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# **ABSTRACTS**

**Jan Acedański (University of Economics in Katowice, Poland)**

*Estimation and forecasting regional GDP dynamics in Poland*

Conducting the efficient regional economic policy requires accurate and up-to-date information on the level of economic activity. In Poland, the data on regional GDP dynamics is published only once a year with a substantial delay which makes it difficult to use the data for policy design and monitoring. In this study, we propose a method for estimation and short-term forecasting the unknown quarterly growth rates of regional GDP. The approach uses the available annual data on regional GDP dynamics, quarterly GDP growth rates for Poland as well as several high-frequency economic indicators that are available at regional level. We consider a few different sets of indicators and estimation procedures that are subsequently evaluated using the ex-post accuracy measures. However, because of the short time series it is difficult to create a clear ranking of the analysed approaches.

**Andrzej Bąk (Wrocław University of Economics, Poland)**

*Selected microeconomic models in the valuation of nonmarket goods*

The valuation of nonmarket goods cannot be carried out through the market, because these goods are by their nature not offered on the markets. Economics has developed methods for valuating such goods, which are divided into indirect (travel cost method) and direct (willingness to pay) methods. The article discusses selected methods for estimating the propensity (willingness) to pay for the use of non-market goods. Among these methods, research based on data on revealed preference and stated preference is distinguished.

The aim of the paper is to present selected methods of valuation of nonmarket goods based on data on stated preferences (including contingent valuation, conjoint analysis, discrete choices) and their applications in empirical research, in which the data collection tool is a questionnaire. In the analysis of these data (microdata) microeconomic models are used due to the unit (individual) nature of these data. The paper presents the results of empirical research using selected methods and microeconomic models. An additional effect of the work is a review of the GNU R program packages supporting empirical research using nonmarket goods valuation methods based on data on stated preferences.

*Keywords: nonmarket goods, willingness to pay, preferences, microeconomics, conjoint analysis, discrete choice, program R*

**Christophe Biernacki (Universite de Lille), Claire Boyer, Gilles Celeux, Julie Josse, Fabien Laporte, Matthieu Marbac, Aude Sportisse**

*Model-based clustering with missing not at random data*

Since the 90s, model-based clustering is largely used to classify data. Nowadays, with the increase of available data, missing values are more frequent. Traditional ways to deal with them consist to obtain a filled data set, either by discarding missing values or by imputing them. In the first case some information is lost; in the second case the final clustering purpose is not taken into account through the imputation step. Thus both solutions risk to blur the clustering estimation result. Alternatively, we defend the need to embed

the missingness mechanism directly within the clustering modeling step. There exists three types of missing data: missing completely at random (MCAR), missing at random (MAR) and missing not at random (MNAR). In all situations, especially the MNAR one, logit and probit regressions are proposed as natural and flexible candidate models. In particular, their flexibility property allows to design some meaningful parsimonious variants, as dependency on missing values or dependency on the cluster label after taking specific attention to related identifiability issues. In this unified context, standard model selection criteria can be used to select between such different missing data mechanisms, simultaneously with the number of clusters. Practical interest of our proposal is illustrated on data derived from medical studies suffering from many missing data, supporting the key idea that the missing data pattern can bring significant additional information for discovering the latent partition.

**Myroslava Chekh (Lviv University of Trade and Economics, Ukraine)**  
**Nataliia Cherkas (Kyiv National Economic University, Ukraine)**

*Assessing the countries' competitiveness based on value added concept*

The paradigms of global competitiveness are changed recently because of the new trade patterns and global production networks development. This tendency requires rethinking of national economic growth policy with focus on the impact of international competitiveness factors.

This study investigates the impact of fundamental macroeconomic parameters on the global competitiveness. A set of 27 European countries is assessed in the period of 2006 – 2018 considering their economic performance and development. The determinants of growth and competitiveness are studied. The results show that competitiveness in European countries depends on exchange rate fluctuations. The paper provides comparative studies including developed countries, Central-East European countries, GIIPS countries and offers insight for policy formulation on growth and competitiveness. Ordinary least squares (OLS) with pooled data, panel data with fixed effects (FE), random effects (RE), and the dynamic panel data model were used as principal methods. The empirical findings obtained are particularly important to consider for economic policies and strategies of economic development.

*Keywords: Global Competitiveness, Value Added, Exchange Rate, FDI*

**Mihaela David (“Al.I. Cuza” University of Iasi, Romania)**  
**Danut-Vasile Jemna (“Al.I. Cuza” University of Iasi, Romania)**

*Fertility and socio-economic uncertainty during post-communist transition in Central and Eastern Europe*

The demographic changes in Central and Eastern European (CEE) countries are of particular interest for at least two reasons. Firstly, the experience of a huge social and economic disruption after the fall of state-socialist political system puts the region aside from other European regions. Secondly, the social and economic insecurities were far stronger and also more permanent feature in the CEE countries than elsewhere in Europe. Considering these coordinates, our study aims to evaluate whether socio-economic uncertainty is linked to fertility developments in this region in the period 1990-2017. In particular, whether unemployment, growth volatility (as an additional indicator of economic insecurity), and female employment rates are relevant to declining fertility is examined, taking into account cross-country and time variations and controlling for a relatively standard set of demographic indicators. Our findings suggest that

the uncertainty installed in CEE region after 1990 had a significant impact on the labor market, leading to the decrease in female employment rate and also to the increase in unemployment rate, both with a significant impact on fertility decline. Additionally, the outcomes show a positive (but insignificant) impact of output growth volatility upon fertility.

**Marek A. Dąbrowski (Cracow University of Economics, Poland)**

**Jakub Janus (Cracow University of Economics, Poland)**

*Does the interest parity puzzle hold for Central and Eastern European economies?*

This paper examines the uncovered interest parity (or forward premium) puzzle in four Central and Eastern European countries - Czechia, Hungary, Poland, and Romania - as well as their aggregates from 1999 to 2019. Because the interest parity is a foundation of open-macroeconomy analyses, with important implications for policymaking, especially central banking, more systematic evidence on interest parities in the CEE economies is needed. In this study, we not only address this need but also add to a broader discussion on the UIP puzzle after the global financial crisis. The UIP is verified vis-à-vis three major currencies: the euro, the U.S. dollar, and the Swiss franc. We start by providing a full set of baseline forward premium regressions for which we examine possible structural breaks and perform a decomposition of deviations from the UIP. Next, we explore augmented UIP models and introduce various factors which potentially account for the UIP puzzle, such as the realized variance of the exchange rate, a volatility model of the excess returns, and international risk and business cycle measures. The study shows that the choice of the reference currency matters for the outcome of the interest parity tests in the CEE economies. The puzzle prevails for the EUR and the CHF but not for the USD, a regularity that has not been documented in previous studies. Second, we find that structural breaks in time-series used to test the UIP are not an essential reason for the general failure of the parity in the region. Third, we demonstrate that even though the risk-based measures largely improve the baseline testing regression, both from statistical and economic points of view, they do not alter the overall outcomes of our empirical models. Additionally, we show that the exchange rate peg of the Czech koruna to the euro from 2013 to 2017 had a significant impact on the UIP. A detailed case study on Poland, using granular survey data, indicates the directly measured exchange rate expectations do not seem to be informed by the UIP relationship. Overall, our results lend support to the UIP puzzle and to its explanation with the rare disaster hypothesis.

