

# CONFERENCE PROCEEDINGS FULL TEXT PAPERS

edited by

Stanislava Hronová, Veronika Ptáčková,  
Karel Šafr, Kristýna Vltavská





# APPLICATION OF MATHEMATICS AND STATISTICS IN ECONOMICS 2018

## CONFERENCE PROCEEDINGS FULL TEXT PAPERS

edited by

Stanislava Hronová, Veronika Ptáčková,  
Karel Šafr, Kristýna Vltavská

KUTNÁ HORA, 29<sup>th</sup> AUGUST – 2<sup>nd</sup> SEPTEMBER 2018

## **Scientific Committee**

*Richard Hindls, Stanislava Hronová, Joanna Dębicka, Walenty Ostasiewicz, Rudolf Zimka, Emília Zimková, Martin Boďa, Kristýna Vltavská, Beata Zmyślona*

## **Organizing Committee**

*Stanislava Hronová, Milan Bašta, Jakub Fischer, Lucie Plzáková, Veronika Ptáčková, Lukáš Sobišek, Karel Šafr, Zdeněk Šulc, Kristýna Vltavská, Šárka Zivalová*

## **Reviewers**

*Milan Bašta, Marek Biernacki, Martin Boďa, Adam Čabla, Joanna Dębicka, Vlastimil Farkašovský, Tomáš Fiala, Jakub Fischer, Samuel Flimmel, Jan Fojtik, Albert Gardoń, Mária Grausová, Stanisław Heilpern, Samuel Hudec, Ján Huňady, Katarína Izáková, Michaela Jirková, Mária Kanderová, Igor Kollár, Cyprian Kozyra, Pavol Král, Martina Kuncová, Peter Laco, Jitka Langhamrová, Agnieszka Marciniuk, Petr Mazouch, Edyta Mazurek, Petra Medved'ová, Michal Mešťan, Petr Musil, Katarzyna Ostasiewicz, Jiří Procházka, Hana Řezanková, Zuzana Rigová, Karel Šafr, Jaroslav Sixta, Jana Špírková, Mária Stachová, Zdeněk Šulc, Kristýna Vltavská, Jana Vrabcová, Jan Zeman, Rudolf Zimka, Emília Zimková, Pavel Zimmermann, Beata Zmyślona*

© Copyright: Authors of the papers.

All rights reserved. No part of this publication may be reproduced in any form or in any means without the prior permission in writing of the publisher.

ISBN 978-80-245-2277-7

Publisher: University of Economics, Prague

Oeconomica Publishing House

Year of Publication: 2018

# Contents

<i>Jitka Bartošová, Vladislav Bína</i> MODELING INCOME DISTRIBUTION OF HOUSEHOLDS IN THE REGIONS OF THE CZECH REPUBLIC .....	7
<i>Marek Biernacki</i> QUALITY OF NATIONAL HEALTHCARE SYSTEMS IN VISEGRAD GROUP COUNTRIES COMPARED TO SELECTED EU COUNTRIES .....	18
<i>Dagmar Blatná</i> TIME SERIES ANALYSIS OF THE EMPLOYMENT RATE IN THE CZECH REPUBLIC IN 2005 - 2016 .....	27
<i>Martin Boďa, Mária Kanderová</i> PERIODIC AND TRESHOLD REBALANCING BASED ON POLAR INVESTMENT STYLE .....	36
<i>Jana Cibulková, Zdeněk Šulc</i> A CASE STUDY OF CUSTOMER SEGMENTATION WITH THE USE OF HIERARCHICAL CLUSTER ANALYSIS OF CATEGORICAL DATA .....	50
<i>Petra Cisková, Rudolf Zimka</i> ON THE EXISTENCE OF BUSINESS CYCLES IN SLOVAK ECONOMY .....	61
<i>Tomáš Fiala, Jitka Langhamrová</i> PENSION AGE BASED ON RELATIVE PROSPECTIVE AGE CONCEPT .....	76
<i>Samuel Flimmel, Jan Fojtík, Ivana Malá, Jiří Procházka</i> COMPARISON OF ROBUST MOMENT METHODS FOR PARAMETER ESTIMATION IN AUTOREGRESSIVE PROCESS .....	85
<i>Jan Fojtík, Jiří Procházka, Pavel Zimmermann, Markéta Švehláková, Simona Macková</i> PRECISION OF ASSET LIABILITY MODEL WITH FAST LIABILITIES ESTIMATION BY CLUSTER ANALYSIS .....	96
<i>Agata Girul, Edyta Mazurek</i> THE ECONOMIC ACTIVITY OF DISABLED PERSONS IN POLAND - STATISTICAL ANALYSIS OF DATA PROVIDED BY THE CENTRAL STATISTICAL OFFICE .....	105
<i>Mária Grausová, Miroslav Hužvár, Zuzana Rigová</i> THE IMPACT OF COMPETITIVE ALLOCATION OF SUBSIDIES ON PRODUCTIVITY CHANGE OF UNIVERSITIES IN SLOVAKIA .....	118
<i>Jolana Gubalova, Petra Medved'ová, Jana Špirková</i> WILL LIFE INSURANCE PRODUCTS MEET OUR EXPECTATIONS? .....	133
<i>Stanislaw Heilpern</i> RISK PROCESS WITH UNCERTAIN CLAIMS AMOUNT .....	144
<i>Miroslav Hužvár, Alena Kaščáková</i> USING OF COMPOSITE INDEX IN MEASURING OF WELL-BEING .....	154
<i>Pavol Kráľ, Peter Laco</i> SCORING OF CORPORATE WEBSITES USING PARTIAL LEAST SQUARES PATH MODELING .....	167
<i>Pavol Kráľ, Ľubica Lesáková, Petra Gundová</i> APPLICATION OF CLUSTER ANALYSIS TO IDENTIFICATION OF INNOVATION CATEGORIES OF SLOVAK SMALL AND MEDIUM ENTERPRISES .....	177

