on the following day. The results are mostly consistent with those from Panel A. This time, however, the average Type O reversal has a positive sign on expiration days and negative on control days in each of the three groups (but the t-statistic values are not significant). Only for the individual stock returns, the difference between the average Type 0 reversal on expiration and control days can be detected at a 10% level. The average Type 1 and Type 2 reversals for the stocks are somewhat higher in the group of expiration days. The values of these measures for WIG20 and mWIG40 do not confirm reversal after expiration.

From among the foregoing studies of price reversal after index future expiration that used such measures, Stoll and Whaley (1987) on the US market and Chamberlain et. al. (1989) on the Canadian market detect the phenomenon of price reversal, while Stoll and Whaley (1997) on the Australian market and Alkebäck and Hagelin (2004) on the Swedish market do not find it.

As in the analysis of the regression model, the measures do not indicate a reversal of the WIG20 and mWIG40 indexes, but they do suggest that such a reversal appears in the individual stock prices.

3.3. Results from event study analysis of daily returns

In this part of the research, a slightly different definition of price reversal is employed. As an event study analysis is normally based on the differences between actual returns and their expected values, price reversal here means that an unexpected rise in the returns on the following day occurs after an unexpected drop in returns on the day of expiration; conversely, returns that are higher than expected on the day of expiration are followed by returns lower than expected on the next day. This is not tantamount to literal meaning of the phrase “price reversal,” which suggests that the price rose and then dropped (or vice versa).

To detect price reversal after future expiration using the event study methodology, each group of events (expiration of futures on WIG20, mWIG40, and for individual stocks) is divided into two subgroups: expiration days with positive abnormal returns and expiration days with negative abnormal returns. Then, an event study analysis is conducted in each of the two clusters with the use of a generalized rank test. The significance of the test statistic on the event day in the groups is obvious due to their definitions. The attention is focused on the day following expiration, so this day is treated as an event day. A test statistic significantly different from zero and with a sign opposite to the sign of a test statistic on expiration day is a signal of price reversal.

Table 3

Reaction of daily abnormal returns of individual stocks to expiration of futures

	Individual stocks (positive abnormal returns on day t = 0)			**Individual stocks (negative abnormal returns on day t = 0)**		
t	$\overline{AR_t}$ **[%]**	**τ-grank**	**p-value**	$\overline{AR_t}$ **[%]**	**τ-grank**	**p-value**
	311 events			**280 events**		
−5	0.055	1.040	0.304	−0.075	−0.253	0.802
−4	0.122	0.941	0.352	0.018	0.482	0.632
−3	−0.007	0.618	0.540	−0.033	0.464	0.645
−2	0.065	0.924	0.361	0.063	0.286	0.776
−1	−0.055	0.285	0.777	0.049	0.843	0.404
1	−0.064	−0.656	0.515	**0.202**	**2.433**	**0.019**
2	−0.188	−1.224	0.228	**0.104**	**2.337**	**0.024**
3	−0.134	−0.641	0.525	−0.128	−0.389	0.699
4	−0.123	−0.121	0.904	−0.024	1.001	0.322
5	−0.132	−0.480	0.634	0.060	1.277	0.208

Source: own calculations

Table 3 presents the following results: the mean abnormal returns in percentages, value of the generalized rank test statistic, and p-values of the test for the research conducted on the individual stocks' daily logarithmic rate of returns. The event day is not included in the table, as the significance of the test statistic on this day is evident in view of the clusters' definitions. In the cluster of expiration days with positive abnormal stock returns, there is no value significantly different from zero throughout the event window. The mean abnormal returns and test statistic on days following an expiration day are negative; however, as they are not significant, they cannot support the assumption of price reversal after expiration. However, in the cluster of expiration days with negative abnormal returns, the test statistic on the two days following expiration are significantly positive (at a 5% level). This means that the prices being lower than expected on the expiration day can be the effect of unwinding long arbitrage positions or speculations conducted on the stocks by investors who have tried to change the settlement price of the contract. After expiration, the prices return to the higher level. Long arbitrage (that is, buying stocks and selling a contract) is more popular than short arbitrage, as it is easier to conduct. Short arbitrage requires the short selling of stocks. Until the release of European Union regulations concerning short selling in May 2015, GPW had published lists of stocks that could have been the objects of short selling. The stocks were required to fulfill the appropriate requirements regarding liquidity. This had caused that short selling had not been practically used. The regulation from May 2015 made short selling easier to conduct, but most of the data in the research came from the period of time from before this change. If the unwinding of arbitrage positions poses an essential part of price changes on expiration day, it is not surprising that price reversal is visible only in the group of expiration days with negative returns, as simply unwinding long arbitrage is connected to selling stocks, resulting in price falls. Even if the speculations have an important influence on prices on expiration, price reversal should be stronger in the cluster of days with negative abnormal returns if arbitragers also have a contribution to this effect.

Analogous research was also conducted in the control group to check if the potential price reversal could be interpreted as the effect of expiration or if it might have been a calendar effect. Detailed results can be provided by the author upon request. All of the test statistic values in the event windows are insignificant, and in both clusters, the average abnormal return on the day following a control day have the same sign as the abnormal returns on day $t = 0$, which rather suggests continuation than reversal in the returns. This supports the conclusion about reversal being caused by future expiration.

The results from the event study analysis conducted for the WIG20 and mWIG40 returns are presented in Table 4. As in the case of the regression models and reversals measures, no evidence of reversal in the returns after expiration were found.

Table 4

Reaction of daily abnormal returns of WIG20 and mWIG40 indexes to expiration of futures

t	**WIG20 Index (positive abnormal returns on day t = 0)**			**WIG20 Index (negative abnormal returns on day t = 0)**			**mWIG40 Index (positive abnormal returns on day t = 0)**			**mWIG40 Index (negative abnormal returns on day t = 0)**		
	$\overline{AR_t}$ [%]	**τ-grank**	**p-value**	$\overline{AR_t}$ [%]	**τ-grank**	**p-value**	$\overline{AR_t}$ [%]	**τ-grank**	**p-value**	$\overline{AR_t}$ [%]	**τ-grank**	**p-value**
	35 events			**32 events**			**23 events**			**18 events**		
−5	**−0.673**	**−2.093**	**0.042**	−0.521	−1.013	0.317	−0.175	−0.797	0.430	−0.488	−1.642	0.108
−4	−0.374	−0.340	0.736	−0.423	−1.346	0.185	−0.409	−0.614	0.543	−0.043	−0.768	0.447
−3	−0.205	−0.484	0.631	−0.053	−0.196	0.846	0.089	1.106	0.275	−0.098	−0.036	0.972
−2	−0.135	0.570	0.572	0.247	1.086	0.284	0.200	0.535	0.596	−0.181	−0.567	0.573
−1	0.435	1.278	0.208	−0.034	0.474	0.638	0.106	−0.141	0.889	0.110	0.817	0.418
1	−0.013	0.399	0.692	−0.010	0.195	0.846	0.048	−0.440	0.662	−0.083	−0.125	0.901
2	−0.165	−0.424	0.674	0.234	0.540	0.592	0.052	0.094	0.925	−0.194	−1.347	0.185
3	0.048	−0.423	0.674	0.006	−0.103	0.918	0.223	0.725	0.472	0.056	−0.355	0.724
4	−0.140	−0.097	0.923	0.084	0.227	0.821	−0.083	0.362	0.719	−0.368	−0.764	0.449
5	−0.246	−0.541	0.591	0.154	0.000	1.000	−0.487	−1.370	0.178	0.223	1.633	0.110

Source: own calculations

Most of the test statistic values in the event windows are not significantly different from zero. Only for WIG20 in the group of expiration days with positive returns, the value of the test statistic five days before expiration is significantly negative (at a 5% level), but this seems to have no connection with the expiration. In the clusters constructed for WIG20 abnormal returns on control days (not presented in the article), there is no test statistic value significantly different from zero. In the case of the mWIG40 Index, the only significant value (at a 5% level) of the test statistic on control days appears in the cluster constructed for days with negative abnormal returns (three days before the control day, and it is also negative). However, the number of events in each sample constructed for mWIG40 is small. The distribution of the test statistic converges to t-student distribution as the sample size increases, so the results here are not quite reliable.

3.4. Results from the event study analysis of overnight and daylong returns of individual stocks

As the analysis of the individual stocks' daily returns gives the basis for the occurrence of the price reversal effect of future expiration, more-detailed research is conducted. Alkebäck and Hagelin (2004) suggested that day-to-day returns can be unable to reflect price reversal, as prices can reverse before the close of the market. To check whether the effect appears immediately after expiration and if it can be reflected in the overnight returns of the stocks, overnight abnormal returns are calculated with the use of the market model, and the generalized rank test is used analogously to the daily abnormal returns. Clusters of days with negative and positive abnormal returns are, however, defined in terms of daily abnormal returns on the expiration day, because the overnight returns on the expiration do not mirror the activity of investors on this day, so they are probably not influenced by the expiration. Results presented on the left-hand side of Table 5 show that, in both clusters of expiration days, the test statistic is significant (at a 1% level) on the day after expiration, and the sign of the statistic is opposite to the sign of the abnormal returns on expiration. This is strong evidence that price reversal occurs immediately after expiration and is reflected in the overnight returns (even in the group of expiration days with negative returns, in which this effect was not reflected by the daily returns). Analogous research was conducted in the control group. These results can be provided by the author upon request. In the cluster of control days determined by positive abnormal daily returns, the test statistic is significant and positive on day $t = 0$. This means that positive abnormal daily returns can be a continuation of some trend, as they occur after positive overnight returns. In the cluster of control days with negative abnormal returns, the test statistic is significantly positive (at a 5% level) two days after the event day, but it is difficult for the author to find a potential reason for this significance.

In the next part of the research of the individual stocks returns, the same study is conducted on daylong abnormal returns. Daylong returns are calculated as the natural logarithm of the ratio of stock prices at the close and at the opening on a given day. Abnormal daylong returns are calculated with the use of the market model. The event study was conducted in two clusters, which are defined (as previously) in terms of the sign of the daily abnormal returns on the expiration day. These results are presented on the right-hand side of Table 5. The test statistics are significant on day $t = 0$ in both clusters, which is not surprising (as the daylong returns are usually the same sign as the corresponding daily returns). This time, in the two clusters for expiration days, there is no significance of the test statistic on day $t = 1$. This suggests that, even on days with negative daily returns (in which the research conducted on the daily returns gives a significant and positive statistic on the day following the expiration day), the phenomenon of price reversal occurs immediately after expiration. However, it is stronger in this case and can have a continuation, as the test statistic is also significant (at a 5% level) on the second day after expiration. In the two clusters for the control days (not presented), the abnormal daylong returns follow this trend. The test statistic is significant and positive one day after day $t = 0$ with the positive abnormal returns. In the second cluster, the statistic is not significantly different from zero on each of the days after day $t = 0$, but it is negative through the end of the event window.

As a complement to the research, the event study analysis was also conducted with the use of normal daily returns. The methodology is the same as previously; but now, the expected value of the return is assumed to be equal to zero. Thereby, abnormal returns are equal to the normal daily returns. The significant test statistic on day $t = 1$ with the sign opposite to the sign of the test statistic on the event day suggests a price reversal. Here, the reversal is consistent with the definition employed in the regression models and reversal measures. The results are not presented to avoid making the article too weighty, but they can be provided by the author upon request. They are similar to those from the analysis of daily abnormal returns. In the case of the individual stocks, there is no clear-cut evidence of the reversal in the cluster with positive returns upon expiration. In the cluster with negative returns on day $t = 1$, the test statistic is significantly positive (at a 5% level) on the day following expiration. This supports the previous results that, in this cluster, the reversal is more visible. In the case of WIG20 and mWIG40 returns, no test statistic values statistically different from zero could be found throughout the entire event window. Like the previous methods, this one also does not detect a reversal in the indexes' returns after future expiration.