*Keywords: interest parity puzzle, forward premium puzzle, risk premium, Fama regression, Central and Eastern Europe.*

*JEL Classification: F31, F41, G15.*

**Iwona Foryś (Univeristy of Szczecin, Poland)**

*The size of the flat as a determinant of the duration of the owner property - analysis on the example of a selected cooperative resource*

The family's life cycle and professional development make that the first flat purchased most often small. In countries with a long market tradition (e.g. the USA), improvement of material status usually involves a change of place of residence. This is an effect of striving to improve housing conditions. A household most often buys a larger flats or a house by selling its current flat. In Poland, owners often leave small flats and

use them for rent. The article will analyze the time of maintaining ownership of a flat depending on its area. Do owners keep large flats longer, treating them as their target, and quickly get rid of small flats, changing them for bigger ones? For this purpose, a set of re-sales of cooperative flats on the selected local market is analyzed. Models of duration analysis will be used, taking into account the characteristics of the flats, in particular their area. To estimate the impact of selected variables on the value of property a multiple linear regression model was used (Mayers, 1990). Additionally we explore the expected duration of sell (duration analysis) and investigate the effect of several salient variables on survival time (survival analysis). Methodology stems from the work of Cox and Oakes (1984).

**Diba Erdem (Universidad Católica San Antonio de Murcia, Spain)**

**Joachim Rojahn (FOM Hochschule für Oekonomie & Management, Germany)**

*The importance of financial literacy and personality traits on retirement planning - insights from traditional and data mining classification techniques*

In our analysis, we seek to identify the importance of financial literacy and personality traits on the decision of individuals to save for retirement by applying both traditional and data mining classification techniques. Identifying the most important drivers of retirement planning is of vital interest, as insufficient individual retirement savings go along with higher social cost. Prior research around the globe demonstrates that financial literacy is critical to the individual's decision to save for retirement. Besides common socio-demographic controlling variables, we also include the "Big Five" personality traits in our model, that recently have received more attention when studying the impact of financial literacy on decision making. Specifically, the impact of financial literacy might (partially) diminish when controlling for personality traits.

Most prior studies rely on a single classification technique, usually a form of regression analysis, i.e. logit or probit. However, variable importance may heavily vary with the technique applied. Therefore, we also apply data mining techniques, such as random forests and artificial neural networks, which frequently show superior discriminating power compared to traditional classification techniques. Our analysis relies on the data of the latest wave 7 of the SHARE survey (Survey of Health, Ageing and Retirement in Europe) with a focus on the Baby Boomer generation in Germany. The results provide additional insights to understand, predict and evaluate financial behaviour.

**Katarzyna Frodyma (Cracow University of Economics, Poland)**

*The analysis of the relationship between CO2 emissions and economic growth using the Kuznets Environmental Curve*

In the subject literature the relations between environmental pollution and economic growth are usually tested within the so-called Environmental Kuznets Curve (EKC). The aim of the paper is to confirm the existence of a relationship (U-shaped or N-shaped) between environmental degradation and economic development in the European Union countries.

The analyses conducted so far have taken into account the volume of CO2 emissions related to production in a given country, but have not taken into account a certain part of CO2 emissions related to trade. In order to fill this gap, our study of the relationship between CO2 emissions and economic growth will include both production-based accounting (PBA) and consumption-based accounting (CBA).

The results of previous studies lead to ambiguous conclusions. Some studies concerning selected EU countries confirm the Environmental Kuznets Curve, while other studies do not confirm it. A partial explanation of this discrepancy and a basic objection to these studies is the selection of countries for the panels under consideration. The correct conclusions can be ensured only if the panel model is built for groups of countries which are homogeneous with reference to relevant criteria, therefore, in our paper the EU countries will be divided into groups taking into account their energy policy.

The inclusion of control variables that have not been used in this context so far will be a novel element of the study. The variables will include factors affecting CO<sub>2</sub> emissions (energy efficiency and renewable consumption energy) and the ND-GAIN index (showing the country's vulnerability to climate change and other global challenges combined with its readiness to improve resilience).

### **Andreas Geyer-Schulz (Karlsruhe Institute of Technology, Germany)**

*A review of three techniques of grammar evolution and a mathematical analysis of some of their properties*

In this contribution we review and compare three techniques of grammar evolution, namely the genetic programming approach developed by J. Koza, genetic algorithms over context-free languages (or grammar-based genetic programming) independently developed by P.A. Whigham and A. Geyer-Schulz, and, last but not least, grammatical evolution developed by M. O'Neill and C. Ryan. We explain the commonalities and differences of the three approaches followed by an analysis of some mathematical properties of these algorithms. The analysis is mainly based on the representation of grammars as formal power series as well as on some result of the theory of formal languages. Finally, we link our results with Gödel's speedup theorem of 1936.

### **Bożena Gil (Silesian University of Technology, Poland)**

*Comparison of statistical methods for detecting changes in the conditions for measuring waste water flows*

In recent years, flow monitoring has become increasingly important in the management of waste water management. The measurement of the flow of sewage in the sewage system is not a simple task. The most common measurement method is an indirect method based on simultaneous measurement of the level and velocity of sewage.

The measurement of waste water flows is not only important for the management of the network, but also for the accounts between municipalities and businesses. When measurement is used for financial settlements, particular attention should be paid to the quality of measurement. The results of the measurements are significantly influenced by the changes of operating conditions of the sewage network (i.e. sewage sludges, wastewater flow disturbances, ...), so a systematic check of the flow meter operation conditions is required to obtain data with an acceptable measurement error.

Hydraulic methods, which require a longer period of analysis, are most commonly used to assess the quality of measurements. Statistical methods are used much less frequently to assess the quality of measurements.

The aim of this work will be to compare statistical methods and neural networks to classify data. The criterion for assessing the methods used will be the rate at which changes in the measurement conditions are detected. The analysis will use empirical data from a measuring point where the measurement conditions have been assessed using hydraulic analysis.

**Elżbieta Gołata (Poznań University of Economics and Business, Poland)**

*Population and workforce perspectives in Poland in view of population ageing*

In the second decade of the 21st century, the aging of European population became a key demographic problem to global and local authorities, social and health-care institutions and organizations. According to the UN, in 2017, 25% of Europeans were at least 60 years old and it is expected that this proportion will increase to 35% in 2050. Aging is analysed in relation to economic issues, living conditions, welfare state, pension security, consequences for the labour market. A separate, very important group of considerations are issues of social welfare, health care, and disability.