<i>Jana Kramulová, Helena Houžvičková, Jakub Vincenc</i> MARGINS ON BUYING AND SELLING TRANSACTIONS AND THEIR CAPTURING IN THE SYSTEM OF NATIONAL ACCOUNTS .....	187
<i>Agnieszka Marciniuk, Emília Zimková</i> ANALYSIS OF POTENTIAL MARRIAGE REVERSE ANNUITY CONTRACTS BENEFITS IN SLOVAK REPUBLIC .....	200
<i>Luboš Marek, Michal Vrabec, Petr Berka</i> EX-POST VERIFICATION OF PREDICTION MODELS OF WAGE DISTRIBUTIONS .....	211
<i>Petr Mazouch</i> YOUNG ADULTS' EXCESS MORTALITY: COHORT PERSPECTIVE .....	222
<i>Maria Piotrowska, Marek Košny</i> HOUSEHOLD ECONOMIC SECURITY ACROSS COHORTS .....	230
<i>Veronika Ptáčková, Lubomír Štěpánek, Vít Hanzal</i> ARE INDUSTRIAL COMPANIES IN THE CZECH REPUBLIC ABLE TO PREDICT THE SHORT-TERM FUTURE OF THE ECONOMY? .....	246
<i>Hana Řezanková</i> DIFFERENT APPROACHES TO THE SILHOUETTE COEFFICIENT CALCULATION IN CLUSTER EVALUATION .....	259
<i>Václav Sládek, Ivana Malá, Adam Čabla</i> IDENTIFICATION OF PROBABILITY DISTRIBUTION USING SKEWNESS-KURTOSIS GRAPH IN INSURANCE .....	269
<i>Petr Sotona</i> MORTALITY RISK ASSESSMENT UNDER IFRS 17 .....	281
<i>Mária Stachová, Lukáš Sobišek</i> CAN LONGITUDINAL CLUSTERING HELP TO DEFINE FINANCIAL DISTRESS CRITERIA? .....	290
<i>Karel Šafr</i> COMBINATION OF REGIONAL AND WORLD INPUT-OUTPUT TABLES: A CZECH CASE OF TERRITORIAL EXPORT AT THE REGIONAL LEVEL .....	300
<i>Karel Šafr, Petr Musil, Jaroslav Sixta</i> ESTIMATES OF REGIONAL CAPITAL MATRICES: A CASE STUDY OF THE CZECH REPUBLIC .....	312
<i>Jana Špírková, Igor Kollár, Gábor Szücs</i> A PAYOUT PRODUCT WITH INCREASING PAYMENTS IN THE OLD-AGE PENSION SAVINGS SCHEME IN SLOVAKIA .....	322
<i>Tomáš Virdzek, Peter Kubaška, Petra Cisková</i> PORTFOLIO PERFORMANCE: AN ACTIVE APPROACH TO WEIGHTING ASSETS IN THE PORTFOLIO VERSUS NAIVE DIVERSIFICATION .....	333
<i>Prokop Závodský, Ondřej Šimpach</i> SCIENTIFIC AND PUBLISHING ACTIVITIES OF THE LAND STATISTICAL OFFICE IN BOHEMIA .....	348

## Foreword

In 1998, when AMSE conference was held for the first time, the representatives of the Department of Statistics from the Faculty of Informatics and Statistics at the University of Economics and the Applied Informatics Department at the Economic Faculty of Matej Bel University agreed on intensifying their co-operation. The two institutions, in addition to personal professional contacts of the members of the departments, have developed a tradition of alternating the hosting of international conferences with the same or similar focus. In 2000, the Polish colleagues from Wroclaw University of Economics whose statistical work places have always had very good relations with the departments of statistics at the University of Economics, Prague, were also invited to contribute to organisational issues. The Conference has been gradually upgraded both in terms of programme and participants (bigger share of PhD students) and has become an integral part of professional contacts of the members of statistics departments from the above-mentioned universities as well as a venue of regular friendly gatherings.

Since its 17th year (from 2014) the AMSE Conference proceedings have been included into the Web of Science database.

The data and venues of twenty previous AMSE conferences:

Year	Date	Place	Organizer
1998	3rd – 4th Sept.	Liptovský Trnovec	Matej Bel University, Banská Bystrica
1999	2nd – 3rd Sept.	Liptovský Trnovec	Matej Bel University, Banská Bystrica
2000	31st Aug. – 1st Sept.	Poprad	Matej Bel University, Banská Bystrica
2001	13th – 14th Sept.	Zadov	University of Economics, Prague
2002	4th – 7th Sept.	Kudova Zdroj	Wrocław University of Economics
2003	4th – 5th Sept.	Banská Bystrica	Matej Bel University, Banská Bystrica
2004	3rd – 4th Sept.	České Budějovice	University of Economics, Prague
2005	1st – 2nd Sept.	Wroclaw	Wrocław University of Economics
2006	31st Aug. – 1st Sept.	Trutnov	University of Economics, Prague
2007	29th Aug. – 1st Sept.	Poprad	Matej Bel University, Banská Bystrica
2008	27th – 29th Aug.	Wisla	Wrocław University of Economics
2009	27th – 28th Aug.	Uherské Hradiště	University of Economics, Prague
2010	25th – 29th Aug.	Demänovská Dolina	Matej Bel University, Banská Bystrica
2011	31st Aug. – 3rd Sept.	Łądek Zdrój	Wrocław University of Economics
2012	30th – 31st Aug.	Liberec	University of Economics, Prague

2013	28th Aug. – 1st Sept.	Gerlachov	Matej Bel University, Banská Bystrica
2014	27th – 31st Aug.	Jerzmanowice	Wrocław University of Economics
2015	2nd – 6th Sept.	Jindřichův Hradec	University of Economics, Prague
2016	31st Aug. – 4th Sept.	Banská Štiavnica	Matej Bel University, Banská Bystrica
2017	30th Aug. – 3rd Sept.	Szklarska Poręba	Wrocław University of Economics

The aim of the yearly international conference is to acquaint participants with the latest statistical and mathematical methods suitable for solving theoretical and practical issues of economics and economy. The AMSE conference thus offers a possibility to present results of scientific work of European academic workplaces.

We hope this year's conference will be as interesting and inspiring as in previous years and we are looking forward to the traditional friendly meetings.

We wish you a pleasant stay in Kutná Hora.

*Stanislava Hronová*

**JITKA BARTOŠOVÁ, VLADISLAV BÍNA**  
University of Economics, Prague, Faculty of Management,  
Department of Exact Methods,  
Jarošovská 1117/II, Jindřichův Hradec, Czech Republic  
e-mails: bartosov@fm.vse.cz, bina@fm.vse.cz

---

## **MODELING INCOME DISTRIBUTION OF HOUSEHOLDS IN THE REGIONS OF THE CZECH REPUBLIC**

Analysis of incomes of inhabitants is in focus in all developed countries mainly because of the assessment and comparison of living standards of inhabitants. Knowledge of the income distribution and its comparison using different socio-economic, demographic and spatiotemporal perspectives is a prerequisite for the quantitative evaluation of living standard, level of social welfare and equality in redistribution of the goods created in society.