Table 5

Reaction of overnight and daylong abnormal returns of individual stocks to futures expirations

t	**Overnight returns**						**Daylong returns**					
	Individual stocks (positive daily abnormal returns on day $t = 0$)			**Individual stocks (negative daily abnormal returns on day $t = 0$)**			**Individual stocks (positive daily abnormal returns on day $t = 0$)**			**Individual stocks (negative daily abnormal returns on day $t = 0$)**		
	$\overline{AR_t}$ [%]	**τ-grank**	**p-value**	$\overline{AR_t}$ [%]	**τ-grank**	**p-value**	$\overline{AR_t}$ [%]	**τ-grank**	**p-value**	$\overline{AR_t}$ [%]	**τ-grank**	**p-value**
	311 events			**280 events**			**311 events**			**280 events**		
−5	0.088	1.958	0.057	−0.044	−0.490	0.627	−0.045	0.368	0.715	−0.045	0.084	0.933
−4	0.071	0.516	0.609	−0.029	−0.695	0.491	0.046	1.248	0.218	0.064	0.900	0.373
−3	−0.012	−0.405	0.687	−0.037	0.259	0.797	0.008	1.164	0.251	−0.024	0.489	0.627
−2	0.020	0.465	0.644	−0.025	0.434	0.666	0.067	1.007	0.319	0.092	0.633	0.530
−1	−0.013	−0.365	0.717	0.056	0.314	0.755	−0.002	1.011	0.318	0.005	0.684	0.498
0	0.090	1.972	0.055	−0.074	−1.758	0.086	**1.331**	**19.113**	**0.000**	**−1.176**	**−10.964**	**0.000**
1	**−0.135**	**−3.275**	**0.002**	**0.147**	**3.988**	**0.000**	0.122	1.542	0.130	0.050	0.929	0.358
2	−0.039	−0.847	0.401	−0.008	0.508	0.614	−0.174	−1.212	0.232	**0.083**	**2.158**	**0.036**
3	0.013	−0.475	0.637	0.014	0.545	0.589	−0.145	−0.658	0.514	−0.176	−0.871	0.389
4	0.034	0.790	0.434	0.026	1.169	0.249	−0.185	−0.225	0.823	−0.039	1.003	0.321
5	−0.181	−0.951	0.347	−0.075	0.244	0.808	0.004	0.496	0.622	0.086	1.394	0.170

Source: own calculations

4. Conclusions

In this paper, the impact of futures' expiration days on the returns of their underlying assets was researched. The data covers the period from January 2001 to December 2016. Three potential effects of future expiration are evident in the literature: increased trading volume on the day of expiration, increased volatility in the prices, and abnormal price changes upon expiration resulting in price reversal on the following day. The author focused on the last of the above-mentioned effects and conducted detailed research on abnormal price changes around the expiration of futures on the WI20 and mWIG40 indexes as well as futures on individual stocks. Three different methods were employed to investigate the occurrence of the phenomenon of price reversal. First, linear regression models were constructed with returns on the day following expiration as a dependent variable as well as returns on the day of expiration as an explanatory variable. Then, three measures of price reversal given by other researchers were calculated. Finally, an event study analysis was employed to test the occurrence of price reversal (which is defined in a slightly different way than in the two previous methods).

The research does not detect the reversal of index returns and, thus, does not confirm the previous results on this issue obtained by Morawska (2007). In the case of the individual stock returns, all three methods support the assumption that price reversal occurs after expiration. Results from the regression model as well as from the event study analysis show that the reversal is immediate and is reflected in overnight returns more than in daily returns. The phenomenon of price reversal seems to be stronger in the case of negative abnormal returns on the expiration day. Author suggests that it can be connected with the unwinding of long arbitrage positions. Short arbitrage, which involves the short selling of stocks, was constricted during the period under study due to the restrictive regulations regarding short selling.

The differences in the results obtained for the stocks and the indices are not surprising. The way the contracts are settled is a very important factor that influences the effects of expiration day. The final settlement price of futures on individual stocks is calculated as the rate of the stock from the last transaction on the expiration day. Thus, to manipulate the settlement price, speculators should increase their activity mostly at the close of the market. Long arbitragers (with long positions in stocks) have only to place market-on-close orders on the stocks to realize their strategies. In the case of index futures, the final settlement rate is equal to the mean of the continuous quotations from the last trading hour and the value at the close, where the five highest and five lowest values are eliminated. Speculation on an index is more difficult than on individual stocks, as an investor has to buy or sell only this one stock to manipulate the price of the stock. To manipulate the index, it is necessary to make appropriate transactions on all of the stocks in it. Changing the value of the index is quite difficult as the indices represent the entire market; therefore, as Stoll and Whaley (1986) write, they "are deeper and broader than the market in any stock." Construction of the settlement rate of index futures additionally restricts speculation on it in order to manipulate a contract's price.

The index arbitrage is also intrinsically more complex than the arbitrage on a single stock and is further hampered by the settlement procedure of index futures. Focusing on a long arbitrage (which is more-readily-available on the Polish market), the settlement procedure makes that unwinding a position in the stocks by ordinary market-on-close orders does not give an investor profits exactly equal to the costs associated with the trade of the contract.

All of the above-mentioned reasons suggest that the price effects of future expiration are more likely in stock prices than in the returns of the indices, and the results of the research confirm this thesis. There can be one additional reason why price effects in indice returns were not found. This research uses daily data. Alkebäck and Hagelin (2004) wrote that it is an "important methodological concern, whether lower frequency data allow expiration day effects to be detected." They give two arguments supporting the thesis that daily returns can be unable to detect price effects. First, extending the event window reduces the relative size of the effect, thereby reducing the probability of detection. Moreover, prices can be reversed before the exchange close, and the day-to-day returns cannot reflect the price distortion. The results from the analysis of the daily and overnight returns of the stocks reinforce the second argument. However, in the case of the WIG20 and mWIG40 indexes, an event study on the overnight returns was also conducted by the author; however, as it does not show any significant test statistic value in the event window, the results are not included in the article. Nevertheless, the issue of whether higher-frequency data is better able to detect expiration effects remains an open question that inspires this author to further study their use.

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Appendix

Table 6 contains list of futures used in the research with their characteristics. The names of the underlying assets are given by their abbreviations. The first expiration means the first one included in the research. If the contract was introduced before the period under study, it is not its first expiration at all.

Table 6

A list of futures used in research and their characteristics

Underlying asset (abbreviation)	Multiplier	First expiration	Number of expiration days (with positive number of opened positions)
WIG20	10,20*	13-06-2001	64
mWIG40	10	15-06-2007	39
ACP	100	18-06-2010	27
ALR	100	21-03-2014	9
ATT	100	16-12-2016	1
BRS	1,000	15-06-2012	13
BZW	100	20-06-2003**	24
CCC	100	18-12-2015	4
CDR	100	16-09-2011	22
CIE	100	16-12-2016	1
CPS	100	18-12-2015	4
ENA	100	18-12-2015	5
GPW	100	16-03-2012	20
GTC	1,000	16-12-2011	14
ING	100	16-12-2016	1
JSW	100	16-12-2011	21
KER	100	16-12-2011	15
KGH	100	21-03-2003	56
KRU	100	16-12-2016	1
LTS	100	26-06-2011	23
LWB	100	16-12-2011	21

Table 6 cont.

MBK	100	16-12-2016	1
MIL	1,000	20-06-2003***	17
OPL	100	21-03-2014	12
PEO	100	21-03-2003	56
PGE	100	18-06-2010	27
PGN	1,000	18-06-2010	27
PKN	100	21-03-2003	56
PKO	100	16-09-2005	46
PZU	100	17-09-2010	26
SNS	1,000	21-09-2012	17
TPE	1,000	18-03-2011	24

* First futures on WIG20 Index with multiplier 20 were put on the market in September 2013.
** Contracts on BZW had been traded through December 2008. Then, the markings were suspended and restarted in December 2016.
*** Contracts on MIL had been traded through March 2007. Then, the markings were suspended and restarted in December 2015.

Source: own compilation on the basis of data from www.gpwinfostrefa.pl

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CAPM applications for appropriate stock pricing – impact of speculation companies

1. Introduction

The phenomena of incompatible pricing with the classic CAPM may be, for example, the size effect of Banz (1981), the January effect, the reversal of long-term returns documented by DeBondt and Thaler (1985), or the continuation of short term returns found by Jegadeesh and Titman (1993). The effect of DeBondt and Thaler is captured by the Fama-French three-factor model. The above anomalies deny pricing in light of the CAPM.

Research on stock pricing on the Polish market has been presented by Adamczak (2000), Jajuga (2000), Bołt and Miłobędzki (2002), Osińska and Stempińska (2003), Byrka-Kita and Rozkrut (2004), Zarzecki et al. (2004–2005), Fiszeder (2006), Czapkiewicz and Skalna (2010), and Gurgul and Wójtowicz (2014). The vast majority of the results deny pricing in light of the CAPM.

Czapkiewicz and Wójtowicz (2014) simulated returns of Polish stocks by a four-factor pricing model. Urbański (2012) tested the Fama and French (1993) model and proposed its modification based on the Fama and French (1995) work. In his further work, Urbański (2015) investigated whether stocks pricing simulated by the classic and modified Fama and French models is consistent in light of the ICAPM. The author also explored the impact of speculative stocks on the ICAPM stock pricing results. He stated that, if speculative stocks are eliminated, pricing errors generated by the model decrease, and the model generates multifactor-efficient portfolios.

Is commonly known that ICAPM applications and the classic CAPM can be employed to estimate the cost of company capital. Used for this purpose, ICAPM applications provide a lot of difficulties, and the procedures built on the clas-

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sic CAPM are usually applied. However, if the pricing is not consistent with the pricing that could be observed with the CAPM rules (which is confirmed by the above-shown work), the estimated capital cost may be incorrect.

To our knowledge, there are no studies to explain the reasons for the incorrect stock pricing in light of the classic CAPM. Thus, leaning again on Urbański's (2015) work and the need for a simple-to-use and correct capital cost estimation, it seems justified to also examine the influence of speculation stocks on pricing in light of the classic CAPM.

In this paper, we explain the reasons of inconsistent stock pricing. The basis of the correct test of the CAPM application is the appropriate formation of portfolios. Therefore, we use the injunctions by Cochrane (2001). He said: "Finally, I think much of the attachment to portfolios comes from a desire to more closely mimic what actual investors would do rather than simply form a test." (see Cochrane, 2001, p. 445). "If your portfolios have no spread in average returns – if you just choose 25 random portfolios – then there will be nothing for the asset pricing model to test." (see Cochrane, 2001, p. 453).

The present work is a continuation of the preliminary study in this field presented by Urbański et al. (2014) and Urbański (2015). They note that many speculative stocks(described by bad financial indicators and penny prices) are characterized by extremely high returns (in the USA, a penny stock is defined by the Securities and Exchange Commission [SEC] as a security whose price is below 5 $ per share, while in the UK, this threshold is 1 £. Penny stocks in the USA are often traded on over-the-counter markets. The SEC has defined specific rules for the sale of penny stocks.)

Therefore, we expect that the following conjectures are true:

Conjecture 1

Speculative stocks are the cause of inconsistent stock pricing in light of the CAPM.

Conjecture 2

Improper procedures for the construction of test portfolios are an additional factor leading to incompatible stock pricing.

Section 2 presents the data and procedures of portfolio construction. Section 3 widely analyzes the results of pricing in light of the classic CAPM for each procedure presented in Section 2. Section 4 tests the influence of additional boundary conditions on the pricing correctness in light of the classic CAPM. Section 5 presents our conclusions.

2. Data and procedures of portfolio construction

The study is based on stocks quoted on the WSE during the period of 1995–2012. The full-sample observations are divided into two separate sub-periods: 1995–2005 (the years preceding Poland's accession to the EU) and 2005–2012 (the years of Poland's membership in the EU). Necessary data characterizing the inspected companies (such as fundamental indicators and stock quotes) were provided by Notoria Serwis Company and the Warsaw Stock Exchange.

Procedures of portfolio forming are defined in two variants. According to Cochrane's guidelines, Variant 1 provides practical investment strategies. In this variant, the model of portfolio management described in the work of Urbański (2012) and briefly presented in the appendix is used. In Variant 2, portfolios are built according to the methodology of Fama and French (1993).

In each variant, three modes of samples are analyzed. Mode M1 considers all WSE stocks except for companies characterized by a negative book value. In Mode M2, we eliminate speculative stocks that meet one of the following boundary conditions: a) MV/BV > 100; b) ROE < 0 and BV > 0 and $r_{it} > 0$; c) MV/BV > 30 and $r_{it} > 0$, where r_{it} is return of stock i in period t. In Mode M3, we eliminate speculative stocks meeting an additional condition d) $MV/E < 0$. The speculative stocks, defined in Mode M2 appear from Q1 of 2005. The speculative stocks defined in Mode M3 appear throughout the whole analyzed period. The number of analyzed companies decreased from 14% in 2005 to 21% in 2012 after the exclusion of the speculative stocks defined in Variant 3 (see Tab. 1) (230 companies were listed on WSE in 2004, while 426 were listed at the end of 2011).