The aim of this study is to show aging of the Polish population against the background of European Union countries with special emphasis on Central and Eastern European Countries which experienced similar social and economic development. The empirical study used statistical data presenting the degree of advancement of the aging process on the regional basis during the transformation period. When conducting a comparative analysis, a number of traditional measures showing the severity of aging as a result of extending the life expectancy, reducing the intensity of births and migration were used. The consequences of population aging are also presented in a prospective approach with the use of alternative measures.

Particular attention was paid to the ageing of the labour force. Economic activity of older people, work time and the average effective age of retirement and is analysed. The Eurostat demographic forecast data were used as the basis for presenting a simulation of the workforce perspective. Various scenarios regarding increasing labour force participation were adopted. Consequences of the demographic changes are presented by the analysis of dependency ratios.

**Francesca Greselin (University of Milano Bicocca, Italy)**

**Andrea Cappozzo (University of Milano Bicocca, Italy)**

**Ludovic Duponchel (University of Lille, France)**

**Brendan Murphy (University College Dublin, Ireland)**

*Robust dimension reduction for classification of spectroscopic data in agri-food*

In analytical chemistry, high-dimensional spectroscopic data are classified to identify similar spectra and discover anomalies. Well-established procedures like support vector machines (SVMs) and partial least squares discriminant analysis (PLS-DA) are the most common methods for tackling this supervised learning problem. Nonetheless, interpretation of these models remains sometimes difficult, and solutions based on feature selection are often adopted as they lead to the automatic identification of the most informative wavelengths. Unfortunately, for some delicate applications like food authenticity, mislabeled and adulterated spectra occur both in the calibration and/or validation sets, with dramatic effects on the model development, its prediction accuracy and robustness. Motivated by these issues, the present paper proposes a robust model-based method that simultaneously performs variable selection, outliers and label noise detection. We demonstrate the effectiveness of our proposal in dealing with three agri-food spectroscopic studies, where several forms of perturbations are considered. Our approach succeeds in diminishing problem complexity, identifying anomalous spectra and attaining competitive predictive accuracy considering a very low number of selected wavelengths.

## **Wioletta Grzenda (SGH Warsaw School of Economics, Poland)**

### *Prediction of the probability of employment termination by people over the age of 50 using parametric survival models*

Survival analysis methods are increasingly used to study the economic activity of the population. They enable the modelling of the transitions of individuals between various states such as employed, unemployed, and economically inactive while taking into account the duration of the period an individual remains in a given state. The added value of this work is the prediction of the probability of transition from employed to unemployed or economically inactive of the people aged over 50, after different periods of time. The study considers the periods of three, five and ten years. The use of parametric survival models for the prediction has additionally allowed to indicate these characteristics of respondents that have the greatest impact on the probability of transition under consideration.

The analysis is based on the data from the Labour Force Survey from 2018. Two models were considered due to the differences in the retirement age for women and men. For both women and men, the generalized gamma model turned out to be the model best fitted to empirical data. Apart from the age of the respondents, the probability of employment termination was most influenced by such features as education, form of employment and place of residence. In addition, it was received that if an individual reaches retirement age and does not terminate employment then in the next few years they still have a high probability of remaining economically active.

## **Roman Huptas (Cracow University of Economics, Poland)**

### *Macroeconomic announcements effect on trading volume - analysis of intraday data in emerging stock markets*

Modelling of trading volume has become one of the crucial tasks for many international financial institutions, professionals and, especially, traders. The reason for this is that the trading volume plays a significant role in the trading process and is one of the key measures of liquidity on stock markets. A solid understanding of trading volume dynamics is very important for implementing optimal execution strategies, for instance Volume Weighted Average Price (VWAP) trading strategy.

In most of the research focusing on modelling of intraday trading volumes, the pattern of intraday periodicity is assumed to be a deterministic function of time and the same for every trading day, which is a standard assumption in the existing literature. However, it is worth pointing out that trading volume on the days of publishing of various macroeconomic indicators and company revenues can dramatically differ (e.g. Nadler and Schmidt 2015). Moreover, these days may have their own intraday dynamics.

The main aim of this research is to examine the impact of macroeconomic announcements on intraday trading volumes. To describe the dynamics of intraday trading volume we use the linear Autoregressive Conditional Volume (ACV) model with external factors that account for possible effects of macroeconomic news. In the empirical study, we analyze the impact of major economic indicators on intraday trading volumes of selected emerging stock market indices. In particular, empirical study is performed for 15-minute traded volume data. Moreover, the Fourier series approximation technique is adopted for capturing intraday periodic patterns. Finally, Bayesian approach with relevant MCMC techniques is applied to estimate the proposed model.

*Keywords: intraday trading volume, ACV model, macroeconomic announcements, Bayesian inference, high frequency*

**Stanisław Jaworski (Warsaw University of Life Sciences – SGGW, Poland)**

**Zofia Zieliska-Kolasińska (Siedlce University of Natural Sciences and Humanities, Poland)**

*A chance to achieve a target employment rate by age and gender groups across European countries*

The idea of model-based estimate of achieving the specified employment rate level represented by the one of the strongest labour markets in Europe, that is Germany. This approach takes into account the structure of employment rate time series and allows to forecast the chance of achieving the given level. The research comprises groups by age and gender. The prognosis is based on the data from 2005 to 2019. The data embracing the year 2020 are not included into the analysis because of the unpredictable impact of the pandemic.

**Paweł Kaczmarczyk (The Mazovian State University in Płock)**

*The application of statistical methods for analysis of the telecommunications traffic – approach adopting per second billing*

The aim of this research study is to identify the impact of defined type of time period (i.e. classification factor) on hourly demand for telecommunications services. Therefore, hour during 24-hours, particular type of 24-hours, and month have been used as qualitative classification factors. The statistical research has been carried out on the basis of data that has been transferred to author by the selected telecommunication network operator (which was interested in the research results end their application in forecasting). In the structure of the data (i.e. hourly combined demand for specified outgoing telephone calls in sec.) particular subscribers groups (business or individual subscribers), types of 24-hours (e.g. Monday, Saturday, Christmas Day, New Year's Day), particular months, and specific categories of connections (e.g. mobile networks, calls to the same network) have been taken into account. The data is for two years ( $366 \cdot 24 + 365 \cdot 24 = 17544$  observations for each category of connection and selected subscribers group). 24 levels of classification factor have been defined in the case of identification of the impact of hour during 24-hours on the explored demand. 9 levels and 12 levels of classification have been defined in terms of analyses of the impact of type of day and month respectively.