The presented paper focuses on an analysis and comparison of the income distribution shape in the households of all 14 Czech regions. According to the fact that regions of the Czech Republic mutually differ not only in the extent of job opportunities, but also in demographic structure of inhabitants (age, education, etc.), we can expect also differences in the shape of regional income distributions. The aim of the paper is to construct suitable models of income distribution and identify regional differences. For this purpose, both parametric and nonparametric models of frequency distributions will be used. Nonparametric approaches are represented by Gaussian kernel estimates. Among parametric methods we can employ some of simple probability distribution models – most frequently two- and three-parametric lognormal models – or chose more demanding but also more accurate methods, i.e. estimate a model of income distribution based on finite mixtures of densities. This method is usually used for the modeling of distributions of random variables in heterogeneous populations and therefore in our case it comprises a better alternative.

*Keywords:* income distribution, kernel density estimate, finite mixtures of densities, regions of CR



## **MAREK BIERNACKI**

Wroclaw University of Economics, Faculty of Management and Computer Science,  
Department of Mathematics and Cybernetics,  
Komandorska Street 118/120, Wroclaw, Poland  
e-mail: marek.biernacki@ue.wroc.pl

---

### **QUALITY OF NATIONAL HEALTHCARE SYSTEMS IN VISEGRAD GROUP COUNTRIES COMPARED TO SELECTED EU COUNTRIES**

The quality of national healthcare systems in Visegrad Group countries (G4), was analyzed based on data obtained from Eurostat, WHO, and Health Consumer Powerhouse for 2004 and 2012 and compared to selected EU countries. The non-parametric DEA method was applied to analyze efficiency and the standardized result of the Euro Health Consumer Index was employed to analyze effectiveness. Relying on these two measures, the performance of national healthcare systems was assessed by means of the “modified” Pareto ordering. An index which takes into account 4 dimensions: efficiency, effectiveness, patients' satisfaction and social welfare growth was proposed for system quality assessment. In the analyzed period, the performance of social healthcare systems in G4 countries increased the most in Slovakia (by 23 percentage points), Hungary (21 points) and the Czech Republic (8 points). In Poland the system performance decreased by 1 percentage point. The quality of healthcare systems in G4 countries is higher than in Portugal and Spain and comparable to the system quality in the United Kingdom and Germany when we treat each dimension equally. When the quality of the system is measured from patients' point of view (performance and patients' satisfaction weigh more), G4 countries offer a significantly lower quality of healthcare systems.

*Keywords:* healthcare system, quality, DEA, EHCI (Euro Health Consumer Index)

**DAGMAR BLATNÁ**

University of Economics, Prague, Faculty of Informatics and Statistics,  
Department of Statistics and Probability,  
W. Churchill Sq. 4, Prague, Czech Republic  
e-mail: blatna@vse.cz

---

## **TIME SERIES ANALYSIS OF THE EMPLOYMENT RATE IN THE CZECH REPUBLIC IN 2005–2016**

When analysing labour market trends, the employment rate serves as a key social indicator, defined as a ratio measuring the proportion of the employed working-age population. The rate of employment is one of the headline indicators in the Europe 2020 strategy for smart, sustainable and inclusive growth. The development of the employment rate both in the EU and the Czech Republic in 2005–2016 is examined with reference to achieving the objectives set in the Europe 2020 strategy, the Czech Republic having already exceeded the 2020 national target. The aim of the paper is to analyse the relationship between the employment rate and selected socio-economic indicators such as real per capita GDP growth rate, inflation rate, educational attainment, level of lifelong learning, social benefits, etc., in the Czech Republic. The regression analysis was used as the main tool of analysis. The employment rate regression analysis was carried out applying multivariate non-stationary time series methodology. The analysis covers the period between 2005 and 2016.

*Keywords:* employment rate, non-stationary time series, regression analysis, cointegration

**MARTIN BOĎA, MÁRIA KANDEROVÁ**

Matej Bel University, Faculty of Economics,  
Department of Quantitative Methods and Information Systems,  
Tajovského 10, Banská Bystrica, Slovakia  
e-mails: martin.boda@umb.sk, maria.kanderova@umb.sk

---

## **PERIODIC AND THRESHOLD REBALANCING BASED ON POLAR INVESTMENT STYLES**

The paper investigates usefulness of a rebalancing strategy that conjoins polar investment styles in both asset pre-selection and portfolio selection. It is customary in investing to adhere to a particular investment style defined on the basis of a measurable quantifiable characteristic (using screening) and to invest into assets that have this characteristic high or low, respectively. The strategy assumes that the portfolio is created by investing into both such polar classes of assets in certain proportions and these proportions would be maintained by periodic and threshold rebalancing over the investment horizon. The usefulness of the rebalancing strategy is evaluated by a case study oriented on the US stock market.

*Keywords:* investment style, screening, periodic rebalancing, threshold rebalancing, transaction costs, S&P 500 Index

**JANA CIBULKOVÁ, ZDENĚK ŠULC**

University of Economics, Prague, Faculty of Informatics and Statistics,  
Department of Statistics and Probability,  
W. Churchill Sq. 4, Prague, Czech Republic  
e-mails: jana.cibulkova@vse.cz, zdenek.sulc@vse.cz

---

## **A CASE STUDY OF CUSTOMER SEGMENTATION WITH THE USE OF HIERARCHICAL CLUSTER ANALYSIS OF CATEGORICAL DATA**

Cluster analysis is a multivariate statistical method with a wide range of possible applications. It is especially useful for market segmentation, in which objects are divided into homogenous segments (clusters) which are further analyzed to obtain segment-specific insights. This contribution presents an application of cluster analysis on multivariate data provided by a company from a field of tourism. The dataset contains information about 5,755 travels of its customers, such as the number of passengers traveling together, age, nationality, route details, price, number of destinations booked, etc. The goal of the analysis is to divide the customers into several distinct segments according to their profiles, while demonstrating the importance of distance measure selection and linkage method selection. The results of the analysis will help to develop a targeted marketing program for the company. Since the dataset contains categorical or categorized variables, hierarchical cluster analysis for categorical data is applied to perform the market segmentation. Due to the fact, that clustering process is always strongly dependent on a similarity measure used and also on a linkage method, the optimal cluster assignment is being chosen among five similarity measures for categorical data and three linkage methods. Clustering solutions corresponding to a specific similarity measure and a specific linkage method are compared and evaluated by internal evaluation indices, which allow finding the optimal number of segments, evaluate their internal consistency and determine the best clustering solution possible.