The analyzed securities are sorted into quintile portfolios built on the basis of fundamental functional FUN as well as the NUM and DEN functions presented in the appendix – in Variant 1 (five portfolios are formed on FUN, five on NUM, and five on DEN) as well as on BV/MV and CAP (five portfolios are formed on BV/MV and five on CAP) in Variant 2. FUN, NUM, DEN, BV/MV, and CAP are calculated for all analyzed securities at the beginning of each investment period in which the return is to be calculated. FUN, NUM, DEN, BV/MV, and CAP for the portfolios constitute the average arithmetical values of these functions of various portfolio securities. Returns on the given portfolios are average stock returns weighted by market capitalizations. Function NUM represents an investor forming a portfolio that consists of the best fundamental companies, whereas DEN represents an investor portfolio that consists of the undervalued stocks. Functional FUN represents an investor building a portfolio that consists of the best fundamental and simultaneously undervalued stocks (the argumentation relates to long investments).

Table 1 presents the number of listed companies classified into quintile portfolios during the chosen periods. Table 2 shows the return spreads of the portfolios formed on the maximal (Quintile 1) and minimal (Quintile 5) values of FUN, NUM, DEN, BV/MV, and CAP.

Table 1

Number of companies in quintile portfolios

Portfolio	IQ1996			IQ2005			IQ2012		
	M1	**M2**	**M3**	**M1**	**M2**	**M3**	**M1**	**M2**	**M3**
1	11	11	11	33	30	27	63	61	50
2	11	11	11	33	30	27	63	61	50
3	11	11	11	33	30	27	63	61	50
4	11	11	11	33	30	27	63	61	50
5	13	13	10	34	28	29	62	60	49

In M1 negative-BV stocks are excluded from portfolios. Mode M2 eliminates speculative stocks meeting one of the following boundary conditions: 1) MV/BV > 100; 2) ROE < 0 and BV > 0 and $r_{it} > 0$; 3) MV/BV > 30 and $r_{it} > 0$, where MV is stock market value, ROE is return on book value (BV), r_{it} is return of portfolio i during period t. Mode M3 eliminates speculative stocks meeting additional condition 4) MV/E < 0, where E is average earning for last four quarters.

Source: own research

The maximal return spreads are for portfolios formed on FUN, NUM, and DEN in M2 and M3 (p-values < 0.001%). The spreads for the portfolios formed on BV/MV are lower and are insignificantly different from zero in the first subperiod. The spreads for the portfolios formed on CAP are insignificantly different from zero in all of the tested periods (p-values > 10%).

Table 2

Average return spreads of portfolio formed on maximal and minimal values of FUN, NUM, DEN, BV/MV, and CAP

Portfolios are formed on:	FUN	NUM	DEN	BV/MV	CAP
M1: 1995–2005, 36 quarters $\bar{r}$ (p-value [%])[a]	0.09 (0.00)	0.07 (0.17)	–0.00 (0.49)	0.05 (13.98)	−0.00 (97.62)
M1: 2005–2012, 28 quarters $\bar{r}$ (p-value [%])[a]	0.04 (2.31)	0.03 (7.69)	−0.06 (0.83)	0.05 (2.65)	−0.03 (28.93)
M2: 1995–2012, 64 quarters $\bar{r}$ (p-value [%])[a]	0,11 (0.00)	0.08 (0.00)	−0.08 (0.00)	0.03 (6.83)	−0.01 (74.84)

Table 2 cont.

$\bar{r}_{variant}$	$\bar{r}_{variant\_1} = 0.09$			$\bar{r}_{variant\_2} = 0.01$	
(p-value [%])[b]	0.00				
M2: 1995–2005, 36 quarters $\bar{r}$ (p-value [%])[a]	0.09 (0.00)	0.07 (0.17)	−0.05 (0.49)	0.05 (13.98)	−0.00 (97.62)
M2: 2005–2012, 28 quarters $\bar{r}$ (p-value [%])[a]	0.12 (0.00)	0.10 (0.00)	−0.13 (0.00)	0.04 (2.02)	−0.02 (48.47)
M3: 1995–2005, 36 quarters $\bar{r}$ (p-value [%])[a]	0.12 (0.00)	0.10 (0.06)	−0.06 (3.77)	0.04 (19.53)	−0.02 58.84)
M3: 2005–2012, 28 quarters $\bar{r}$ (p-value [%])[a]	0.06 (2.15)	0.03 (6.50)	−0.05 (1.49)	0.04 (4.52)	−0.05 (11.27)

$\bar{r}$ is average spread value, [a] H_0: $\bar{r} = 0$, H_1: $\bar{r} \neq 0$; [b] H_0: $\bar{r}_{variant\_1} = \bar{r}_{variant\_2}$, H_1: $\bar{r}_{variant\_1} > \bar{r}_{variant\_2}$. In Mode M1, negative-BV stocks are excluded from portfolios. Mode M2 eliminates speculative stocks meeting one of the following boundary conditions: 1) MV/BV > 100; 2) ROE < 0 and BV > 0 and $r_{it} > 0$; 3) MV/BV > 30 and $r_{it} > 0$, where MV is the stock market value, ROE is return on book value (BV), r_{it} is return of portfolio i during period t. Mode M3 eliminates speculative stocks meeting additional condition 4) MV/E < 0, where E is average earning for last four quarters. Spread values in M1 and M3 for whole investigated period (1995–2012) are available from authors upon request.

Source: own research

3. Stock pricing under conditions of CAPM

The statistical model testing the classic CAPM can be described by Equations (1) and (2). The regressions of time series (1) are analyzed in the first pass. Equation (2) is analyzed in the second pass as cross-section regressions ($\forall t = 1,\ldots, T$; see Fama-MacBeth [1973], whose procedure is used) and the time-cross-section regression using panel data:

$$r_{it} - RF_t = \alpha_i + \beta_{i,M}(RM_t - RF_t) + e_{it},\ t = 1, \ldots, T;\ \forall i = 1,\ldots, 15 \qquad (1)$$

$$r_{it} - RF_t = \gamma_0 + \gamma_M \hat{\beta}_{i,M} + \varepsilon_{it};\ i = 1, \ldots, 15;\ t = 1, \ldots, T \qquad (2)$$

The response variable of the above regressions is the excess of return ($r_{it} - RF_t$) of 15 test portfolios constructed on FUN, NUM, and DEN as well as the excess of returns of 10 portfolios built on BV/MV and CAP. Risk-free rate of return (RF) is evaluated by the 91-day Treasury bill rate of return. Explanatory variable of regression (1) is a market factor defined as an excess market return over risk-free rate

(RM_t – RF_t). Market return (RM) is evaluated by the return on the WIG index of the WSE. Explanatory variable of regression (2) constitutes the loading of market factor (beta) estimated in the first pass.

The values of parameters of regressions (1) are determined by means of the GLS method with the application of the Prais-Winsten procedure with first-order autocorrelation. Table 3 presents the values of parameters of regression (1) for the full-sample and for the portfolios of the Mode-M1 type (the parameter values for the sub-periods and for Modes M2 and M3 are similar and are available upon request).

Beta values are estimators of systematic risk connected with the market factor. The betas are significantly different from zero for the all of the tested cases (p-values = 0.00). The beta values are similar for the different modes and variants of portfolio building. They change as follows: in the first sub-period – from 0.61 to 1.37; in the second sub-period – from 0.69 to 1.4; and for the whole sample – from 0.75 to 1.26. Coefficients R^2 seem to be independent of portfolio forming, ranging from 32% to 92%.

If speculative stocks are eliminated, the intercepts of regressions (1) are equal to zero for all portfolios formed on FUN, NUM, and DEN. This is confirmed by the GRS-F statistic (see Gibbons et al., 1989) equal for the whole sample to 3.65 (p-value = 0.03%) for Mode M1, 1.18 (p-value = 32.19%) for Mode M2, and 0.78 (p-value = 69.20%) for Mode M3. The changes of the GRS-F statistic for Modes M1, M2, and M3 in sub-periods are similar. This proves that the tested CAPM generates mean-variance-efficient portfolios.

The changes of the GRS-F statistic for portfolios formed on BV/MV and CAP are more difficult to interpret.

Table 3

Time-series regression of excess stock returns on stock-market factor (RM − RF)

$$r_{it} - RF_t = \alpha_i + \alpha_{i,M}(RM_t - RF_t) + e_{it},\ t = 1, \ldots, 64;\ \forall i = 1, \ldots, n$$

Response variable **Panel A**: Excess returns on n = 15 stock portfolios formed on FUN, NUM, and DEN **Mode M1**: GRS-F = 3.65, p-value(GRS) = 0.03%; R^2 = 62%−89%. **Mode M2**: GRS-F = 1.18, p-value(GRS) = 32.19%; R^2 = 52%−87%. **Mode M3**: GRS-F = 0.78, p-value(GRS) = 69.20%; R^2 = 43%−86%. **Panel B**: Excess returns on n = 10 stock portfolios formed on BV/MV and CAP **Mode M1**: GRS-F = 1.68, p-value(GRS) = 10.93%; R^2 = 32%−92%. **Mode M2**: GRS-F = 0.89, p-value(GRS) = 54.53%; R^2 = 42%−92%. **Mode M3**: GRS-F = 1.74, p-value(GRS) = 9.56%; R^2 = 38%−90%.								
GLS method	**Mode M1; Panel A**				**Mode M1; Panel B**			
Portfel	α_i	p-value [%]	$\beta_{i,M}$	p-value [%]	α_i	p-value [%]	$\beta_{i,M}$	p-value [%]

Table 3 cont.

Portfel	Portfolios formed on FUN				Portfolios formed on BV/MV			
MIN, $Quintile_1$	−0.05	0.27	1.10	0.00	−0.02	0.24	1.00	0.00
$Quintile_2$	−0.05	0.03	0.89	0.00	−0.01	22.53	0.93	0.00
$Quintile_3$	−0.02	4.41	0.83	0.00	0.01	19.44	1.07	0.00
$Quintile_4$	−0.00	60.30	0.97	0.00	0.01	72.99	0.75	0.00
MAX, $Quintile_5$	0.03	0.19	1.03	0.00	0.02	27.18	0.89	0.00
Portfel	**Portfolios formed on NUM**				**Portfolios formed on CAP**			
MIN, $Quintile_1$	−0.04	3.42	1.10	0.00	0.01	50.57	1.26	0.00
$Quintile_2$	−0.04	0.13	0.84	0.00	0.00	89.88	0.99	0.00
$Quintile_3$	−0.02	2.05	0.75	0.00	−0.00	96.76	1.09	0.00
$Quintile_4$	−0.00	77.09	1.06	0.00	−0.01	50.42	1.11	0.00
MAX, $Quintile_5$	0.02	4.23	1.02	0.00	−0.00	54.86	0.97	0.00
Portfel	**Portfolios formed on DEN**				–			
MIN, $Quintile_1$	0.03	0.20	0.90	0.00				
$Quintile_2$	0.00	90.63	1.00	0.00				
$Quintile_3$	−0.02	5.04	0.87	0.00				
$Quintile_4$	−0.02	8.62	0.95	0.00				
MAX, $Quintile_5$	−0.03	2.22	1.18	0.00				

RF is 91-day Treasury bill rate of return. RM is evaluated by return on WIG index of WSE. GRS-F is F-statistic of Gibbons et al. (1989). Prais-Winsten algorithm is used for correction of autocorrelation. In Mode M1, negative-BV stocks are excluded from portfolios. Mode M2 eliminates speculative stocks meeting one of the following boundary conditions: 1) MV/BV > 100; 2) ROE < 0 and BV > 0; and 3) MV/BV > 30 and $r_{it} > 0$, where MV is stock market value, ROE is return on book value (BV), r_{it} is return of portfolio i during period t. Mode M3 eliminates speculative stocks meeting additional condition 4) MV/E < 0, where E is average earning for last four quarters. Sample period is from 1995 to 2012, 64 Quarters.

Source: own research

In the second pass, the value of beta loading is estimated. Beta loading defines the risk premium for the market factor. The beta (for portfolio *i*) is constant for all periods, while response variables constitute the returns that should by nature be random (see Cochrane 2001, p. 231). Therefore, in the time-cross-section estimation, the lack of autocorrelation of the residual component may be presumed. The impact of heteroskedasticity is taken into account by means of the change of the variables method. If the Fama-MacBeth procedure is run, the Prais-Winsten method is used. In each tested period (for cross-section data), first-order autocorrelation of the residual component is taken into account.

The impact of estimation errors of the true beta values in the first pass is taken into account by correcting the standard errors of the beta loadings estimated in the second pass. With this purpose in mind, application is made of Shanken's estimator (see Shanken, 1992). In order to assess the risk premium values (in keeping with the proposal of Jagannathan and Wang [1998]), t-statistics are analyzed without consideration and with consideration (SH-*t* statistics) to Shanken's corrections.