Research results indicate the statistical significance of the impact of factors arising from the calendar and the need to take them into account in the forecasting process.

**Jadwiga Kostrzewska (Cracow University of Economics, Poland)**

**Maciej Kostrzewski (Cracow University of Economics, Poland)**

*Forecasting upward and downward jumps in Nord Pool electricity prices by means of the generalised ordered logistic regression*

In the paper, we analyse how variables such as electricity consumption forecast, wind power forecast, water level in hydroelectric power plant forecast and power plant outages as well seasonality, influence on the probability of upward or downward electricity price jumps. Jumps are detected e.g. by means of quantile analysis and a method based on adjusted boxplot. We analyse electricity prices for 24 hours of a day, separately. We apply the rolling forecasting scheme. The analysis is carried out on the basis of prices from the Nord Pool market.

**Tadeusz Kufel (Nicolaus Copernicus University in Toruń, Poland)**  
**Marcin Błażejowski (WSB University in Toruń, Poland)**  
**Paweł Kufel (WSB University in Toruń, Poland)**

*Automatic model selection procedures vs model averaging – different ways of dealing with model uncertainty*

Automation (in the algorithmic sense) of model selection procedures is present in econometric literature for over 20 years and it is related with both: an increase in computing power of modern computers as well as good theoretical background. In the case of single-equation models the most known software for such analysis is Autometrics which implement Sargan's "general-to-specific" framework, later improved and disseminated by Hendry and Doornik. An alternative approach that can be easily automated is Zieliński's congruent modeling. Finally, we can use an approach which enables pooling from different specifications, like Bayesian or frequentist model averaging.

In our work, we compare the results of various approaches to automatic model selection and forecasting procedures for artificial and empirical data sets.

**Olga Kutera (Cracow University of Economics, Poland)**

*Fine wine hedging properties in risk-minimizing portfolio*

We study the dynamics of relationship between the global, European and Chinese stock markets, fine wine market and exchange rates of CNY/USD and GBP/USD by using VAR-DCC-GARCH framework and daily closing prices of LIVX50, S&P500, FTSE100, Shanghai Composite indices from 2010 to 2019. We find evidence of negative correlation between fine wines market and global stock markets in few periods. Most important results provide empirical evidence that fine wines can be hedge against declines of British currency and can help investors minimize risk to build optimal portfolios. Moreover, results of this study reveal that fine wine could act as hedge against slowdown of the Chinese economy growth and depreciation of the Chinese currency. In addition, risk-minimizing hedge ratios were estimated, and optimal investment portfolios have been created including transaction costs.

**Marek Kwas (SGH Warsaw School of Economics, Poland)**  
**Michał Rubaszek (SGH Warsaw School of Economics, Poland)**  
**Zuzanna Karolak (SGH Warsaw School of Economics, Poland)**

*Mean-reversion, non-linearities and the dynamics of industrial metal prices. A forecasting perspective*

We analyse the dynamics of real prices for main non-ferrous industrial metals: aluminium, copper, nickel and zinc. The estimates based on monthly data from 1980 to 2019 show that the prices are mean reverting and the pace of mean reversion is regime dependent. The results of the out-of-sample forecasting competition provide ample evidence that mean-reverting models deliver significantly better forecasts than the naive random walk. However, allowing for non-linearity by introducing threshold structure does not lead to further improvement in the quality of forecasts.

**Lukasz Kwiatkowski (Cracow University of Economics, Poland)**

*Bayesian VEC models with Markov-switching heteroscedasticity in forecasting macroeconomic time series*

In the paper, we examine the predictive performance of Bayesian vector autoregressive (VAR) models featuring Markovian breaks in the conditional covariance matrix, so as to capture heteroscedasticity typically recognized in macroeconomic data. To account for possible long-term relationships between modelled variables, we resort to the cointegration analysis, which requires reframing the models into their vector error correction (VEC) form. Since the resulting VEC-MSH (i.e. VEC with Markov-switching heteroscedasticity) models combine the above two aspects most commonly encountered in macroeconomic data, while their parametrization still remaining quite parsimonious, they may prove a valid tool for forecasting macroeconomic data. The predictive performance of the models in question (alongside with ‘standard’ VEC structures) is studied through two empirical examples, based on small models of monetary policies in the US and, separately, in Poland. In both cases we allow for regime changes of the conditional covariance matrix between two states of economy, characterized by high and low volatility. The estimation and prediction of the models are performed within the Bayesian statistical framework, which is regarded most suitable and natural while dealing with latent variables (the states of regime-changing process) and probabilistic (rather than only point) forecasting. Evaluation of the obtained sequences of predictive densities for modelled variables is carried out by means of the so-called predictive Bayes factor as well as some non-Bayesian tools, typically utilized in the context of *ex post* probabilistic forecasting experiments.

*Keywords: cointegration, probabilistic forecasting, stochastic volatility, predictive Bayes factor*

*JEL Classification: C11, C53*

**Lukasz Lenart (Cracow University of Economics, Poland)**

*Combining density forecasts by linear pooling using Continuous Ranked Probability Score*

It is well known that to produce better forecast one can combine multiple forecasts which are available from different models or sources. Such aggregation tries to make use of all relevant information on the variable to be predicted and generally is one of the important sources of improving the quality of forecast. However, if practitioners determine weights based only on historical analysis of forecast errors for individual models (see for example [2-3]) then this approach does not consider the relationship between the distribution of forecasts for individual models. In this research we plan to deal with the construction of an algorithm for selecting the weights of the mixture of distributions to consider the relationships between individual predictive densities. The goal will be to determine the (time-varying) weights for a linear mixture of predictive distributions, which minimize the continuous ranked probability score (CRPS in short, see [1]) of this mixture. It will be shown that the minimization of CRPS for a mixture of distributions is equivalent to the minimization of some quadratic form. The matrix, that determines this quadratic form depends on the predictive densities and observation that materializes. The main diagonal of this matrix contains CRPS values for individual predictive distributions. Finally, the relationship between the individual predictive densities is then considered in the other elements of this matrix. The few examples and simulation study will be shown.

[1] T. Gneiting and A.E. Raftery. Strictly proper scoring rules, prediction, and estimation. *Journal of the American Statistical Association*, 102(447):359–378, 2007.

[2] S.G. Hall and J. Mitchell. Combining density forecasts. *International Journal of Forecasting*, 23(1):1–13, 2007.

[3] Ch. McDonald and L.A. Thorsrud. Evaluating density forecasts: model combination strategies versus the RBNZ. Reserve Bank of New Zealand Discussion Paper Series DP2011/03, Reserve Bank of New Zealand, 2011.