*Keywords:* hierarchical clustering, categorical data, customer segmentation

**PETRA CISKOVÁ, RUDOLF ZIMKA**

Matej Bel University, Faculty of Economics,  
Department of Quantitative Methods and Information Systems,  
Tajovského 10, Banská Bystrica, Slovakia  
e-mails: petra.ciskova@umb.sk, rudolf.zimka@umb.sk

---

## **ON THE EXISTENCE OF BUSINESS CYCLES IN SLOVAK ECONOMY**

In the paper, a simple Asada's macroeconomic model of monetary policy describing the development of the nominal rate of interest and the expected rate of inflation is investigated. The normal equilibrium point of the model is derived and its dynamic stability is studied in conditions of Slovak economy. Questions concerning the existence of business cycles are examined rigorously. The bifurcation equation is found. The formulae for the calculation of its coefficients are gained. Theorem on the existence of limit cycles is stated. A numerical example utilizing the macroeconomic data of Slovak economy from the years 2005-2017 is presented by means of numerical simulations.

*Keywords:* dynamic model, equilibrium, stability, business cycles

**TOMÁŠ FIALA, JITKA LANGHAMROVÁ**

University of Economics, Prague, Faculty of Informatics and Statistics,  
Department of Demography,  
W. Churchill Sq. 4, Prague, Czech Republic  
e-mails: fiala@vse.cz, langhamj@vse.cz

---

## **PENSION AGE BASED ON RELATIVE PROSPECTIVE AGE CONCEPT**

To ensure appropriate pension for seniors is a very important task for social policy. A very frequent discussed consequence of the population aging is the financial sustainability of the pension system, especially, if it is based on PAYG principle. One of the possible measure supposed is logically increase of the retirement age. There naturally arises an important question of the appropriate linkage of the retirement age with the level of mortality. Alternative threshold can be based on the concept of so-called prospective age (the age in which the remaining life expectancy is the same as the remaining life expectancy of a person in given age and standard mortality pattern). However this threshold does not reflect well the actual age of the person and it would cause that the period of expected economic activity would rise while the period of pension receipt would remain constant. A possible compromise of these both definitions may be the concept of so-called “relative” prospective pension age based on the relative remaining life expectancy (the ratio of remaining life expectancy and the total expected life span – the sum of age reached and remaining life expectancy at this age). The pension age can be thereafter defined e.g. as the relative prospective age corresponding to the age of 65 years and mortality pattern of European Union in 2016. The paper presents the computation of proposed pension age in the Czech Republic, Slovakia, Poland and Spain until 2080 based on the relative prospective age concept and corresponding old age dependency ratios. The baseline scenario of the population projection of Eurostat 2015 has been used for mortality projection.

*Keywords:* population aging, prospective age, pension age, old-age-dependency ratio

**SAMUEL FLIMMEL, JAN FOJTÍK, IVANA MALÁ, JIŘÍ PROCHÁZKA**

University of Economics, Prague, Faculty of Informatics and Statistics,  
Department of Statistics and Probability,  
W. Churchill Sq. 4, Prague, Czech Republic  
e-mails: samuel.flimmel@vse.cz, xfojj00@vse.cz, malai@vse.cz, xproj16@vse.cz

---

## **COMPARISON OF ROBUST MOMENT METHODS FOR PARAMATER ESTIMATION IN AUTOREGRESSIVE PROCESS**

Autoregressive process  $AR(p)$  is very popular and frequently used when working with time series, especially in financial mathematics. One of the requirements for working with  $AR(p)$  is the ability to estimate parameters of the model correctly. However, we currently often deal with big data, which can lead, among others, to a higher probability of outlier presence. As it is known, standard methods for parameter estimation are often not able to work correctly with outliers, and, consequently, standard estimates are usually biased. Therefore, working with sufficiently robust methods has increased in importance. In this paper, we present several robust moment methods for parameter estimation in  $AR(p)$  and we compare them using a simulation study. Outliers in the simulations are modelled using two most frequently used outlier models: additive outlier (AO) and innovative outlier (IO). For the simulation study, we use the R statistical software.

*Keywords:* robust methods, parameter estimation, autoregressive process

**JAN FOJTÍK, JIŘÍ PROCHÁZKA, PAVEL ZIMMERMANN, MARKÉTA  
ŠVEHLÁKOVÁ, SIMONA MACKOVÁ**

University of Economics, Prague, Faculty of Informatics and Statistics,  
Department of Statistics and Probability,  
W. Churchill Sq. 4, Prague, Czech Republic  
e-mails: xfojj00@vse.cz, xproj16@vse.cz, zimmerp@vse.cz, xsvem35@vse.cz,  
simona.mackova@vse.cz

---

## **PRECISION OF ASSET LIABILITY MODEL WITH FAST LIABILITIES ESTIMATION BY CLUSTER ANALYSIS**

Accurate modelling of insurance liabilities which is able to reflect the time value of financial options and guarantees (FOGs) is one of the essential actuarial tasks required by Solvency II and IFRS. Liability modelling of large insurance portfolio that requires running thousands of economic scenarios is very demanding on computational time. In our previous research, we proved that cluster analysis, which limits the number of the modelpoints to be modelled, is a good approximative method which can be used to speed up the liability estimation while preserving the accuracy. Using a faster method for the estimation of the liability value allows the actuaries to study more investment strategies and provide a more complex analysis or sensitivities to understand market risk or manage proper investment strategies by asset liability management. In this paper, we focus on the application of the dynamic asset liability management in life insurance business and the faster liability model based on cluster analysis. In the results, we present the answer to whether the faster liability model is suitable for two basic ALM methods – cash flow matching and duration.

*Keywords:* life insurance, estimation of BEL, cluster analysis



**AGATA GIRUL**

Statistical Office in Wrocław,  
Olawska Street 31, Wrocław, Poland  
e-mail: A.Girul@stat.gov.pl

**EDYTA MAZUREK**

Wrocław University of Economics, Faculty of Management, Computer and Finance,  
Department of Statistics,  
Komandorska Street 118/120, Wrocław, Poland  
e-mail: edyta.mazurek@ue.wroc.pl

---

**THE ECONOMIC ACTIVITY OF DISABLED PERSONS IN POLAND –  
STATISTICAL ANALYSIS OF DATA PROVIDED BY THE CENTRAL  
STATISTICAL OFFICE**

Increased numbers of disabled persons both in Poland, as well as in other European countries, have been triggering many political debates. Guaranteeing dignity and full inclusion of persons with disabilities in society is one of the main objectives embraced by the new disability action plan 2016–2020 of the Council of Europe as regards the promotion of full social participation of persons with disabilities. The accomplishment of the targeted objective depends on an insightful monitoring of the situation of persons with disabilities. Factors that differentiate persons with disabilities with respect to their economic activity have been identified focusing on the problem of employment of disabled persons. For this purpose a multivariate correspondence analysis was applied with data provided by the National Census of Population and Housing 2011. In Poland, women aged 65+, with secondary education or lower, predominate the group of persons with disabilities. Most of disabled persons are related by marriage contract. Statistical analysis did not indicate any significant correlation between the categories of economic activity, and marital status and the degree of disability, whereas significant correlations have been observed between the categories of economic activity and such characteristics as: age, sex, education, and pursued profession.