Tables 4 and 5 present the values of estimated parameters of regressions (2), the values of informal determination coefficient R^2_{LL} applied by Lettau and Ludvigson (2001), and the values of the $Q^A(F)$ statistic for the test of Shanken (1985) that the pricing errors in the model are jointly zero (R^2_{LL} is a measure following Lettau and Ludvigson [2001] that show the fraction of the cross-sectional variation in average returns that are explained by a tested model and is calculated as follows: $R^2_{LL} = [\sigma^2_c(\overline{r_i}) - \sigma^2_c(\overline{e_i})] / \sigma^2_c(\overline{r_i})$, where σ^2_c denotes a cross-sectional variance, and the variables with bars over them denote time-series averages).

Comparing the results placed in Tables 4 and 5, it can be stated that, if portfolios are built on BV/MV and CAP, the tested application of CAPM does not price risk on WSE. The values of risk premium γ_M is insignificantly different from zero for all of the tested cases (p-values > 37% after correction of error in the variables).

Table 4

Values of risk premium (γ_m) estimated from second-pass regression for portfolios formed on FUN, NUM, and DEN

$$r_{it} - RF_t = \gamma_0 + \gamma_M \hat{\beta}_{i,M} + \varepsilon_{it};\ i = 1, \ldots, 15;\ t = 1, \ldots, T$$

Parameter	1995–2012			1995–2004		2005–2012		
	Conditions of forming portfolios							
	M1	M2	M3	M1 = M2	M3	M1	M2	M3
Time-cross-sectional regression								
γ_0	-0.03^b	-0.14^b	-0.19^b	−0.10	−0.16	0.02	−0.22	−0.07
p-value [%]	40.61	0.42	0.00	2.09	0.01	56.39	0.18	25.84

Table 4 cont.

p-value [%][a]	40.94	3.16	1.10	4.11	0.56	57.52	9.36	30.55
γ_M	0.02[b]	0.12[b]	0.19[b]	0.07	0.15	−0.03	0.22	0.07
p-value [%]	70.18	1.71	0.01	9.48	0.05	44.67	0.41	28.72
p-value [%][a]	70.35	6.61	1.36	12.76	0.94	45.54	10.76	32.64
R^2_{LL} [%]	0.99[b]	11.48[b]	56.74[b]	9.36	44.74	16.10	26.09	6.18
$Q^A(F)$ (p-value [%])	4.05[b] (0.02)	1.28[b] (25.69)	0.81[b] (64.73)	2.92 (1.29)	2.23 (4.73)	2.60 (0.77)	5.37 (0.18)	1.09 (43.30)
Fama-MacBeth cross-sectional regressions								
γ_0	−0.02	−0.13	−0.19	−0.09	−0.16	0.04	−0.24	−0.05
p-value [%]	61.66	0.01	0.00	0.66	0.04	11.56	0.00	22.18
p-value [%][a]	61.68	0.17	0.63	1.35	0.96	14.52	1.89	24.95
γ_M	−0.01	0.11	0.19	0.07	0.14	−0.06	0.23	0.05
p-value [%]	89.61	0.20	0.00	9.35	0.32	16.34	0.04	32.93
p-value [%][a]	89.61	1.03	0.88	11.66	2.38	18.34	3.22	35.50
R^2_{LL} [%]	0.05	11.50	56.56	9.66	44.99	19.29	26.10	7.15
$Q^A(F)$ (p-value [%])	4.05 (0.02)	1.28 (25.69)	0.81 (64.73)	2.92 (1.29)	2.23 (4.73)	2.60 (0.77)	5.37 (0.18)	1.09 (43.30)

In Mode M1, negative-BV stocks are excluded from portfolios. Mode M2 eliminates speculative stocks meeting one of the following boundary conditions: 1) MV/BV > 100; 2) ROE < 0 and BV > 0; and 3) MV/BV > 30 and $r_{it} > 0$, where MV is stock market value, ROE is return on book value (BV), r_{it} is return of portfolio i during period t. Mode M3 eliminates speculative stocks meeting additional condition 4) MV/E < 0, where E is average earning for last four quarters. R^2_{LL} is measure following Lettau and Ludvigson (2001) showing fraction of cross-sectional variation in average returns that are explained by each model. $Q^A(F)$ reports F-statistic and its corresponding p-value (indicated below in brackets) for test of Shanken (1985) that pricing errors in model are jointly zero. SH t-stat statistic of Shanken (1992) adjusting for errors-in-variables.[a] After adjusting for errors-in-variables, according to Shanken (1992).

Source: own research, [b] Urbański et al. (2014)

Forming portfolios on FUN, NUM, and DEN reflects investment strategies used by investors, which is confirmed by the high return spreads (see Tab. 2). The values of risk premium γ_M for these portfolios are significantly different from zero for Modes M2 and M3 in the whole sample, for Mode M3 in the first sub-period, and for Mode M2 in the second sub-period. Coefficient R^2_L grows if speculative stocks are eliminated from the portfolios, assuming for the whole sample values less than 1% for Mode M1, about 11.5% for Mode M2, and more than 56% for Mode 3. Also, pricing errors decrease after the elimination of speculative stocks. This is documented by the values of the $Q^A(F)$ statistic (see Tab. 4). This proves that mean-variance-efficient portfolios are generated if speculative stocks are excluded from consideration.

Table 5

Values of risk premium (γ_m) estimated from second-pass regression for portfolios formed on BV/MV and CAP

$$r_{it} - RF_t = \gamma_0 + \gamma_M \hat{\beta}_{i,M} + \varepsilon_{it};\ \ i = 1, \ldots, 15;\ \ t = 1, \ldots, T$$

Parameter	**1995–2012**			**1995–2004**		**2005–2012**		
	Conditions of forming portfolios							
	M1	**M2**	**M3**	**M1=M2**	**M3**	**M1**	**M2**	**M3**
Time-cross-sectional regression								
γ_0	−0.00[b]	−0.00[b]	−0.08[b]	0.01	−0.05	0.04	−0.06	0.02
p-value [%]	98.39	94.81	46.97	86.13	56.74	54.71	34.83	7.50
p-value [%][a]	98.40	94.82	53.21	86.44	58.21	56.09	36.31	7.54
γ_M	−0.00[b]	−0.01[b]	0.08[b]	−0.03	0.04	−0.04	0.05	−0.01
p-value [%]	94.28	89.05	45.52	61.91	67.25	58.94	36.28	38.29
p-value [%][a]	94.28	89.07	51.73	62.59	68.38	60.04	37.08	37.70
R^2_{LL} [%]	0.23[b]	0.39[b]	10.70[b]	16.08	2.07	0.07	30.66	0.81
$Q^A(F)$ (p-value [%])	1.98 (6.65)	1.00 (44.61)	1.32 (25.85)	1.33 (27.04)	0.84 (57.98)	1.33 (28.78)	0.76 (64.29)	2.05 (9.54)
Fama-MacBeth cross-sectional regressions								
γ_0	0.01	0.00	−0.11	0.02	−0.01	−0.02	−0.04	0.01
p-value [%]	88.36	98.01	24.22	72.76	84.85	51.31	27.71	93.46

Table 5 cont.

p-value [%][a]	88.39	98.02	35.84	73.56	84.85	52.18	28.63	93.52
γ_M	−0.01	−0.01	0.11	−0.04	0.00	0.03	0.04	0.02
p-value [%]	80.45	81.65	23.04	72.76	96.95	55.28	39.91	76.16
p-value [%][a]	80.50	81.70	34.28	73.56	96.95	55.85	40.22	76.32
R^2_{LL} [%]	0.36	0.97	23.55	16.43	0.34	0.17	31.58	6.52
$Q^A(F)$ (p-value [%])	1.98 (6.65)	1.00 (44.61)	1.32 (25.85)	1.33 (27.04)	0.84 (57.98)	1.33 (28.78)	0.76 (64.29)	2.05 (9.54)

In Mode M1, negative-BV stocks are excluded from portfolios. Mode M2 eliminates speculative stocks meeting one of the following boundary conditions: 1) MV/BV > 100; 2) ROE < 0 and BV > 0; and 3) MV/BV > 30 and $r_{it} > 0$, where MV is stock market value, ROE is return on book value (BV), r_{it} is return of portfolio i during period t. Mode M3 eliminates speculative stocks meeting additional condition 4) MV/E < 0, where E is average earning for last four quarters. R^2_{LL} is measure following Lettau and Ludvigson (2001) showing fraction of cross-sectional variation in average returns that are explained by each model. $Q^A(F)$ reports F-statistic and its corresponding p-value (indicated below in brackets) for test of Shanken (1985) that pricing errors in model are jointly zero. SH t-stat is statistic of Shanken (1992) adjusting for errors-in-variables. [a] After adjusting for errors-in-variables, according to Shanken (1992).

Source: own research, [b] Urbański et al. (2014)

4. Influence of feature of constructed portfolios on classic CAPM application

Jagannathan and Wang (1998) argue that taking into account a characteristic of the formed portfolios is necessary in testing the CAPM applications, while Urbański (2011) presents the predictive possibilities of FUN, NUM, and DEN on the basis of which portfolios are formed. Therefore, it seems necessary to verify the validity of the tested CAPM application in the presence of the characteristics of the built portfolios. Tests are conducted for regression (2) supplemented with portfolio characterizing factors. The testing procedure is shown by Equations (3) through (7):

$$r_{it} - RF_t = \gamma_0 + \gamma_M \hat{\beta}_{i,M} + \gamma_Z Z_{i,t-1} + \varepsilon_{it};\ \ i = 1, \ldots, 15\ t = 1, \ldots, T \qquad (3)$$

where $Z_{i,t-1}$ are FUN_i, NUM_i, or DEN_i for period $t-1$, and null hypothesis is H_0: $\gamma_Z = 0$.

Practically, the following regressions are analyzed:

$$r_{it} - RF_t = \gamma_0 + \gamma_M \hat{\beta}_{i,M} + \gamma_Z \text{ FUN}_{i,t-1} + \varepsilon_{it}; \quad i = 1, \ldots, 15; t = 1, \ldots, T \qquad (4)$$

$$r_{it} - RF_t = \gamma_0 + \gamma_M \hat{\beta}_{i,M} + \gamma_Z \text{ NUM}_{i,t-1} + \varepsilon_{it}; \quad i = 1, \ldots, 15; t = 1, \ldots, T \qquad (5)$$

$$r_{it} - RF_t = \gamma_0 + \gamma_M \hat{\beta}_{i,M} + \gamma_Z \text{ DEN}_{i,t-1} + \varepsilon_{it}; \quad i = 1, \ldots, 15; t = 1, \ldots, T \qquad (6)$$

$$r_{it} - RF_t = \gamma_0 + \gamma_M \hat{\beta}_{i,M} + \gamma_Z \text{ FND}_{i,t-1} + \varepsilon_{it}; \quad i = 1, \ldots, 15; t = 1, \ldots, T \qquad (7)$$

In regression (4), $\text{FUN}_{i,t-1}$ is a vector with coordinates: $\text{FUN}_{1,t-1}, \ldots, \text{FUN}_{5,t-1}$, $\text{FUN}_{1,t-1}, \ldots, \text{FUN}_{5,t-1}$, $\text{FUN}_{1,t-1}, \ldots, \text{FUN}_{5,t-1}$. Similarly, in regressions (5–7), $\text{NUM}_{i,t-1}$ is a vector: $\text{NUM}_{1,t-1}, \ldots, \text{NUM}_{5,t-1}$, $\text{NUM}_{1,t-1}, \ldots, \text{NUM}_{5,t-1}$, $\text{NUM}_{1,t-1}, \ldots, \text{NUM}_{5,t-1}$. $\text{DEN}_{i,t-1}$ is a vector: $\text{DEN}_{1,t-1}, \ldots, \text{DEN}_{5,t-1}$, $\text{DEN}_{1,t-1}, \ldots, \text{DEN}_{5,t-1}$, $\text{DEN}_{1,t-1}, \ldots, \text{DEN}_{5,t-1}$. Variable $\text{FND}_{i,t-1}$ is a vector with coordinates: $\text{FUN}_{i,t-1}$, i = 1, ..., 5, $\text{NUM}_{i,t-1}$, $i = 1, \ldots, 5$ and $\text{DEN}_{i,t-1}$, $i = 1, \ldots, 5$.

The estimated parameter values of regressions (4–7) are presented in Table 6.