**Agnieszka Lipieta (Cracow University of Economics, Poland)**

**Artur Lipieta (Cracow University of Economics, Poland)**

*Mechanism of creative destructive within evolution of the economy – Schumpeterian approach*

This research is inspired by Schumpeter’s theory of economic evolution and the main findings of papers by Aghion and Howitt. It aims in expansion of the results concerning analysis of mechanisms occurring during the development of the economy with the special focus on effects of creative destruction. According to Schumpeter, creative destruction consists of two opposite processes: introducing innovations and processes of elimination of existing, outdated solutions: commodities, firms, technologies etc.

Schumpeter maintained that, within the diffusion of innovations, mechanism of creation destruction leads the economy to the circular flow while Aghion and Howitt proved that creative destruction generates the economic growth.

In this context, we present some results of the theoretical analysis on the role of creative destruction within economic evolution supported by empirical results. As a result, an optimal mechanism of economic evolution will be specified.

*Keywords: economic evolution, mechanism, innovation, destruction*

*JEL classification: D41, L20, O12*

**Karsten Lübke (FOM Hochschule für Oekonomie & Management, Germany)**

**Grzegorz Kończak (University of Economics in Katowice, Poland)**

*Interactive data analysis of OECD-data: introduction to permutation tests*

For a long time there has been a call for the use of real, multivariate data within statistical education (e.g. Guidelines for Assessment and Instruction in Statistics Education, 2016) and to integrate civic data (e.g. ProCivicStat Report: Engaging Civic Statistics: A Call for Action and Recommendations, 2018).

On the other hand there is some evidence that Simulation Based Inference, i.e. Bootstrapping and Permutation Tests can help to improve conceptual understanding of inferential statistics (see e.g. Chance et al. (2016), Maurer and Lock (2016), Beckman et al. (2017), Tintle et al. (2018), Hildreth et al. (2018), Lübke et al. (2019)). Many researchers consider the permutation methods and bootstrapping are closely related. In general the permutation methods are considered to be more powerful than bootstrap (Berry et al., 2014) for calculating e.g. p-values. In permutation tests a test statistic is calculated for the observed data. Next the distribution of this tests statistic is estimated using permutations of the observations over all possible arrangements (Kończak 2016) or by Monte-Carlo Methods .

By the help of a interactive Shiny Apps (Doi et al., 2016) we combine these ideas, real, civic data and permutation tests: From the OECD Regional Well-Being (OECD Regions and Cities at a Glance 2018) data-set users can choose the indicators and the two countries they want to compare. By using ggplot2

graphics (Wickham 2016) we hope to ease the transition from learning to doing statistics (see e.g. McNamara, 2019). Currently the app is available in Polish, German and English.

**Pawel Lula (Cracow University of Economics, Poland)**

**Monika Hamerska (Cracow University of Economics, Poland)**

*Analysis of patterns of cooperation in the preparation of scientific publications*

The analysis of the structure of teams of authors of research publications is the main goal of the paper. The study will concern the following features of teams: number of team members, team structure with regard to demographic attributes, scientific degrees, positions or affiliation. During the study typical forms of cooperation (“patterns of cooperation”) among authors will be identified. Also the analysis of changeability of authors’ teams will be discussed.

The analysis of cooperation will be based on graph-based models. Every case of cooperation will be represented by a subgraph of the whole graph of cooperation. Patterns of cooperation will be identified with the use of cluster analysis of subgraph representing authors’ teams. All methods will be implemented with the use of “igraph” package for R system.

The empirical part of the research will present the analysis of patterns of cooperation existing among researchers working for the Cracow University of Economics. The scope of analysis will cover all research publications published in ten-year period of scientific activity.

**Ewa Majerowska (University of Gdańsk, Poland)**

**Magdalena Gostkowska-Drzewicka (University of Gdańsk, Poland)**

*The capital and assets structure of the Visegrad Group stock companies*

Objective - To investigate whether the capital and asset structure of companies listed on stock exchanges from individual countries of the Visegrad Group differs significantly and whether it can be concluded that there are dependencies between the structure of assets and the relations describing the golden and silver financing rules.

Research methodology - The assumed research hypotheses were verified with the use of appropriate statistical tools. The calculations were made with the use of Gretl and Excel programs.

Result - The assumed research hypotheses were confirmed. The basis for financing the activities of the analyzed companies was mainly equity. In practice, this means that the surveyed entities mostly follow the rules of the silver, less often the golden, more restrictive balance rule. However, the results obtained for individual countries differed significantly from one another.

Originality / Value - The conducted research provides a basis for determining whether the gold and silver balance rule are factors influencing decision-making in the field of shaping the capital structure of companies from the Visegrad Group countries. The research concerns listed companies from four countries and provides the basis for further research in this area, both in terms of sample size and the length of time series.

**Justyna Majewska (Univeristy of Economics in Katowice, Poland)**

*Analysis and comparison of lifespan inequalities for some Central and Eastern European countries*

Life expectancy at birth is commonly used to measure longevity. However, in recent years, the importance of measures of inequality in the length of life (lifespan inequality) has been emphasized, which are of great importance in health research and policy interventions. Life span inequality gives insights into uncertainty about age at death (while life expectancy provides a measure of average life spans).

For selected populations from Central and Eastern Europe we investigated life expectancy and lifespan disparity in periods of time determined by trends in the coefficient of variation of (fe)male life expectancy: stagnation improvements, deterioration, divergence and convergence. Periods were initially determined using a divisive hierarchical estimation algorithm for multiple change-points analysis. Different measures of lifespan disparity were used, including life disparity (i.e. life years lost due to death,  $e^\dagger$ ), Gini coefficient, standard deviation in age at death, life table entropy (i.e., the ratio of  $e^\dagger$  to life expectancy at birth) and the ratio of expansion to compression.

The aim was to analyze and compare a long time series of life disparity for some countries from CEE. Decomposing these trends by age and cause of death provides the platform for a discussion on the determinants of lifespan inequality across countries and over time.

We decomposed changes in life expectancy and lifespan disparity by single age, period, and cause of death. For the age-cause decomposition, we used the five-year age group mortality rates from the Human Cause-of-Death Database, and population exposures and period life tables - from the Human Mortality Database (from 1960 to the most recent year available in the data set).

**Pawel Miłobędzki (University of Gdańsk, Poland)**

*Tracking the Polonia rate and WIBOR O/N*

In this paper I examine whether the Benford's law is applicable to track the daily changes in the Polonia rate and WIBOR (Warsaw Interbank Offered Rate) O/N over the period 2005 to 2019. I build upon the Benford first digit (FD) distribution which is present in many naturally occurring and financial data sets and serves as a screen to detect data irregularities and data management. I compare the empirical frequencies of the FDs with those resulting from the reference distribution and apply the goodness of fit test to check if the empirical distribution differs from the reference distribution. The analysis shows that the Polonia rate was not Benford but was close to it. More interestingly, it remained Benford over many six-month subsequent periods except from those in which the monetary authority initiated the interest rates change cycle. The empirical frequencies of the WIBOR FDs were only occasionally consistent with the reference distribution. These weaken concerns about potential manipulation in the Polonia rate and strengthen a conjecture that it better exhibits the price of overnight money in Poland than the WIBOR O/N does.