*Keywords:* disabled persons, correspondence analysis, economic activity

**MÁRIA GRAUSOVÁ, MIROSLAV HUŽVÁR, ZUZANA RIGOVÁ**

Matej Bel University, Faculty of Economics,  
Department of Quantitative Methods and Information Systems,  
Tajovského 10, Banská Bystrica, Slovakia  
e-mails: maria.grausova@umb.sk, miroslav.huzvar@umb.sk, zuzana.rigova@umb.sk

---

## **THE IMPACT OF COMPETITIVE ALLOCATION OF SUBSIDIES ON PRODUCTIVITY CHANGE OF UNIVERSITIES IN SLOVAKIA**

The implementation of the Higher Education Act of 2002 in Slovakia has significantly changed the economic conditions for universities that were transformed to public higher education institutions. Subsidies from the state budget are allocated to individual universities based on their share on the total performance of all public higher education institutions in education and research. The competition for financial resources has greatly influenced the behaviour of universities. Although some effects of this system of financing are considered questionable, it is naturally expected that the increasing competition may have a positive impact on the productivity of universities in the transformation of input resources into desirable outputs. We study the productivity change of Slovakian universities over the period when the new legislation is applied. Malmquist index is used for the assessment of total productivity change, and data envelopment analysis for calculating efficiency scores to construct the index.

*Keywords:* data envelopment analysis, Malmquist index, productivity change, Slovakian public higher education institutions

**JOLANA GUBALOVA, PETRA MEDVEĎOVÁ, JANA ŠPIRKOVÁ**

Matej Bel University, Faculty of Economics,  
Department of Quantitative Methods and Information Systems,  
Tajovského 10, Banská Bystrica, Slovakia  
e-mails: jolana.gubalova@umb.sk, petra.medvedova@umb.sk, jana.spirkova@umb.sk

---

## **WILL LIFE INSURANCE PRODUCTS MEET OUR EXPECTATIONS?**

About fifteen to twenty years ago, funds invested in a life insurance in Slovakia were being valued by a guaranteed so-called technical interest rate of (5-6)% p.a. Gradually, this interest rate was declined to 0.7 % p.a. in 2016. Consequently, with the entry into force of the Directive 2009/138/EC of the European Parliament and of the Council of 25 November 2009, known as Solvency II, and the Directive 2014/51/EU of the European Parliament and of the Council of 16 April 2014, known as Omnibus II Directive, insurance companies should guarantee maximum returns on finance on the level of the yields of the risk-free bonds, traded in the eurozone. This paper offers a case study related to the amount of premium, the advantages or disadvantages of an insurance policy and of the selected insurance contracts. Based on our analysis, we recommend insurance as an actual risk coverage and not as an investment.

*Keywords:* insurance, yield, directive, term life insurance, endowment insurance

**STANISLAW HEILPERN**

Wroclaw University of Economics, Faculty of Management, Information Systems and Finance,  
Department of Statistics,  
Komandorska Street 118/120, Wroclaw, Poland  
e-mail: stanislaw.heilpern@ue.wroc.pl

---

**RISK PROCESS WITH UNCERTAIN CLAIMS AMOUNT**

The contribution is devoted to the risk process in which the claims amount are uncertain. The uncertainty is modeled using the randomness and fuzziness simultaneously and the claim amount are treated as the fuzzy random variable. The definition of the fuzzy random variables proposed by Kwakernaak (1978, 1979) is used in this contribution. The problem connected with the ruin of such process is investigated and some numerical examples are presented. The situation when the initial capital is equal zero is studied and the fuzzy ruin and the mean value of it are computed for the fuzzy exponential random variables. The spread of fuzzy ruin, the measure of uncertainty, is investigated.

*Keywords:* risk process, probability of ruin, fuzzy numbers, fuzzy random variables, uncertainty

**MIROSLAV HUŽVÁR, ALENA KAŠČÁKOVÁ**

Matej Bel University, Faculty of Economics,  
Department of Quantitative Methods and Information Systems,  
Tajovského 10, Banská Bystrica, Slovakia  
e-mails: miroslav.huzvar@umb.sk, alena.kascakova@umb.sk

---

**USING OF COMPOSITE INDEX IN MEASURING OF WELL-BEING**

Measuring the well-being of people and the progress of societies should be a key priority for development and policy making. Better Life Index is a newly designed tool which provides a comprehensive picture of well-being in OECD countries and other major economies, by looking at people's material conditions and quality of life across the population. The index is based on twenty-four indicators grouped in eleven topics concerning housing, income, jobs, community, education, environment, civic engagement, health, life satisfaction, safety and work-life balance. However, the OECD does not rank countries by the Better Life Index. Instead, users are encouraged to assign and share their own weights for the topics to design a composite indicator that can express their preferences on the contribution of each topic to well-being. The aim of this paper is to present and discuss the "benefit of doubt" approach to the construction of a composite index of well-being based on the eleven topics. By this approach, we assign to each country individual weights for the topics that can emphasize the strengths of the country in people's material conditions and quality of life. We show that such composite index is capable to provide policy makers with additional valuable information on untapped potential of individual countries in well-being.

*Keywords:* well-being, DEA method, composite index

**PAVOL KRÁL, PETER LACO**

Matej Bel University, Faculty of Economics,  
Department of Quantitative Methods and Information Systems,  
Tajovského 10, Banská Bystrica, Slovakia  
e-mails: pavol.kral@umb.sk, peter.laco@umb.sk

---

## **SCORING OF CORPORATE WEBSITES USING PARTIAL LEAST SQUARES PATH MODELING**

World Wide Web, especially corporate websites are used by businesses to publish contacts, billing and service information, and product offerings. Businesses can also engage in interactive communication through questionnaires, discussion forums, and on-line news to help them react very flexibly and provide feedback to their customers. In practice, however, not all businesses use these options effectively and the level of quality on business websites varies wildly. Consequently, a flexible and easy applicable methodology providing companies with a possibility to evaluate their own presence would be beneficial. There are many mathematical, statistical and decision-making methods which could form its core. In our contribution, we create such a methodology for scoring of corporate websites based on partial least squares path modeling. The proposed methodology is intended for application in the conditions of Slovak SMEs.