Table 6

Time-cross-section regressions showing effect of portfolio characteristics representing specification tests of CAPM for whole sample

	M1	M2	M3	M1	M2	M3	M1	M2	M3
$r_{it} - RF_t = \gamma_0 + \gamma_M \hat{\beta}_{i,M} + \gamma_{\text{FUN}} \text{ FUN}_{i,t-1} + \varepsilon_{it}; \quad i = 1, \ldots, 15\ t = 1, \ldots, 64$									
Panel A	γ_0			γ_M			γ_{FUN}		
Parameter	–0.03	–0.10	–0.18	0.01	0.07	0.16	0.01	0.01	0.01
p-value [%]	43.14	5.86	0.01	89.74	26.37	0.09	20.54	13.72	18.44
$r_{it} - RF_t = \gamma_0 + \gamma_M \hat{\beta}_{i,M} + \gamma_{\text{NUM}} \text{ NUM}_{i,t-1} + \varepsilon_{it}; \quad i = 1, \ldots, 15; t = 1, \ldots, 64$									
Panel B	γ_0			γ_M			γ_{NUM}		
Parameter	–0.03	–0.10	–0.18	0.01	0.07	0.17	0.01	0.01	0.00
p-value [%]	40.85	4.36	0.00	88.58	22.26	0.05	19.81	16.19	42.37
$r_{it} - RF_t = \gamma_0 + \gamma_M \hat{\beta}_{i,M} + \gamma_{\text{DEN}} \text{ DEN}_{i,t-1} + \varepsilon_{it}; \quad i = 1, \ldots, 15\ t = 1, \ldots, 64$									
Panel C	γ_0			γ_M			γ_{DEN}		
Parameter	–0.01	–0.12	–0.17	–0.04	0.10	0.19	0.02	0.00	–0.01
p-value [%]	72.80	1.95	0.02	44.76	11.13	0.01	1.12	70.62	64.63

Table 6 cont.

$r_{it} - RF_t = \gamma_0 + \gamma_M \hat{\beta}_{i,M} + \gamma_{FND}\,\text{FND}_{i,t-1} + \varepsilon_{it};\quad i = 1, \ldots, 15;\ t = 1, \ldots, 64$									
Panel D	γ_0			γ_M			γ_{FND}		
Parameter	–0.04	–0.10	–0.17	0.00	0.06	0.15	0.01	0.01	0.01
p-value[%]	37.06	4.53	0.01	92.63	26.65	0.14	5.59	4.33	25.45

Time-cross-section estimation is applied using panel data. Beta parameters are estimated (in first pass) by GLS using Prais-Winsten procedure while, heteroskedasticity is corrected (in second pass) by means of change of variables method. Panels A, B, C, and D show whether lagged FUN, NUM, DEN, and FND add new information to classical CAPM. Variable $\text{FND}_{i,t-1}$ is vector with the following coordinates: $\text{FUN}_{i,t-1}$, $i = 1, \ldots, 5$, $\text{NUM}_{i,t-1}$, $i = 1, \ldots, 5$ and $\text{DEN}_{i,t-1}$, $i = 1, \ldots, 5$. In Mode M1, negative-BV stocks are excluded from portfolios. Mode M2 eliminates speculative stocks meeting one of the following boundary conditions: 1) MV/BV > 100; 2) ROE < 0 and BV > 0; and 3) MV/BV > 30 and $r_{it} > 0$, where MV is stock market value, ROE is return on book value (BV), r_{it} is return of portfolio i during period t. Mode M3 eliminates speculative stocks meeting additional condition 4) MV/E < 0, where E is average earning for last four quarters. Sample period is from 1995 to 2012, 64 Quarters.

Source: own research

Panel A shows whether lagged FUN adds new information to classical CAPM. Panels B, C, and D show whether lagged NUM, DEN, and FND (respectively) add new information to CAPM. The test results show that FUN and NUM added separately to the regressions (see Panels A and B) have insignificant influence on the estimation results in three tested cases (M1, M2, and M3). Function DEN added to the regression has a significant influence on estimation if the portfolios are formed according to Modes M1 and M2. However, if the speculative stocks, defined in Mode M3, are excluded from portfolios, FUN, NUM, and DEN have not significant influence on estimation.

Table 7 shows the values of informal determination coefficient R^2_{LL} computed for regressions (4–7) as compared to R^2_{LL} for regression (2).

The values of the R^2_{LL} coefficients for regressions supplemented with portfolio characterizing factors $Z_{i,t-1}$ are higher as compared to R^2_{LL} computed for regression (2). However, the increases are the highest for Mode M1 (where only negative-BV stocks are eliminated) – reaching 1599%. The lower increases are in the case of Mode M2, and the lowest (about 3%) if the speculative stocks, defined in Mode M3, are excluded from portfolios. This means that, in the case of Mode M3, the characteristics of the formed portfolios have the lowest impact on the value of risk premium γ_M. Also, in this case, the average returns of the formed portfolios are best explained by the tested specification representing the classic CAPM.

Table 7

Measures showing fraction of cross-sectional variation in average returns explained by tested specification of CAPM

	$r_{it}^{ex} = \gamma_0 + \gamma_M \hat{\beta}_{i,M} + \varepsilon_{it}$			$r_{it}^{ex} = \gamma_0 + \gamma_M \hat{\beta}_{i,M} + \gamma_Z Z_{i,t-1} + \varepsilon_{it}$			$Z_{i,t-1}$
Mode	**M1**	**M2**	**M3**	**M1**	**M2**	**M3**	
$\bar{R}_{LL}^2$ [%]	0.99	11.48	56.74	11.81	14.42	57.41	FUN
				11.18	14.45	58.12	NUM
				20.05	12.25	57.51	DEN
				24.23	24.28	61.29	FND
$\bar{R}_{LL}^2$ [%]				16.82	16.35	58.58	–
$d\bar{R}_{LL}^2$ [%]				1,599.0	42	3	

$\bar{R}_{LL}^2$ is informal determination coefficient following Lettau and Ludvigson (2001), showing fraction of cross-sectional variation in average returns that are explained by each specification. $\bar{R}_{LL}^2$ is average value of $\bar{R}_{LL}^2$ for regressions with added FUN, NUM, DEN, and FND, respectively. $d\bar{R}_{LL}^2$ is increase of $\bar{R}_{LL}^2$ after added of $Z_{i,t-1}$ into regression. In Mode M1, negative-BV stocks are excluded from portfolios. Mode M2 eliminates speculative stocks meeting one of the following boundary conditions: 1) MV/BV > 100; 2) ROE < 0 and BV > 0; and 3) MV/BV > 30 and $r_{it} > 0$, where MV is stock market value, ROE is return on book value (BV), r_{it} is return of portfolio i during period t. Mode M3 eliminates speculative stocks meeting additional condition 4) MV/E < 0, where E is average earning for last four quarters. r_{it}^{ex} is excess of returns over risk free rate: $r_{it}^{ex} = r_{it} - RF_t$. Sample period is from 1995 to 2012, 64 Quarters.

Source: own research

5. Conclusions

In this paper, we examine the influence of speculative stocks on pricing that would result from the correctness of CAPM assumptions. The study leads to the following conclusions:

1. The values of systematic risk are significantly different from zero for all of the tested cases, and they are similar for the different modes and variants of portfolio building.
2. However, if speculative stocks are eliminated, the classic CAPM generates mean-variance-efficient portfolios formed on FUN, NUM, and DEN in all of the tested periods. This is confirmed by the GRS-F statistic being less than 1.18 (p-value = 32.19%).
3. If portfolios are built on BV/MV and CAP, the classic CAPM does not price the risk premium on WSE.
4. The return spreads for portfolios formed on FUN, NUM, and DEN are significantly higher than the spreads for portfolios formed on BV/MV and CAP.
5. If speculative stocks are excluded from the analysis, the values of risk premium for portfolios formed on FUN, NUM, and DEN are significantly different from zero in all of the tested periods.
6. If speculative stocks are excluded from the portfolios formed on FUN, NUM, or DEN, the values of informal determination coefficient R^2_{LL} (showing the explained fraction of the cross-sectional variation in average returns) grows from 1% to 56%.
7. If speculative stocks are excluded from the portfolios formed on FUN, NUM, or DEN, pricing errors decrease; the values of $Q^A(F)$ statistic fall from 4.05 (p-value = 0.02%) to 0.81 (p-value = 64.73%). This confirms that the classic CAPM generates mean-variance-efficient portfolios.
8. The correctness of the tested CAPM application in the presence of characteristics of the built portfolios is verified; if speculative stocks are excluded from the portfolios, FUN, NUM, and DEN do not have a significant influence on the estimation results.
9. Research results are in line with Conjectures 1 and 2.

The research results may be a contribution to explaining the incorrect stock pricing in highly developed capital markets in light of the classic CAPM.

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Appendix. The model of portfolio management

The algorithm that groups companies into portfolios is based on functional FUN, defined by Equations (1), (2), and (3). The comprehensive economic interpretation of FUN is presented in the work of Urbański (2011). The investment is more attractive if the FUN value is higher. Functional FUN provides the characteristics of the companies that are assessed well by NUM and at the same time priced lowly by DEN:

$$\mathrm{FUN} = \frac{\mathrm{nor(ROE)} \cdot \mathrm{nor(AS)} \cdot \mathrm{nor(APO)} \cdot \mathrm{nor(APN)}}{\mathrm{nor(MV/\ E)} \cdot \mathrm{nor(MV/\ BV)}} \tag{1A}$$

where:

$$\begin{aligned} &\mathrm{ROE} = \mathrm{F}_1; \mathrm{AS} = \mathrm{F}_2 = \frac{\sum_{t=1}^{i} S(Q_t)}{\sum_{t=1}^{i} \overline{S(nQ_t)}}; \mathrm{APO} = \mathrm{F}_3 = \frac{\sum_{t=1}^{i} \mathrm{PO}(Q_t)}{\sum_{t=1}^{i} \overline{\mathrm{PO}(nQ_t)}}; \\ &\mathrm{APN} = \mathrm{F}_4 = \frac{\sum_{t=1}^{i} \mathrm{PN}(Q_t)}{\sum_{t=1}^{i} \overline{\mathrm{PN}(nQ_t)}}, \mathrm{MV/\ E} = \mathrm{F}_5; \mathrm{MV/\ BV} = \mathrm{F}_6 \end{aligned} \tag{2A}$$

F_j variables are functions of company evaluation indicators (for j = 1,…, 4) and functions of pricing indicators (for j = 5, 6). Functions F_j (j = 1,…, 6) are transformed to normalized areas $<a_j ; b_j>$ according to Eq. (3A):

$$\mathrm{nor}(F_j) = \left[a_j + (b_j - a_j) \cdot \frac{F_j - c_j \cdot F_j^{\min}}{d_j \cdot F_j^{\max} - c_j \cdot F_j^{\min} + e_j} \right] \tag{3A}$$

In Equations (1A), (2A), and (3A), the corresponding indications are as follows: ROE is a return on book equity; $\sum_{t=1}^{i} S(Q_t), \sum_{t=1}^{i} \mathrm{PO}(Q_t), \sum_{t=1}^{i} \mathrm{PN}(Q_t)$ are values that are accumulated from the beginning of the year as net sales revenue (S), operating profit (PO), and net profit (PN) at the end of the "ith" quarter (Q_i); $\sum_{t=1}^{i} \overline{S(nQ_t)}, \sum_{t=1}^{i} \overline{\mathrm{PO}(nQ_t)}, \sum_{t=1}^{i} \overline{\mathrm{PN}(nQ_t)}$ are average values, accumulated from the beginning of the year as S, PO, and PN at the end of Q_i over the last n years (the present research assumes that n = 3 years); MV/E is the market-to-earning value ratio; E is the average earning for the last four quarters; MV/BV is the market-to-book value ratio; a_j, b_j, c_j, d_j, e_j are variation parameters. Functions F_j (j = 1,…, 6) are transformed into equal normalized area <1;2> (if $\sum_{t=1}^{i} \mathrm{PN}(Q_t)$, $\sum_{t=1}^{i} \mathrm{PO}(Q_t)$, $\sum_{t=1}^{i} \overline{\mathrm{PN}(nQ_t)}$ or $\sum_{t=1}^{i} \overline{\mathrm{PO}(nQ_t)}$ in equation (2A) is negative, Functions F_j (j = 1, 3, 4) are transformed into area (0,1)).

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Human and social capital facing challenges of economic convergence processes in Poland

1. Introduction

Economic convergence is a category that carries a positive connotation, indicating that there is a possibility of bridging the growth disparities in socio-economic space. In the real economy, however, the phenomenon of economic convergence is rare (Prichett 1997). The dynamics of growth processes and socio-economic development is contextual; it depends on a combination of many mutually interacting economic and socio-political factors (as emphasized in endogenous growth theories or the concept of conditional convergence) (Romer 1986; Barro 1992; 1996; Dowrick 2003).