**Janusz Niezgoda (Cracow University of Economics, Poland)**

*The impact of changes in sample allocation on distributions of examined sample variables*

The knowledge of the population may be taken from exhaustive or partial research. It is assumed that exhaustive research provides full information about the population under analysis. However, because of the

constant increase of research costs, the short validity of data and the continuous demand for information, it is necessary to use the representative sampling method, allowing researchers to acquire knowledge quickly. Being based on the examination of a part of the population (sample), it brings forth such problems as the method of sampling, missing answers or an increase of the sample.

The aim of this study is to analyse the results of modifying the stratified sampling scheme, where the size of the sample is increased in selected strata.

The research was done with the use of computer simulation and the sampling scheme in stratified sampling.

The results show that an increase of the size of the population in selected strata results in a change of the distribution of the examined variable.

**Viera Pacáková (University of Pardubice, the Czech Republic)**

**Petr Šild (University of Pardubice, the Czech Republic)**

**Lucie Zapletalová (University of Pardubice, the Czech Republic)**

*Unmet health care needs and avoidable mortality in European Union countries*

Quality health care is an important factor of health status and mortality in each country. The aim of this article is to assess and compare the level of healthcare in the Member States of the European Union (EU-27) and also to identify the main causes of the identified inequalities. The importance of good health of the population, functioning health systems and quality health care now has been significantly strengthened in the context of the global Covid-19 pandemic. The indicators of unmet healthcare needs and avoidable mortality (preventable and treatable) were used to achieve the set goal of article. Graphical methods of descriptive statistics, methods of multidimensional comparison using a synthetic variable and Pearson's rank correlation coefficient have been used. The obtained results of statistical analysis allow to assess inequalities in unmet healthcare needs and in treatable and preventable mortality incidences in EU-27 countries and also for different groups of inhabitants by age, education, income amount or insufficient availability to the healthcare services. The analyses of unmet needs for health care and of avoidable mortality in this article use the most up-to-date data available from years 2017 and 2018. In the future, it will certainly be interesting to compare the results obtained in article with the results of analogous analyses based on data from the Covid-19 pandemic and the post-pandemic period.

**Anna Pajor (Cracow University of Economics, Poland)**

**Justyna Wróblewska (Cracow University of Economics, Poland)**

**Łukasz Kwiatkowski (Cracow University of Economics, Poland)**

**Jacek Osiewalski (Cracow University of Economics, Poland)**

*Hybrid MSV-MGARCH vs t-GARCH covariance structures in VEC models. Which is better from a predictive point of view?*

In empirical macroeconomics and macroeconometrics, it is the most popular practice to use vector autoregressive (VAR) processes in order to model time series data. Already for some time, it has been recognized in the literature that a large number of macroeconomic variables share two particular features: non-stationarity and conditional heteroscedasticity, with the first one necessitating cointegration analysis within the vector error correction (VEC) representation of VAR, while the second one requiring time-

varying specifications of the conditional covariance matrix. The dynamics of conditional covariance matrices can be captured using quite a variety of stochastic processes. In this research, we attempt to answer a question of which of some alternative approaches to modelling conditional heteroscedasticity in VAR/VEC models is empirically more valid in terms of the resulting models' predictive abilities. Particularly, we specify the conditional covariance matrices to follow either a (multivariate) GARCH process with the Student t conditional distribution or a process representing hybrid SV-GARCH family. Such a choice is intended to provide indications as on which is more essential for enhancement of the VAR/VEC models' predictive performance: allowing for thick tails in GARCH specifications or enabling additional source of dependence via hybrid SV-GARCH structures. Within the framework of the resulting two types of model structures, i.e. VEC-t-GARCH and VEC-SV-GARCH, Bayesian analysis of cointegration is performed, using macroeconomic data for the US and, separately, Polish economies. The focus is on evaluation and comparison of the models' predictive performance by means of predictive Bayes factor as well as some non-Bayesian tools.

**Anatoliy Pilyavskyy (Lviv University of Trade and Economics, Ukraine)**

**Anna Maryniak (Poznań University of Economics and Business, Poland)**

**Yuliia Bulhakova (Poznań University of Economics and Business, Poland)**

*Use of the ISM method in research on success factors of Polish and Ukrainian supply chains*

Objective: to illustrate the usefulness of the Interpretative Structural Model (ISM) method for studying supply chains (SC) and related methods and to identify the key success factors for SC management in terms of their interdependence. The ISM method is presented in detail on the example of dairy supply chains embedded in the economic reality of Polish and Ukrainian.

Despite numerous articles in world literature, this method, as far as we know, is extremely rarely used by Polish and Ukrainian scientists. The subject adopted for illustration is also poorly recognized. Therefore, the article fills a research gap in the area of methodology as well as in the research topic itself.

Based on the empirical research carried out, among other things, it has been founded that it is possible to single out the success factors of SC management, which are characteristic of both the Polish and Ukrainian side. The activities within the framework of the "analyst" construct were considered most important in connection with other factors for success. These are supply chain evaluation indicator analysis, preparation, and analysis of reports in the area of logistics, identification, and evaluation of risk elements in the supply chain and ordering data and improving data acquisition.

In addition, it was found that the factors which represent factors with a high power of dependence and a high driving force belong to the transport construction and procedural conditions. It has also been shown that the application of the ISM method can provide valuable information to support supply chain management decisions.

**Włodzimirz Rembisz (Institute of Agricultural and Food Economics in Warsaw, Poland)**  
**Justyna Góral (SGH Warsaw School of Economics, Poland)**  
**Krzysztof Drachal (University of Warsaw, Poland)**

*Analysis of global food prices with new Bayesian model combination schemes*

**Purpose** – The purpose of this paper is to indicate key determinants of food prices and methods of their forecasting.

**Design/methodology/approach** – The aim of the research is to apply Dynamic Model Averaging (DMA), Median Probability Model (MPM) and Bayesian Model Averaging (BMA), and their “model selection” versions to global food prices. The analysed data consist of 5 food price indices provided by FAO: food, meat, dairy, cereals, oils and sugar price indices. The analysed period covers monthly data from 1990 to 2016.

**Findings** – First of all, model combination scheme is one of the possible econometric tool to deal with model uncertainty. Secondly, for various commodities prices some of these methods were found to produce more accurate price forecasts than the previously studied (applied) methods. Therefore, it is interesting to verify the usefulness of them in case of global food prices. Basing on the literature review, several fundamental, macroeconomic and financial factors are taken as potentially important explanatory variables. In particular, GDP per capita growth in BRIC countries, global economic activity, market stress, interest rates, biofuels production, exchange rates, stock market index, energy and fertilizers prices.