*Keywords:* internet, corporate website, partial least squares path modeling

**PAVOL KRÁĽ**

Matej Bel University, Faculty of Economics,  
Department of Quantitative Methods and Information Systems,  
Tajovského 10, Banská Bystrica, Slovakia  
e-mail: pavol.kral@umb.sk

**LUBICA LESÁKOVÁ, PETRA GUNDOVÁ**

Matej Bel University, Faculty of Economics,  
Department of Corporate Economics and Management,  
Tajovského 10, Banská Bystrica, Slovakia  
e-mails: lubica.lesakova@umb.sk, petra.gundova@umb.sk

---

**APPLICATION OF CLUSTER ANALYSIS TO IDENTIFICATION OF  
INNOVATION CATEGORIES OF SLOVAK SMALL AND MEDIUM  
ENTERPRISES**

When studying key factors and barriers determining innovation activities of enterprises, we need to identify unique categories of enterprises which provides us with a good representation of innovation focused behavior of enterprises. Based on their innovation activities, enterprises are usually classified into two basic categories: innovative enterprises and non-innovative enterprises. Innovation activities of an enterprise could result in various types of innovations - product innovations, process innovations, organizational innovations and marketing innovations. These types of innovations could be combined for each enterprise in very different and unique way, which results in high variability of differences among enterprises. Consequently, standard classification into two groups seems to be unnecessary rough one. In our contribution, we aim to identify a more suitable set of innovation categories by applying various clustering methods to data of Slovak medium and small enterprises collected in the period November 2015–January 2016. Identified innovation categories will be examined more closely via descriptive statistics and exploratory graphical techniques.

*Keywords:* small and medium enterprises, cluster analysis, innovations

**JANA KRAMULOVÁ**

University of Economics, Prague, Faculty of Informatics and Statistics,  
Department of Economic Statistics,  
W. Churchill Sq. 4, Prague, Czech Republic  
and  
Czech Statistical Office,  
Department of Financial Accounts,  
Na padesátém 81, Prague 10  
e-mail: jana.kramulova@vse.cz

**HELENA HOUŽVIČKOVÁ, JAKUB VINCENC**

Czech Statistical Office,  
Department of Financial Accounts,  
Na padesátém 81, Prague 10  
e-mails: helena.houzvickova@czso.cz, jakub.vincenc@czso.cz

---

**MARGINS ON BUYING AND SELLING TRANSACTIONS AND THEIR  
CAPTURING IN THE SYSTEM OF NATIONAL ACCOUNTS**

Margins on buying and selling transactions form one part of this complex system, apart from e.g. transport or trade margins. These financial services in acquiring and disposing of financial assets and liabilities in financial markets constitute an important role in output of financial institutions. Up to now, the Czech Statistical Office recorded only small part of “financial” margins in national accounts, but in the next revision being published in June 2020 the system should include all types.

The aim of this paper is to develop missing methodology of capturing margins and demonstrate all difficulties connected with their estimation. Preliminary results are deeply analysed and also included.

Our approach is affected by the fact that in the Czech Republic no suitable database with detailed information about transactions is available. That is why simplifications and assumptions needed to be formulated in order to obtain the best possible results. The paper contains time series of cross-border margins, experimental estimates of domestic margins on transactions with securities, shares, investment fund shares and foreign currencies.

*Keywords:* national accounts, margins on buying and selling transactions, Czech Statistical Office



**AGNIESZKA MARCINIUK**

Wroclaw University of Economics, Faculty of Management, Computer Science and Finance,  
Department of Statistics,  
Komandorska Street 118/120, Wrocław, Poland  
e-mail: agnieszka.marciniuk@ue.wroc.pl

**EMÍLIA ZIMKOVÁ**

Matej Bel University, Faculty of Economics,  
Department of Finance and Accounting,  
Tajovského 10, Banská Bystrica, Slovakia  
e-mail: emilia.zimkova@umb.sk

---

**ANALYSIS OF POTENTIAL MARRIAGE REVERSE ANNUITY  
CONTRACTS BENEFITS IN SLOVAK REPUBLIC**

Demographic trends in Europe reveal that the pension funding gap will become one of the key social issues in coming years. On the other hand, many of these people hold a large amount of wealth in their property which, being reasonably utilized by equity release products, could help them cover their needs. People can surrender their real estate to a company interested in the acquisition of their property in exchange for the whole life monthly benefits. The aim of the contribution is to analyze the potential benefits of marriage reverse annuity contracts in the Slovak Republic by the use of the Svensson model function, considering the reversionary annuity and the real value of estate in different cities. The real value of the properties is determined by the place where spouses live and has significant influence on the amount of the benefit. While in many countries the equity release products have been offered to clients for dozens years, a product of this nature has not been established so far in the Slovak Republic. Hopefully, this contribution might initiate discussions on the introduction of similar equity release products market in the Slovak Republic as well.

*Keywords:* reverse annuity contract, reverse mortgage, reversionary annuity

**LUBOS MAREK, MICHAL VRABEC**

University of Economics, Prague, Faculty of Informatics and Statistics,  
Department of Statistics and Probability,  
W. Churchill Sq. 4, Prague, Czech Republic  
e-mails: marek@vse.cz, vrabec@vse.cz

**PETR BERKA**

University of Economics, Faculty of Informatics and Statistics,  
Department of Information and Knowledge Engineering,  
W. Churchill Sq. 4, Prague, Czech Republic  
and  
University of Finance and Administration,  
Department of Computer Science and Mathematics,  
Estonska 500, Prague, Czech Republic  
e-mail: berka@vse.cz

---

**EX-POST VERIFICATION OF PREDICTION MODELS OF WAGE  
DISTRIBUTIONS**

Our paper deals with the ex-post verification of models of wage distributions designed to predict wage distributions in the last three years. We will use the prediction results of Lognormal, Lognormal (3p), Johnson SB, Log-Logistic, Log-Logistic (3p) and Normal Mixture distributions and compare them with the empirical distribution from the period 2015-2017. The selection of the used distributions is based on the wage distribution models for the years 2000-2014. Our results show, that the best (and comparable) results can be obtained using three-parameter Log-logistic distribution and Normal Mixture distribution with two components. These results confirm our expectation that due to the fact, that empirical wage distribution becomes less smooth over time, a mixture model should be preferred for the future.