Moreover, debates on the driving forces of development are continually being enriched with new lines of research. New development factors are sought, as those identified by our predecessors have proven to be insufficient over time. Simultaneously, there has been a shift in the theoretical approach as to the importance and strength of the impact of these factors. In the knowledge-based economy, the focus is gradually shifting from quantitative and tangible factors to qualitative and intangible ones (and this set is also being broadened by social factors). The importance of the institutional settings of development and social capital standing on the verge of social and economic dimension are highlighted. In conjunction with this, research on the multidimensional structure of intangible forms of capital (human capital, social capital) is on the increase, as are studies regarding the importance of two-way interactions between these capitals in boosting the efficiency of business processes (Czapiński 2008; Dinda 2008, 2014; Piazza-Georgi 2002; Schuller 2000; Kaasa and Parts 2008; Miguélez, et al., 2009). At the same time, the discussion around the phenomenon of real convergence

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gradually goes beyond the scope of the theory of economic growth, often involving issues of development and economic prosperity.

In economic debates, the way we approach human capital is also changing. It presents a more-humanistic feature, taking into account various aspects of its presence in economic processes as well as the empathy towards the social environment in which it operates. Human capital is activated in action processes, where the support functions of social capital (i.e., willingness of business entities to cooperate and coordinate activities) are manifest. Relationships between human and social capitals are complementary; that is to say, the economic effects of human capital can be enhanced if it functions in an environment with a strong social capital (of an appropriate structure). This is confirmed by the results of pilot studies indicating that the impact of human capital on economic development and innovative activity is stronger in societies with greater social capital (Kaasa and Parts 2008, p. 30; Miguélez et al. 2009, p. 19–24).

The importance of intangible factors in generating differences in development is not the same in time and space. Benefits arising from individual knowledge (human capital) and the willingness of business entities to cooperate (social capital)[1] may materialize if the traditional factors and conditions of development in the form of physical capital are provided. Furthermore, the impact of intangible resources increases with the transition of an economy to higher stages of development. The impact of intangible forms of capital on shaping the trajectory of development processes can, thus, indirectly indicate the maturity level of the structures and economic processes in a given area.

The endogenization of the development factors means that the conditions in which they operate and accumulate do matter. Depending on this, correlations between them can lead to either divergence or convergence. Investment in human capital and knowledge is not necessarily subject to the law of diminishing marginal returns, which gives raise to poorer areas catching up with their richer counterparts (Ortigueira and Santos 1997). Under the findings of the new economic geography, the mechanisms responsible for the polarization extend to the processes of spatial concentration of the production factors and economic

[1] This is only one of the possible ways of understanding the social capital that concerns economic organizations/enterprises. The notion of social capital has a very broad meaning – it is considered as an indispensable determinant for the stable and efficient functioning of a democratic political system and market economy: a) in the economic dimension, it can be interpreted metaphorically as a kind of binding agent, a factor integrating the other, material and non-material forms of capital; b) in the public sphere, social capital coordinates individual and collective actions, allowing "participants to act together more effectively to pursue shared objectives" (Putnam, 1995, p. 664–665), determining the scale of citizens' involvement and complementing the deficiencies of formal institutions.

activity in growth centers; e.g., metropolitan areas (Krugman 1991; Gorzelak 2008). From economic debates emerges an ambiguous role of human capital in the processes of economic convergence. Depending on the assumptions being made (neoclassical versus endogenous growth theory) and operating conditions (practice), it can either increase or decrease the chances of economic convergence (Jabłoński 2012). Human capital boosts the growth of the areas that are able to take advantage of this attribute.

In this context, the challenge as far as the processes of economic convergence are concerned is to identify the key development factors for a given area, ensure their appropriate level and structure, and create operating conditions that enable them to increase the chance of bridging the income gap. The aggravation of uneven development is likely to have significant social and economic costs. This leads to the incomplete or inadequate use of the production potential of peripheral areas; and in the long term, it disrupts the allocation of resources throughout the economic system. The outlined challenge also remains valid for the Polish economy, where the differences in living standards have built up between regions basically from the beginning of the transformation period.

Considering the rationale, the subject matter explored in this study is the role of human and social capital in shaping the processes of regional development in Poland. The study is aimed at seeking answers to the questions of whether and to what extent the characteristics of human and social capital development impeded or fostered the achievement of convergence in the living standards (GDP *per capita*) in regional systems (NUTS-2). The reflections are based on a data analysis of the Polish Central Statistical Office (GUS) and periodic panel studies "The Social Diagnosis." The following tools were used: a multidimensional statistical exploratory analysis – a cluster analysis (Ward's, k-means); linear ordering – as well as a correlation analysis; and measures of statistical dispersion. Given the availability of data describing the social capital in the regions, the analysis covered the years period of 2002–2014[2].

2. Methodology

Research addressing the issue of economic convergence usually starts by determining whether β-convergence occurs, implying that areas with lower GDP *per capita* show a faster rate of change of this measure (Kusideł 2013, p. 74). The fundamental verification tools are econometric models estimating the equa-

[2] Due to editorial requirements, only the results of analysis from the first and last years of this period are depicted.

tion under the assumptions of the neoclassical model of growth (Dańska-Borsiak 2011, p. 194):

$$\ln\left(y_{j,t}\right) = \alpha_0 + (\gamma + 1)\ln\left(y_{j,t-1}\right) + \theta^T X_{j,t} + \left(\alpha_j + \varepsilon_{j,t}\right) \tag{1}$$

where:

$y_{j,t}$ – GDP per capita (in constant prices) of region *j* at time *t*,
$X_{j,t}$ – vector of explanatory variables,
α_0, γ, θ – regression coefficients,
α_j – fixed-region effects,
μ_t – fixed (annual) time effects,
$\varepsilon_{j,t}$ – error term of the specification.

Through different estimation methods and considering a different set of explanatory variables, the estimation results of the above-mentioned equation – shown in numerous studies devoted to regional development in Poland (Dańska-Borsiak 2011, p. 200–201, Wójcik 2008; Kusideł 2013; Kliber 2007; 2011; Gajewski, Tokarski 2004; Bal-Domańska 2014; Kosmalski 2016) – indicate a growing income gap between the richer and poorer regions of Poland. These studies also demonstrate the likelihood of the so-called club convergence occurring in Poland; i.e., the reduction of growth disparities in narrower clusters (clubs) of regions that are more homogeneous due to their structural characteristics.

Regarding Poland, however, econometric tools are of limited use in verifying the hypothesis of the occurrence of the club convergence due to the small number of regions within clubs (Dańska-Borsiak 2011, p. 202). For preliminary determination of whether Polish regions can create the so-called convergence clubs in the current study, exploratory data analysis tools were used (such as a cluster analysis) with the aim of identifying the most-homogeneous clusters of regions according to pre-set parameters. The grouping was based on the variables used in the basic version of the conditional β-convergence equation: GDP *per capita*, capital expenditure per employee (expressed in constant prices from the year 2000), and population growth rate. Ward's method and the k-means method were used.

To answer the question of whether the changes in GDP *per capita* in regions were related to human and social capital after 2002 (and if so, to what extent), indicators were selected to diagnose the condition of both capitals (Tab. 1).

The operationalization of human capital was based on the definition stemming from the reflections by T.W. Schultz (1961) and G.S. Becker (1975), according to which (in broad terms) human capital includes knowledge, skills, health, and vital energy, which are the carriers of a person, society, or nation (Domański 1993, p. 10). Two fundamental dimensions of this capital were distinguished: knowledge and skills as well as health. The operationalization of social capital was based on the concept by R. Putnam (1995) and F. Fukuyama (1997), according to which social capital is embedded in the quantity and quality of social relations; its structure is subdivided into three dimensions: normative (trust and social norms), behavioral (active citizenship), and structural (formal and informal networks functioning in society[3]).

Table 1

Analytical indicators of human capital and social capital

Variable	Statistical indicators evaluating human/social capital	Variables' character
	Human capital components	
	Knowledge and skills	
hc_1	Percentage of population aged 15 or above with tertiary level of educational attainment	S
hc_2	Percentage of population aged 15 or above with lower secondary, primary, and lower levels of educational attainment	D
hc_3	Entrepreneurship – people conducting economic activity per 1000 population	S
	Health	
hc_4	Life expectancy at birth (male)	S
hc_5	Infant deaths per 1000 live births	D
hc_6	The rate of natural increase[a)]	S
hc_7	Demographic dependency ratio – post-working age population per 100 population of working age	D
	Social capital components	
	Normative (trust and social norms)	
sc_1	Level of generalized trust – most people can be trusted (percentage of respondents)	S
	Behavioral (active citizenship)	
sc_2	Activity on behalf of local community (percentage of respondents)	S
sc_3	Participation in public meetings (percentage of respondents)	S

[3] Indicators describing informal social networks (circle of friends, frequency of meetings with friends, satisfaction from relationships with those closest to them as well as their colleagues) were characterized by a low variability. Therefore, this dimension was not included in the structural construct of the social capital (Table 1).

Table 1 cont.

Variable	Statistical indicators evaluating human/social capital	Variables' character
sc_4	Crimes ascertained by the Police per 1000 population	D
sc_5	Positive attitude towards democracy (percentage of respondents)	S
Structural (formal networks)		
sc_6	Participation in associations (percentage of respondents)	S
sc_7	Active exercise of functions in organizations (percentage of respondents)	S
sc_8	Performance of public administration institutions – "You have had to use connections or other ways to deal with some formal matter" – percentage of respondents claiming "often"	D

S – stimulant; D – destimulant.

[a)] In order for the used diagnostic variables to have a positive value on the construction of the taxonomical measure of human capital, the rate of natural increase for each region and each year was increased by a constant (a = 3).

Source: own study

Cluster analyses (Ward's method, k-means method) were used to seek answers to the following questions:

- Do similarities of regions in terms of human capital coincide with the ones specific to social capital?
- Are there similarities between the clustering of regions by traditional factors of economic development and their possession of human and social capital?

The Pearson coefficients of correlation between the variables of human and social capital and the level and changes in GDP *per capita* were also calculated. On this basis, conclusions were made regarding the cohesion in the development of human and social capital in regional space in Poland and their relationship to economic development.

In accordance with the theoretical prerequisites, the nature of the variables from Table 1 was determined as follows. As far as stimulants are concerned, higher values of variables contribute to the increase of human and social capital, whereas for destimulants, the direction of impact is reverse. In order to harmonize the nature of the variables, destimulants were transformed into stimulants by inverting the values of the characteristics (Młodak 2006, p. 34). The ability of discriminatory variables was verified by adopting a critical value of the coefficient of variation of 10%[4] and a Pearson correlation coefficient of 0.85. The variables were normalized to ensure their comparability (Strahl 2006, p. 163):

$$z_{ij,t} = \frac{x_{ij,t}}{\max\limits_{j=1,2....16,t}\left[x_{ij,t}\right]} \tag{2}$$

where:

$x_{ij,t}$ – shall mean the value of *i* stimulant in *j* region in *t* year,

z_{ijt} – the values of the standardized stimulants.

As a basis for normalization, the maximum value of *i* in the group of all regions throughout the considered period was used. The advantage of the presented formula is that the transformed variables retain the primary level of variability. In addition, the values of z_{ij} are normalized in interval [0,1] and may be compared inter-periodically.

To get an overall picture of the deployment of human and social capital in the regional space, a synthetic measure of human and social capital was calculated for each region (Strahl 2006, p. 166):

$$\mu_{j,t} = \frac{1}{m}\sum_{i=1}^{m} z_{ijt} \tag{3}$$

Values of the measures belong to interval [0,1], and higher values indicate a higher human or social capital.

3. Economic polarization of Polish regions

The results of clustering regions by capital expenditure per employee, rate of population growth, and GDP *per capita* (Tab. 2) as well as the measures of differentiation confirm previous findings that, in the processes of regional development in Poland from 2002 through 2014, divergence processes prevailed over the convergence ones. The value of the variation coefficient (for GDP *per capita*) based on the standard deviation (V_s) increased from 0.211 in 2002 to 0.252 in 2014; for the coefficient using the quartile deviation (V_Q), it increased from 0.126 in 2002 to 0.145 in 2014. The distances between the clusters of similar regions (measured in the Euclidean setting) increased further as well. The furthest distance was between the Mazovia region and the eastern ones – in 2002, this amounted to 12,470, and in 2014 – 14,270. At the same time, the distance between the Mazovia and Cluster

[4] The variable describing the life expectancy presented a low variability (coefficient of variation ranged between 0.01 and 0.02), and after 2006, so did the natural increase rate (the value of the coefficient of variation was about 0.08).

No. 3 continued to expand (from 10,740 to 11,711), whereas between Mazovia and Cluster No. 2, it remained at a similar level (8310 as opposed to 831[5]). By comparison, the distances between Clusters No. 2, 3, and 4 were smaller (from 2430 to 6004), but they also increased during the period considered.