**Originality/value** – The novel methods applied herein are characterized by the use of time-varying parameters approach and dealing with model uncertainty. In other words, several component linear regression models are estimated and given time-varying weights due to their performance. These weights can be used to both model averaging across all the considered component models, or to select one “best” model, basing on certain criterion. These methods are compared with Historical Average forecasting, ARIMA and the naïve method. The comparison between models is done with the Diebold-Mariano test and the Giacomini-White test. For meat price index, DMA is found to produce the most accurate forecasts (for food price index – Median Probability Model, for other indices – ARIMA method).

*Keywords food prices, model averaging, model uncertainty, Bayesian model combination schemes*

**Michał Rubaszek (SGH Warsaw School of Economics, Poland)**  
**Karol Szafranek**  
**Gazi Uddin**

*The dynamics and elasticities on the U.S. natural gas market. A Bayesian structural VAR analysis*

Natural gas is an important source of energy in the global economy, hence understanding the drivers of its prices is of significant interest for economic agents. This paper investigates the role of structural shocks for the dynamics of the U.S. natural gas market within the Bayesian Structural Vector Autoregression framework applied by Baumeister and Hamilton (2019) for the crude oil market. This approach provides clear intuition for the identification strategy and allows deriving posterior with sound economic interpretation. We show that the short-term price elasticity of natural gas supply is low, whereas the demand price elasticity is higher than the consensus estimate in the literature. Next, we argue that demand shocks specific to the U.S. natural gas market explain a large fraction of real natural gas prices variability, while the overall small contribution of supply and inventory shocks rises occasionally during specific

market events. Finally, we illustrate how changes in supply in the era of shale gas revolution contributed to the dynamics of natural gas prices.

**Viktor Shevchuk (Tadeusz Kościuszko Cracow University of Technology, Poland)**

*Exchange-rate pass-through in Ukraine*

The paper provides estimates of the exchange rate pass-through (ERPT) to consumer prices for Ukraine. Using a five-variable VECM (vector error correction model), including the nominal effective exchange rate, consumer prices, terms of trade, the central bank reference rate and output), it is shown that both long- and short-term ERPT to consumer prices are likely to increase since the adoption of a floating exchange rate regime in 2014. Dependent on the alternative ordering of the impulse responses, estimates of the long-term ERPT increase from approximately 0.2-0.7 in the 2002-2019 sample to 0.8-0.9 in the 2010-2019 sample, while short-term estimates increase from 0.3-0.5 to 0.4-0.7. Our estimates are in accordance with similar estimates of long- and short-term ERPT for the Central and Eastern European countries at 0.6 and 0.5, respectively. As suggested by the forecast error variance decomposition (FEVD), the share of exchange rate in changes of consumer prices is significantly higher according to the ordering of impulse responses with output and exchange rate shocks preceding consumer price outcomes. However, the ERPT becomes substantially weaker if assume that inflationary shock is followed by other macroeconomic developments, including the central bank setting, an ordering that is more consistent with the theoretical framework of the familiar IS-MP-IA model. Somewhat surprisingly, estimates for a shorter 2010-2019 sample reveal that improvement of the terms of trade leads to exchange rate depreciation. At the same time, there is a much stronger response of exchange rate to the central bank reference rate, while the reverse causality becomes more significant either.

**Agata Sielska (SGH Warsaw School of Economics, Poland)**

**Ewelina Nojszewska (SGH Warsaw School of Economics, Poland)**

*Efficiency of Polish county hospitals*

The situation of Polish hospitals is subject to changes resulting both from the changes in health policy and decisions regarding the whole economics. During last years financial situation of Polish hospitals is still worsening. Due to this fact it is now even more important to assess the efficiency of those units.

The goal of the paper is to compare the performance of county hospitals in Poland over the period 2015-2018 using the Data Envelopment Analysis method. We use superefficiency model with two outputs: total number of discharged and dead patients and total person-days. 12 inputs were used including: number of beds, energy expenditure, medical and non-medical materials expenditure, employment of doctors and other personnel. The results are further compared with hospitals' characteristics such as legal form or owning an emergency department.

**Romana Šipoldová (University of Economics in Bratislava, Slovakia)**  
**Ondrej Dúžik (University of Economics in Bratislava, Slovakia)**  
**Tatiana Šoltéssová (University of Economics in Bratislava, Slovakia)**

*Analysis of demographic factors influence on environmental feeling of Slovak population*

The issue of environmental protection is very actual topic and the popularity of ECO (environmentally friendly) products is increasing. Various associations and protest meetings are known around the world to protect the planet. It is true that nature is in real danger. However, we perceive that this topic is only really accepted by a certain group of people, and in order to make more radical solutions it is necessary to identify real promoters and a second group of people who are not familiar with this idea. There are many studies on this topic. We focused on data of the Slovak population. We examined what are the demographic and geographical factors that significantly characterize the ecological feeling of people. It is still a current statement that the preference of environmentally friendly products is only a matter of money. The data for the research were obtained from a partner of the University of Economics - GroupM Slovakia. We used Live Panel, GroupM yearly study which runs in selected countries around the world. In Slovakia, 3300 respondents participated in this study. This is a quota sample, representative of age, sex and region. We have chosen the method of logistic regression to determine significant characteristics. With it we proved the significance / insignificance of individual factors, but also differences in relevant categories. The results of our research will provide a better understanding of the characteristics of Slovak citizens who are willing to live healthier and pay more for environmentally friendly products.

*Keywords: environmental, ecological feeling, logistic regression*

**Andrzej Sokolowski (Cracow University of Economics, Poland)**  
**Małgorzata Markowska (Wroclaw University of Economics, Poland)**

*Comparing partitions of non-identical sets*

There are measures to compare two identical sets. The most popular are those proposed by Rand, Hubert and Arabie, Wallace, and Fowlkes and Mallows. The case of non-identical sets has been considered only by Cugmas and Ferligoj. In cluster analysis of economic problems, the cases of non-identical sets is becoming more and more important. Administrative units are being split or merge, some of the companies go bankrupt, other are newly born. The number of countries in the European Union increased in years and now will be smaller through Brexit. So to be able to perform the comparison of partitions it time, we need the special measure for comparing non-identical sets.

In this paper we discuss the possibility to transform classical indexes (for identical sets) to the case of two non-equal sets of objects. Practically, only rather small number of objects is not present in both sets, but we have to considered also the limit case when two partitions are completely different.

In order to study the distribution of proposed measures we have to consider also the efficient algorithm for generating random partitions.

Finally the economic example will be provided.