*Keywords:* wage distribution, prediction, model verification

**PETR MAZOUCH**

University of Economics, Prague, Faculty of Informatics and Statistics,  
Department of Economic Statistics,  
W. Churchill Sq. 4, Prague, Czech Republic  
e-mail: mazouchp@vse.cz

---

**YOUNG ADULTS' EXCESS MORTALITY: COHORT PERSPECTIVE**

Young adults' excess mortality - between age of adolescence and young adult - is well known fact. In some literature this excess is called "mortality bump" and reason why we can find it in the development of mortality is usually justified just theoretically and measured for males only. This article describes development of the "bump" in cohort perspective of males in the Czech Republic. In time we can observe changes and shift of the excess to the lower level for younger generations. It seems that younger cohorts have lower mortality risk but the question is if the increase in the period of 18-21 years is decreasing also or not.

*Keywords:* mortality, cohort, young adult, Czech Republic

**MARIA PIOTROWSKA**

Wrocław University of Economics, Faculty of Economic Science,  
Department of Mathematical Economics,  
Komandorska Street 118/120, Wrocław, Poland  
e-mail: maria.piotrowska@ue.wroc.pl

**MAREK KOŚNY**

Wrocław University of Economics, Faculty of Management, Information Systems and Finance,  
Department of Econometrics and Operations Research,  
Komandorska Street 118/120, Wrocław, Poland  
e-mail: marek.kosny@ue.wroc.pl

---

**HOUSEHOLD ECONOMIC SECURITY ACROSS COHORTS**

The paper is aimed at explaining differentiation in economic security of households through cohort differences. Identifying cohorts is based on common educational and professional experiences. The research introduces the concept of economic resourcefulness defined as the capability to make economic decisions that contribute to economic security of a household. Economic security of a household is defined as the ability to achieve income necessary for covering household needs at its suitable level and to create financial reserves to be at disposal in case of unfavorable accident. The research uses an exploratory analysis based on structural equation modeling. The questionnaire survey carried out in Poland in 2013 is a source of data for observed variables in an empirical model of economic security. The findings confirm that common educational and professional experiences, controlling for economy conditions, influence economic resourcefulness of household's members and, as a consequence, their economic security. The conclusion, however, refers to the Polish society and socio-economic development experienced by cohorts of Poles since 1990.

*Keywords:* security, household, cohort, resourcefulness

## **VERONIKA PTÁČKOVÁ**

University of Economics, Prague, Faculty of Informatics and Statistics,  
Department of Economic Statistics,  
W. Churchill Sq. 4, Prague, Czech Republic  
e-mail: veronika.ptackova@vse.cz

## **LUBOMÍR ŠTĚPÁNEK, VÍT HANZAL**

University of Economics, Prague, Faculty of Informatics and Statistics,  
Department of Statistics and Probability,  
W. Churchill Sq. 4, Prague, Czech Republic  
e-mails: stel04@vse.cz, xhanv16@vse.cz

---

### **ARE INDUSTRIAL COMPANIES IN THE CZECH REPUBLIC ABLE TO PREDICT THE SHORT-TERM FUTURE OF THE ECONOMY?**

Economists, politicians or managers always want to know what mood the economy is in. Economic surveys, Short-term statistics and Business tendency survey, can give the answer to this question. However, the short-term business statistics describe real data about companies; the results are published with a two months delay. By way of contrast, the Business tendency survey indicates predictions of this economic development. Since the Business tendency survey is based on opinions of selected companies, a quality and confidence of predictions in the previously mentioned survey is opened to discussion.

The article focuses on evaluation predictions and the real development of industrial companies in the Czech Republic. Authors are comparing results from Short-term statistics in the industry and the Business tendency survey. The Czech Statistical Office collects data from the both surveys. Using mathematical and statistical methods, authors want to scale and categorize real data-based economic development, recorded by short-term business statistics, into categories corresponding within predictions, offered by Business tendency survey, such that the appropriate categories from the both sources correlate themselves enough. The categorization attempt is performed for real data of two economic indicators – employment and sales.

In case the categorization of real data is successful, Business tendency surveys published without any significant delay can provide sufficient and early idea about near future economic development. Furthermore, the results of the analysis can help to understand respondents' answer in the Business tendency survey and possibly update methodology, will be used to assemble indicators of the trust.

*Keywords:* business and consumer survey, business tendency survey, prediction ability

**HANA ŘEZANKOVÁ**

University of Economics, Prague, Faculty of Informatics and Statistics,  
Department of Statistics and Probability,  
W. Churchill Sq. 4, Prague, Czech Republic  
e-mail: hana.rezankova@vse.cz

---

**DIFFERENT APPROACHES TO THE SILHOUETTE COEFFICIENT  
CALCULATION IN CLUSTER EVALUATION**

Cluster analysis is a useful statistical tool for data exploration. It can help to identify groups of similar objects (e.g. countries) according to selected variables (e.g. economic indicators). The created groups (clusters) can be characterized based either on the variables used in clustering or on some other variables. The problem with using the methods of cluster analysis is that the analyst can obtain different results (assignments of objects into clusters) by different methods, and moreover, he needs to determine the number of clusters. Many coefficients for solving this problem have been proposed until now. However, the suggestion obtained by a certain coefficient can differ from another suggestion obtained by another coefficient. In addition, values of a certain coefficient can differ depending on the implementation in the software product. In this contribution, different approaches to the silhouette coefficient calculation are discussed. They concern the implementations of calculations in the R language and IBM SPSS Statistics system. It is analyzed how the different results influence decisions of an analyst in terms of both the choice of the suitable assignment of objects into clusters obtained by different algorithms, and the determination of the suitable number of clusters. The studied problems are illustrated using selected methods of cluster analysis applied to the EU countries characterized by the gender indicators.

*Keywords:* cluster analysis, number of clusters, silhouette coefficient

**VÁCLAV SLÁDEK, IVANA MALÁ, ADAM ČABLA**

University of Economics, Prague, Faculty of Informatics and Statistics,  
Department of Statistics and Probability,  
W. Churchill Sq. 4, Prague, Czech Republic  
e-mails: xslav20@vse.cz, malai@vse.cz, adam.cabla@vse.cz

---

## **IDENTIFICATION OF PROBABILITY DISTRIBUTION USING SKEWNESS-KURTOSIS GRAPH IN INSURANCE**

Insurance company has to estimate its liability (present or future) from its business. Estimation could be based on parametric or non-parametric approaches. Correct identification of probability distributions in parametric approach could lead to accurate inferences about liability. It could lead to greater reliability in estimation and in the best case, to reduce the costs of capital. Skewness-kurtosis graph is a very useful tool for an identification of probability distribution. It is based on intra-relations between moments of the probability distribution. Probability distributions typical for insurance are lognormal, Pareto, gamma distribution and many others. A lot of them could be classified as heavy-tail or long-tail distribution, i.e. extreme values have high probability of being selected in a random sample. Estimates of product moments of skewness and kurtosis are sensitive to the extreme values presence and are limited by a sample size. L-moments are a robust alternative to product moments. This contribution is focused on skewness-kurtosis graph based on L-moments, so-called L-skewness, and L-kurtosis. Its application is shown on Monte Carlo simulation and also an empirical study is presented. A distribution of the amount of Motor third-party liability claims is identified.