Table 2

Clustering of regions by traditional factors of economic development[5]

Cluster No.	2002		2014		
	Regions	**GDP *pc* [PLN]** V_s	**Regions**	**GDP pc [PLN]** V_s	
1	Mazovia	31,095 –	Mazovia	43,666 –	
2	Lower Silesia, Pomerania, Wielkopolskie, Silesia	21,371 0.034	Lower Silesia, Wielkopolskie, Silesia, Pomerania	28,549 0.068	29,417* 0.036*
3	Kujawy-Pomerania, Lodzkie, Lubusz, Malopolskie, West Pomerania	18,625 0.033	Kujawy-Pomerania, Opolskie, Lubusz, West Pomerania, Lodzkie, Malopolskie, Podkarpackie, Podlaskie	22, 438 0.10	23,988** 0.064**
4	Lubelskie, Opolskie, Swietokrzyskie, Podkarpackie, Podlaskie, Warmia-Masuria	15,703 0.044	Warmia-Masuria, Lubelskie, Swietokrzyskie	19,519 0.022	19,528*** 0.0183***
16 regions		$V_s = 0.211$ $V_Q = 0.126$	16 regions	$V_s = 0.252$ $V_Q = 0.145$	

pc – per capita; V_s – standard deviation, V_Q – quartile deviation.
* without Pomerania, ** including Pomerania, without Podkarpackie and Podlaskie, *** including Podkarpackie, Podlaskie

Source: own calculations based on Polish Central Statistical Office data – https://bdl.stat.gov.pl/BDLS/metadane

[5] The clustering of regions was conducted on the basis of standardized variables. The analysis of variance showed that, among the adopted variables, the population growth rate is not statistically significant in determining the affiliation of regions to their respective clusters. The cluster analysis was also performed using the original data. In 2002 in both variants of the clustering, a similar composition of clusters was obtained, whereas in 2014, differences in the classification of regions were recorded. In Table 1, symbol * indicates the results of the cluster analysis performed on the basis of the original data.

In the following years, the distinctness of Mazovia could clearly be seen, as this one-element set was better equipped with traditional production factors (as compared to the rest of the country). Other regions formed three distinct clusters with a relatively stable composition. The cluster including the western regions (Lower Silesia, Wielkopolskie, Silesia) stood out due to their developed urban agglomerations (Wroclaw, Poznan, Katowice). In comparison to the rest of the country, the uniqueness of the eastern regions (Lubelskie, Podkarpackie, Podlaskie, Swietokrzyskie, Warmia-Masuria) generally classified into one cluster; and the fact that they were least-equipped in the traditional factors of economic development was also noticeable.

Exploratory cluster analysis revealed a pattern involving the creation of groups of similar regions that increasingly drifted apart over the subsequent years. At the same time, diverging trends can be observed within each cluster. During the analyzed period, the level of uneven development decreased among the eastern regions, remained the same among the western ones, and increased among those from Cluster No. 3.

The observed regularities indicate the possibility of the club convergence phenomenon occurring in Poland. They outline the two clubs created by the western regions (metropolitan) and the eastern ones. It should be taken into account that the multidimensional exploratory analysis tools used are not sufficient to confirm such a convergence; they only show certain symptoms of such a regularity. Nevertheless, the findings presented are partly consistent with the conclusions of P. Kliber (2011, p. 5), who distinguished two convergence clubs in the spatial development of Poland: the western regions and the regions with metropolitan areas. On the other hand, E. Kusideł (2013, p. 132) indicated that convergence clubs are created due to the prosperity of the regions, and Mazovia strives to attain a separate (higher) level of growth path.

4. Human and social capital versus regional diversity

In 2002–2014[6], Polish regions were increasingly equipped in human and social capital, as testified by the growing values of the aggregate measures as well as the majority of analytical indicators of these capitals. Such trends were generally followed by each cluster of regions, distinguished by the characteristics of human capital (Tab. 3) and social capital (Tab. 4). The growth of human capital resulted from the improvement of indicators diagnosing knowledge

[6] The data for social capital is based on periodic panel studies "The Social Diagnosis", conducted every two years (2003, 2005, 2007, 2009, 2011, 2013, 2015). For this reason, the analysis of the social capital in the regions referred to the period of 2003–2015.

and competencies as well as the health of the inhabitants (only the indicators describing demographic processes deteriorated – the rate of natural increase, demographic dependency ratio). Changes in social capital were due to the improvement of those indicators describing citizenship and formal social networks. In line with theoretical prerequisites, the normative dimension turned out to be the least-susceptible to change.

Within an upward trend of human and social capital common to most regions in 2002–2014, significant changes occurred in those clusters of regions identified as similar because of the characteristics of the capitals in question. The composition of clusters was less stable than in the case of traditional factors of development (Tab. 2). This can be partly explained by the fact that, in 2002–2014, the level of regional disparities for human and social capital was lower than for the traditional economic factors; thus, even a small regional differentiation in the pace of change of human or social capital indicators could affect the regions' affiliation to their respective clusters (Tab. 2).

Nevertheless, the values of the variation coefficients based on the quartile deviation indicate that, in 2014, regional variations regarding human and social capital remained at a level similar as in 2002. In addition, when it comes to the structure of human capital, it can be seen that, in 2002–2014, regional differences in terms of education increased, and the regions have become more-and-more alike due to the health of their inhabitants. As for social capital, the largest interregional variations concerned the level of generalized trust, the relatively smallest ones being observed in the behavioral construct of this capital. For all components of social capital, the level of variations observed in 2015 was similar to those from 2003.

The analysis of variance sheds further light as to which variables had a statistically significant impact on determining the composition of the respective clusters. When it comes to human capital, that was the case for all of the elements shown in Table 3 except for the following: the rate of natural increase and (unexpectedly, perhaps) the proportion of people with tertiary-level educational attainment. As for social capital – almost all variables had a statistically significant impact on determining the composition of the respective clusters (the except was the active exercise of functions in organizations, and in 2003 also the activity on behalf of the local community).

In the clustering of regions by characteristics of human capital, a trend to merge the regions with very well-developed urban agglomerations and academic centers into a single cluster was increasingly noticeable in the subsequent years. In 2014, Mazovia (Warsaw), Wielkopolska (Poznan), Malopolska (Krakow), and Pomerania (Tri-city) regions were a part of Cluster No. 2, with the highest values of human capital indicators. With its high values of the variables of human capital, Cluster No. 1 was formed by Lower Silesia (Wroclaw), Silesia (Katowice), and West Pomerania (Szczecin).

Table 3

Clustering of regions by human capital (HC)

Cluster No.	2002				2014			
	Region	HC V_s	Edu V_s	Health V_s	Region	HC V_s	Edu V_s	Health V_s
1	Lower Silesia, Silesia, Mazovia, Lodzkie	0.568 0.07	0.234 0.07	0.334 0.08	Lower Silesia, Silesia, West Pomerania	0.705 0.01	0.339 0.03	0.366 0.02
2	Kujawy-Pomerania, Lubusz, Wielkopolskie, West Pomerania, Malopolskie, Pomerania	0.632 0.03	0.230 0.04	0.402 0.03	Malopolskie, Pomerania, Wielkopolskie, Mazovia	0.797 0.03	0.355 0.09	0.442 0.05
3	Lubelskie, Swietokrzyskie, Podlaskie, Opolskie	0.556 0.04	0.203 0.02	0.353 0.06	Kujawy-Pomerania, Lubusz, Opolskie, Podkarpackie, Podlaskie, Lubelskie, Warmia-Masuria	0.673 0.03	0.282 0.04	0.391 0.05
4	Podkarpackie, Warmia-Masuria	0.612 0.04	0.186 0.01	0.425 0,07	Lodzkie, Swietokrzyskie	0.657 0.04	0.300 0.04	0.357 0.11
16 regions	V_s V_Q	0.071 0.051	0.093 0.061	0.104 0.075	16 regions V_s V_Q	0.081 0.048	0.122 0.089	0.091 0.057

HC – Human Capital, Edu. – Education, V_s – standard deviation, V_Q – quartile deviation.

Source: own calculations based on Polish Central Statistical Office data – https://bdl.stat.gov.pl/BDLS/metadane

Table 4

Clustering of regions by social capital (SC)

Cluster No.	Regions		SC V_s	Trust V_s	Behav. V_s	Struct. V_s
2003						
1	Lower Silesia, Mazovia, Swietokrzyskie, Pomerania		0.551 0.02	0.057 0.16	0.266 0.03	0.229 0.08
2	Kujawy-Pomerania, Opolskie, Lubelskie, Lubusz, Malopolskie		0.516 0.04	0.038 0.17	0.274 0.04	0.203 0.08
3	Lodzkie, Silesia, West Pomerania		0.481 0.07	0.043 0.12	0.228 0.10	0.210 0.04
4	Podkarpackie, Podlaskie, Wielkopolskie		0.518 0.04	0.056 0.01	0.260 0.03	0.202 0.11
5	Warmia-Masuria		0.443	0.067	0.215	0.161
16 regions		V_s V_Q	0.071 0.045	0.228 0.165	0.089 0.028	0.107 0.073
2015						
1	Lower Silesia, Lubelskie, Lubusz, Opolskie		0.682 0.03	0.052 0.11	0.345 0.03	0.284 0.06
2	Kujawy-Pomerania, Mazovia, Swietokrzyskie		0.649 0.05	0.085 0.03	0.320 0.06	0.244 0.05
3	Podkarpackie, West Pomerania		0.619 0.03	0.062 0.04	0.326 0.05	0.231 0.03
4	Lodzkie, Malopolskie, Wielkopolskie, Pomerania, Silesia, Podlaskie		0.636 0.05	0.058 0.20	0.314 0.05	0.264 0.06
5	Warmia-Masuria		0.608	0.125	0.278	0.206
16 regions		V_s V_Q	0.052 0.045	0.313 0.170	0.067 0.032	0.102 0.074

SC – Social Capital; Behav. – Behavioral (active citizenship); Struct. – Structural (formal networks); V_s – standard deviation; V_Q – quartile deviation

Source: own calculation

It is much more difficult to identify a trend for the grouping of regions by social capital. In this cross-sectional analysis, the distinctness of Warmia-Masuria can clearly be seen, showing a higher level of general social trust and significantly lower indicators of active citizenship and the functioning of social networks (when compared to the other regions). The resulting division of regions into those with higher and lower social capital is largely consistent with the one presented in “The Social Diagnosis” (2003–2015). The biggest discrepancies concerned the Podkarpackie and Kujawy-Pomerania regions (in “The Social Diagnosis”, Podkarpackie was ranked among the regions that were best-equipped with social capital, and Kujawy-Pomerania was placed among the regions that were below average values for Poland). However, according to sociologists, the dividing line for social capital runs cross-sectionally: East-West and village-city (an agrarian-modern society versus a modern-postmodern one) (Cierniak-Szóstak 2012; Gorzelak, Jałowiecki 2010).

Comparing the grouping of regions by human capital and social capital, it is hard to see similarities between the two combinations. There is no basis to conclude that regions with a higher human capital form clusters with higher social capital nor that lower human capital coexists with a lower social capital; such correlations are visible when comparing European countries (Wosiek 2016) or at an individual level (Czapiński, Panek, 2013, p. 269–280).

However, certain similarities can be seen between the clusters distinguished for their human capital or for their traditional factors of development. They consist in the fact that the regions belonging to Clusters No. 1 and 2, with a relatively high GDP *per capita*, were at the same time in the set of regions with a relatively high human capital. The regions with relatively lower human capital showed an average or relatively lower saturation with traditional development factors. Such similarity cannot be seen between the grouping of regions by social capital and traditional development factors. In the group of regions with a high social capital, there were regions with both high GDP *per capita* (Mazovia) and low (Swietokrzyskie). This would indicate that the processes of regional development from 2002 through 2015 were linked to human capital to a greater extent and to social capital to a lesser one.

The question arises as to what extent human capital was a factor or a result of the economic development. The conducted grouping shows that high human capital was not a sufficient factor to achieve a high level of income – a set of areas with high human capital (Clusters No. 1 and 2) was formed by the regions with diversified GDP *per capita*. On the other hand, in the group of regions with a higher GDP *per capita*, there were only those with a higher human capital. This would suggest that the impulses running in the direction of “level of GDP *per capita* to human capital” prevailed in the correlation between human capital and economic development. Moving on to the next stage of development, the economy reported increasingly higher requirements for human capital, thus stimulating its changes.

These findings are confirmed by the results of the correlation analysis (Tab. 5):

- human and social capital were more-largely-related to the level of GDP *per capita* than to the stimulation of its change (rate of growth). Human capital showed a greater impact on GDP *per capita* and its growth rate than social capital. However, there is a stimulating impact of human capital (a higher proportion of people with a tertiary level of educational attainment) and social capital (a positive attitude towards democracy) on economic growth when the threshold of statistical significance is set at 10%;
- higher evaluation ratings of human capital coexisted with higher GDP *per capita*, and links with the component describing the knowledge and expertise were stronger than those with the health of the inhabitants;
- coexistence of a high GDP *per capita* and high ratings for social capital was observed for the index describing the attitude towards democracy, and for an active participation in associations. A poor performance of public administration institutions turned out to be an inhibitor. The level of generalized trust fostered a higher GDP *per capita* (but with a significance level of 10%).