**Katarzyna Suszyńska (Poznań University of Economics and Business, Poland)**  
**Wojciech Kisiało (Poznań University of Economics and Business, Poland)**

*Tenure arrangements in the EU countries: the trade-off between ownership and rental housing*

Distinguishable patterns of mass homeownership have emerged across the EU countries in recent decades, and have become commonly addressed in comparative analyses of housing systems in the globalised world. Numerous studies examined the spatial differentiation of housing tenure in the EU-15, yet the situation of the new member states still appears to be only vaguely recognized. The aim of the paper is to identify clusters of countries according to similarities within housing tenure and to explain differences in tenure composition (ownership vs. rental housing). The research procedure relies on cluster analysis that is part of multidimensional statistical classification methods.

The paper uses cross-sectional European Union Statistics on Income and Living Conditions (SILC) data to deconstruct to what extent the living arrangements have varied across the European Union countries. The spatial scope of analysis covers all EU member states.

The results allowed for distinguishing countries that boast similar housing tenure structure. The proposed typology may help to better understand the diversification of living arrangements within the EU and thus be useful in tailoring by authorities of the member states housing policies through identification of role models and good practices.

**Grażyna Trzpiot (Univeristy of Economics in Katowice, Poland)**

*Impact of demographic dividend for longevity economy*

The year 2020 will mark the beginning of the decade of the “young old”, as the Japanese call people aged between 65 and 75. The height of the baby boom, the period of high fertility in rich countries after the Second World War, was 1955-60. One might therefore expect peak retirement for baby-boomers in the coming years—except that they are not retiring. By continuing to work, and staying socially engaged, the boomers, in their new guise as the young old, will change the world, as they have done several times before at different stages of their lives. The lack of demographic dividend is the main impact on longevity economy. The aim of the paper is to establish some projections on some risks related with longevity economy base on macroeconomic factors.

**Marek Walesiak (Wroclaw University of Economics, Poland)**  
**Grażyna Dehnel (Poznań University of Economics and Business, Poland)**

*Relative taxonomy – dynamic approach*

The classic approach to relative taxonomy was proposed by S. Wydymus (2013), and its positional version was developed by J. Lira (2015). Both methods of relative taxonomy are statistic despite being applied to spatiotemporal data. The article presents a dynamic version of relative taxonomy. The static version described by Wydymus and Lira does not account for presents of NA values in the data array, in contrast to the proposed dynamic modification, which does. However, compared to many methods of linear ordering, the method of relative taxonomy does have certain limitations, which will be discussed in detail in the article.

*Keywords: relative taxonomy, composite indicators, median, dynamic approach*  
*JEL Classification: C43, C63, O57*

**Stanisław Wanat (Cracow University of Economics, Poland)**  
**Anna Denkowska (Cracow University of Economics, Poland)**

*A tail dependence-based MST and their topological indicators in modelling systemic risk in the European insurance sector*

Currently, despite many studies that use various methodological and empirical approaches to identify and analyze systemic risk (hereinafter SR) in the insurance sector, there is still no coherent theory to allow its effective monitoring. Ideal methods that could be used for this purpose should support or be associated with the essential elements of macro-prudential policy and surveillance (MPS) by providing information on the build-up of system-wide vulnerabilities in time and cross-section, with an acceptable level of accuracy for both the forecast of the occurrence of a systemic event and its financial effects.

The subject of the talk fits into the current stream of research focused on searching for such a method. We focus on the structure of interlinkages between insurance companies, which plays a key role in the propagation of systemic risk in the insurance sector. We propose to analyze the dynamics of interrelationships using selected topological indicators of minimum spanning trees (MST) constructed on the basis of tail dependence coefficients. Preliminary empirical results show the usefulness of the proposed approach in ex post and ex ante analysis of systemic risk in the insurance sector.

**Adalbert Wilhelm (Jacobs University Bremen, Germany)**  
**Laura Schmid (Jacobs University Bremen, Germany)**

*Combining econometric and machine learning models for agricultural financial futures return prediction*

Economic theory of market efficiency implies returns to be unpredictable based on past historic prices. Based on this theoretical assumption, econometric methods are commonly used to statistically model the fundamental underlying structure of financial data. In econometrics, GARCH models are applied to estimate future return volatility. However, GARCH models lack the capacity to make accurate return predictions because financial data is highly unstructured. This shortcoming of econometrics can be overcome by Machine Learning (ML) which goes beyond parameter estimation by exploring new data patterns. On the other hand, ML often lacks interpretability as well as generalizability. Existing research confirms that combining econometric GARCH models and ML techniques can improve return predictions. In this work, several methodological integrations of GARCH (and its extensions) and ML algorithms are evaluated based on their performance for agricultural financial futures return prediction. Firstly, different GARCH and ML models are estimated separately. Secondly, parametric GARCH is estimated with Gaussian Maximum Likelihood (MLE) and thereafter, a) information from remaining errors are exploited with Support Vector Machine (SVM) and several Neural Network (NN) algorithms b) randomization technique of boosting is used to decrease bias in the prediction using GARCH as the base hypothesis, c) GARCH parameters are estimated with SVM, which make no prior assumption on the distribution. Finally, a non-parametric GARCH-type model is estimated by using the GARCH parameters as input in an ML algorithm such as LSTM RNN. The evaluation shows that all integrations of GARCH and ML outperform single GARCH models and have the potential to enhance single ML algorithms for return prediction.

**Anna Zamojska (University of Gdańsk, Poland)**  
**Lech Marcin Kujawski (University of Gdańsk, Poland)**

*Cyclicalities of the mutual fund performance*

The study focuses on the synchronization of the mutual fund performance on the Polish capital market within 2010-2019. The main aim is to verify whether there were interrelations between the performance of the different mutual fund types. We use monthly total rate of return as a performance measure and we deal with stylized facts such as: non-stationarity, variance clustering and cyclicalities. Therefore we use harmonic analysis especially spectral analysis to conclude the existence of significant seasonal and of other types of periodic fluctuations.

The results of the conducted research will answer two questions. First, is the fund performance in each fund category cyclical and if that is the case, what is the length of these cycles. The second question is whether there is a cycle synchronization between various categories of funds and what is the phase shift. The research results have multiple practical implications. On one hand it will let investors optimise their portfolios and on the other detect the moment when they should transact on particular investment fund type.

**Wojciech Zieliński (Warsaw University of Life Sciences – SGGW, Poland)**

*Analysis of the risk of survival of an enterprise: an application of confidence interval for the odds ratio*

The aim of the research was an assessment of the relative risk of liquidation of a company during the first ten years of its activity. The research covered companies established in 2007 in Mazowieckie voivodship and Warsaw. The question was does the place of establishing of a company influence on its surviving during the ten first years of activity. The odds ratio was applied and an appropriate confidence interval was constructed. Since the standard confidence interval has some statistical disadvantages a new confidence interval is proposed (Zieliński 2019) and applied.