Table 5

Correlation between indicators of human/social capital and level/average growth rate of GDP per capita in 2002–2014

GDP	**Human capital**							
	hc_1	**hc_2**	**hc_3**	**hc_4**	**hc_5**	**hc_6**	**hc_7**	
GDP per capita	0.699	−0.718	0.670	0.007	0.297	0.299	−0.337	
	(0.00)	(0.00)	(0.00)	(0.919)	(0.00)	(0.00)	(0.00)	
GDP per capita growth rate	0.446	0.2501	0.074	−0.361	−0.305	−0.008	−0.048	
	(0.084)	(0.35)	(0.786)	(0.170)	(0.251)	(0.978)	(0.861)	
GDP	**Social capital**							
	sc_1	**sc_2**	**sc_3**	**sc_4**	**sc_5**	**sc_6**	**sc_7**	**sc_8**
GDP per capita	0.116	0.002	−0.007	0.434	0.096	0.179	−0.265	−0.128
	(0.096)	(0.980)	(0.926)	(0.00)	(0.167)	(0.010)	(0.00)	(0.066)
GDP per capita growth rate	0.287	0.123	0.126	0.432	0.299	0.363	−0.145	0.2989
	(0.281)	(0.649)	(0.642)	(0.095)	(0.261)	(0.167)	(0.592)	(0.261)

p-value in brackets.

Descriptions for hc_1, hc_2, hc_3, hc_4, hc_5, hc_6, hc_7 and sc_1, sc_2, sc_3, sc_4, sc_5, sc_6, sc_7, sc_8 – see Table 1.

Source: own calculations

5. Conclusions

Based on the studies conducted, several conclusions can be made:

1. In 2002–2014, the similarities among the regions in terms of human capital did not coincide with those distinctive of social capital. This may indicate an insufficient cohesion in the development of these two forms of capital in the Polish regional space. This would also suggest that these two forms of capital were substitutable to each other rather than complementary, making it difficult to effectively use the potential of the local human and social capital to stimulate development processes. The rule of substitution of social capital with human capital – resourcefulness and entrepreneurship of the inhabitants - is valid for the entire country of Poland. Nevertheless, the scope of this substitutability varies in respective regions and is conditioned by their presenting both forms of capital.
2. There are certain similarities between the clustering of regions by traditional factors of economic development and by the characteristics of human capital, but there was no major compatibility between the division of regions by social capital and their being equipped with classic productive factors. The results of the correlation analysis confirmed a stronger link of the processes of economic development in regions with human capital than in those with social capital, whereby there is evidence indicating that it was rather a higher level of economic development that stimulated changes in human capital ("suction" effect for qualified personnel) and the reverse impact of human capital on the change in GDP *per capita* was weaker.
3. There were no converging trends in human and social capital development in regional systems. Moreover, when it comes to the educational component of human capital (most-strongly associated with the level and changes in GDP *per capita*), there was an increase in regional variations during the analyzed period and a trend for those regions with very well-developed urban agglomerations and academic centers to merge into a single cluster was noticeable. It can be assumed that this component of human capital could have had more of a polarizing impact than a converging one. The activation of this trend might have been impacted by the conditions created for the functioning of human capital – greater complementarity with the physical capital in connection with more-advanced regional structures of production. The social capital did not mitigate nor strengthen the polarizing impact of human capital. Therefore, there was no confirmation to the hypothesis that intangible factors – human and social capitals – contributed to the convergence in living standards among regions in Poland in 2002–2014.

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Summaries

Jakub Bartak: **Does income inequality hamper human capital accumulation in OECD countries?** ▪ Managerial Economics 2017, vol. 18, No. 2

JEL Classification: E24, O15, C23

Keywords: *generalized method of moments, human capital, income inequality*

The purpose of this article is to verify whether income inequality impedes the accumulation of human capital in OECD countries during the years of 1990–2010. The article reviews theoretical findings that suggest a negative impact of income dispersions on human capital, and subsequently, it presents estimations of a dynamic model of human capital accumulation. The results of the study reveal a negative and statistically significant relationship between income inequality and human capital inflow measured as student skills test scores.

Sławomir Czetwertyński: **Importance of copyrights in online society** ▪ Managerial Economics 2017, vol. 18, No. 2

JEL Classification: K11, O34, Z13

Keywords: *copyright, online society, copy culture*

The subject matter of the considerations in this paper is copyrights and their importance in the online society. This issue was selected because of the weight of the copyrights in the access and exchange of content via the Internet and, at the same time, the relatively high rate of unauthorized copying that, in fact, translates as a breach of the copyrights. In practice, this means that copyrights (which, for the online society, are what ownership rights for the industrial society are) have no serious authority. Informal norms of the exchange of digital information goods (called the "copy culture") are not accordant with regulations of the formal copyright institution. The main goal of this paper is to determine the importance of copyrights for relationships taking place in the online society. In the paper, a large part of the considerations regards the bi-polarity of the copyright idea that protects authors on the one hand yet prevents the so-called author's monopoly on the other. In the course of considerations, the author made an attempt to verify the hypothesis stating that the bi-polarity of copyrights responds to the needs of the online society; however, the formal copyright institution has no such serious authority as the institution of ownership rights to tangible things. The research method applied in this paper is of a deductive nature. Considerations are based on an analysis of the copyright idea as well as on the traffic, extent, and content on the Internet – in other words, flows within the online society.

Henryk Gurgul, Roland Mestel, Robert Syrek: **MIDAS models in banking sector–systemic risk comparison** ▪ Managerial Economics 2017, vol. 18, No. 2

JEL Classification: G15, G19

Keywords: *systemic risk measures, GARCH-MIDAS, DCC-MIDAS*

This paper shows the application of MIDAS based models in systemic risk assessment in banking sector. We consider two popular measures of systemic risk i.e. Marginal Expected Shortfall and

Delta Conditional Value at Risk. The GARCH-MIDAS model is used in modelling conditional volatilities. The long-run component is modeled using realized volatility. The conditional correlation, second step of modelling, is described with DCC-MIDAS model. This is novel approach in respect to classical TARCH and DCC modelling. Whereas the information contained in macroeconomic variables, if available, can help to predict short and long-term components, this is the promising option in improvement of systemic risk assessment.

László Pitlik, Péter Kollár, Zsolt Fülöp, Imre Madarász: **Exploring relative instances of exposure in equilibrium of migration processes based on population characteristics** ▪ Managerial Economics 2017, vol. 18, No. 2

JEL Classification: F22

Keywords: *similarity analysis, migration potential, sustainability, automation, objectivity, socio-cybernetics*

Cybernetic states of law try to plan each activity – especially migration issues. The planning process has the following question originating in socio-cybernetics in its core: Where can it be assumed that the population characteristics are higher/lower than rational? The planning levels can be different: from the continent or country levels via statistic regions or micro-regions to settlements (even at the street and house levels). Parallel to the aggregation like population density (or annual growth rate), models can also be developed for arbitrary layers of demographical statistics, like the required ratio of males and females in different age-groups and/or education categories, etc. The models can analyze time-periods (e.g., years, time intervals) to ensure that dynamic processes will not actually be covered through static evaluation. The necessary data asset (a kind of Big Data) is given by OECD/EUROSTAT, for example The questions and data assets are well-known. The modeling methodology consists of potential know-how: through estimations of staircase functions in the framework of online similarity analyses, regional norm values can be derived for targeted population characteristics. Therefore, the European strategy concerning the integration of massive volumes of migrants can be supported in an objective way. Analogue analyses with the same methodology have already been derived for parts of Germany and Hungary. Similarity analysis is an artificial intelligence-based approach with its own consistence-oriented quality assurance layers. The data-driven policy creation needs methodologies where objectivity is provided through optimization in the modeling based on arbitrary phenomena. The modeling philosophy should try to ensure a kind of regional multi-layered equilibrium (sustainability, cf. Kazohinia). The outlined methodology can be seen as a sort of automated SWOT analysis where each conclusion will be derived from the raw statistics in a direct way – without the risk of human subjectivity intervening in the process. The modeling spectrum consists of three levels: (1) Explorative modeling is able to derive basic characteristics for ceteris paribus perspectives through the complex functions. The standard analytical potential works with ceteris paribus parameters, based on the appropriate literature sources. (2) Anti-discriminative modeling is capable of deriving ranks for objects without an actual learning pattern, for the so-called production functions. (3) A cybernetic state of law should be able to have robot-planning values supporting human decision processes. Therefore, 'freedom of press' is basically the capability to explore and publish objective force fields and not to catalyze the spread of subjective evaluations.

Milena Suliga: **Price reversal as potential expiration day effect of stock and index futures: evidence from Warsaw Stock Exchange** ▪ Managerial Economics 2017, vol. 18, No. 2

JEL Classification: G14, G23

Keywords: *futures contracts, expiration day effects, price reversal, abnormal returns, event study methodology*

This paper studies an impact of futures expiration days on the Polish equity market. From three potential expiration effects appearing in the literature (namely, the increased trading volume of underlying assets, increased volatility of their returns, and price reversal after expiration), the latest one is researched in detail for expiration days of futures on the WIG20 index, the mWIG40 index, and individual stocks. The data covers the period from January 2001 to December 2016. The phenomenon of price reversal is studied with the use of regression models, price reversal measures, and event study methodology. The results obtained for expiration days are compared with the results from non-expiration days to check whether a potential price reversal can be interpreted as an effect of expiration. No price reversals after futures expirations were found in the returns of the WIG20 nor mWIG40 indexes. In the case of individual stocks, results from all of the three methods support the assumption that price reversal occurs after expiration. The reversal is immediate and is reflected in overnight returns more than in daily returns.

Stanisław Urbański, Iwona Skalna: **CAPM applications for appropriate stock pricing – impact of speculation companies** ▪ Managerial Economics 2017, vol. 18, No. 2

JEL Classification: G11, G12

Keywords: *stock pricing, penny stocks, speculative stocks, return changes*

Research on the pricing of stocks listed on the Polish market shows a contradiction with the classic CAPM. The results of these studies are consistent with the results carried out on other developed markets. The reasons for inconsistent pricing are not known; this is the main objective of this work. It is a continuation of the authors' previous work on the impact of speculation and penny stocks on the pricing in light of the ICAPM. Despite the scientific justifications for pricing in light of the ICAPM, a common estimate of the capital cost for companies is still performed on the basis of the classic CAPM. It has been conjectured that speculative stocks contribute to incompatible pricing in light of the CAPM. The elimination of speculative stocks would allow for the proper estimate of the cost of capital without the need of complicated and laborious ICAPM applications. The research is conducted on the basis of stocks listed on the Warsaw Stock Exchange from 1995 through 2012. The tested period is divided into two separate sub-periods: 1995–2005 (the years preceding Poland's accession to the EU) and 2005–12 (the years of Poland's membership in the EU). The analyzed stocks are grouped into quintile portfolios according to two variants. The pricing tests are carried out in three modes. In Mode, 1 all listed stocks are analyzed. In Modes 2 and 3, speculative stocks are excluded from the study. The research results prove the validity of the adopted conjectures.

Małgorzata Wosiek: **Human and social capital facing challenges of economic convergence processes in Poland** ▪ Managerial Economics 2017, vol. 18, No. 2

JEL Classification: O15, P48, R11

Keywords: *human capital, social capital, regional convergence*

The article deals with the study of the role of human and social capital in shaping the processes of regional development in Poland in 2002–2014. The study is aimed at seeking answers to the question whether and to what extent the characteristics of human and social capital development impeded or fostered the achievement of convergence in living standards (GDP per capita) in regional systems (NUTS-2). The following tools were used: multidimensional statistical exploratory analysis – the cluster analysis (Ward's, k-means), linear ordering – as well as correlation analysis and measures of statistical dispersion. The analysis confirm a stronger link of the processes of economic development in Polish regions with human capital than in those with social capital, whereby there is evidence indicating that it was rather a higher level of the economic development that stimulated changes in human capital and the reverse impact of human capital on the change in the GDP per capita was weaker. When it comes to the educational component of human capital, it can be assumed that this component of human capital could have had a more polarizing than converging impact. The social capital did not mitigate nor strengthen the polarizing impact of human capital. There was, therefore, no confirmation to the hypothesis that intangible factors – human and social capitals – contributed to the convergence in living standards among regions in Poland in 2002–2014.

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