*Keywords:* skewness-kurtosis graph, L-moments, MTPL claims, loss distribution

**PETR SOTONA**

University of Economics, Prague, Faculty of Informatics and Statistics,  
Department of Statistics and Probability,  
W. Churchill Sq. 4, Prague, Czech Republic  
e-mail: petr.sotona@seznam.cz

---

## **MORTALITY RISK ASSESSMENT UNDER IFRS 17**

The article focuses on the mortality risk assessment in the insurance industry for the Czech Republic. New accounting standard IFRS 17 requires to disclose confidence level at which the insurance company assessed insurance risks inherent in issued insurance contracts. This article analyzes mortality risk which can be further split into four subrisks: volatility, catastrophic risk, level uncertainty and trend uncertainty. On the practical example of insurance portfolio with term insurance product I present the application of various statistical methods to assess mortality risk and to estimate total risk adjustment (under IFRS 17) for mortality risk on 90% confidence level. Final results are analyzed and commented with conclusions.

*Keywords:* mortality risk, IFRS 17, life insurance



## **MÁRIA STACHOVÁ**

Matej Bel University, Faculty of Economics,  
Department of Quantitative Methods and Information Systems,  
Tajovského 10, Banská Bystrica, Slovakia  
e-mail: maria.stachova@umb.sk

## **LUKÁŠ SOBÍŠEK**

University of Economics, Prague, Faculty of Informatics and Statistics,  
Department of Statistics and Probability,  
W. Churchill Sq. 4, Prague, Czech Republic  
e-mail: lukas.sobisek@vse.cz

---

# **CAN LONGITUDINAL CLUSTERING HELP TO DEFINE FINANCIAL DISTRESS CRITERIA?**

One of the main task in each analysis of companies' financial status is to correctly define the criteria that can describe the financial health or financial distress of these enterprises. In general, the financial distress is a situation in which company cannot pay or has difficulty to reach its financial obligations. Our data set consists of three financial indicators of Czech enterprises. These longitudinal data are collected over a few consecutive years. We applied the model-based partitioning and the K-means partitioning to these longitudinal data to cluster the time trajectories of these criteria and subsequently we compare the accuracy of these algorithms. We use packages "mixAK" and "kml" of the statistical system R in our analysis.

*Keywords:* financial distress, longitudinal data clustering, K-means partitioning, model-based partitioning

**KAREL ŠAFR**

University of Economics, Prague, Faculty of Informatics and Statistics,  
Department of Economic Statistics,  
W. Churchill Sq. 4, Prague, Czech Republic  
e-mail: karel.safr@vse.cz

---

**COMBINATION OF REGIONAL AND WORLD INPUT-OUTPUT  
TABLES: A CZECH CASE OF TERRITORIAL EXPORT AT THE  
REGIONAL LEVEL**

Since 2008, when the Czech Statistical Office stopped publishing the territorial structure of Czech regional export, there has not been any other source of these data. This paper focuses on methodology of estimating Czech territorial export at the regional level through a combination of two other data sources: Czech regional input-output tables and world input-output tables for the year 2013 in current prices (in millions of dollars). These two data sources are combined by an adjusted cross-entropy method and other information provided by official statistics. The final figures showed that the overall structure is similar at the regional level. However, the regional detail differs between regions and there are some special examples of connections, which are not as strong in other regions. Moreover, the presented paper is strongly connected with the methodology supporting the data sources. The presented methodology can be used for estimating model application data, e.g. computable general equilibrium and others.

*Keywords:* regional input-output tables, world input-output tables, international trade

**KAREL ŠAFR, PETR MUSIL, JAROSLAV SIXTA**

University of Economics, Prague, Faculty of Informatics and Statistics,  
Department of Economic Statistics,  
W. Churchill Sq. 4, Prague, Czech Republic  
e-mails: karel.safr@vse.cz, petr.musil@vse.cz, jaroslav.sixta@vse.cz

---

## **ESTIMATES OF REGIONAL CAPITAL MATRICES: A CASE STUDY OF THE CZECH REPUBLIC**

The paper is focused on the estimation of symmetric capital matrices by product in the Czech Republic. Symmetrisation is usually related to the intermediate consumption matrix, which is transformed from the dimension product by industry to the product by product matrix that is the starting point for input-output analysis. However, symmetrisation of capital matrix is very rare and has not been done in the Czech Republic. It is a very complex task as it is in fact double symmetrisation as original matrix of stocks of fixed assets is in the dimension type of asset (AN) by industry (NACE). Several data sources were applied the most important are supply and use tables, estimated transformation matrices. The results enable sophisticated input-output analysis focused on the capital and the demand for capital that is caused by economic impulse or shock. Finally, regionalization of the national results is performed by using additional data and RAS procedure. The regional results are compared with other regional economic indicators estimated within the previous research. It extends a list of regional indicators available for analysis and modelling on the regional level.

*Keywords:* capital matrices, Symmetrisation, Capital formation, Fixed assets

**JANA ŠPIRKOVÁ, IGOR KOLLÁR**

Matej Bel University, Faculty of Economics,  
Department of Quantitative Methods and Information Systems,  
Tajovského 10, Banská Bystrica, Slovakia  
e-mails: jana.spirkova@umb.sk, igor.kollar@umb.sk

**GÁBOR SZÚCS**

Comenius University in Bratislava, Faculty of Mathematics, Physics and Informatics,  
Department of Applied Mathematics and Statistics,  
Mlynská dolina, Bratislava, Slovakia  
e-mail: gabor.szucs@fmph.uniba.sk

---

## **A PAYOUT PRODUCT WITH INCREASING PAYMENTS IN THE OLD-AGE PENSION SAVING SCHEME IN SLOVAKIA**

The Act 43/2004 Coll. on the Old-Age Pension Saving Scheme and on amendments and supplements to certain laws offers, among others, an old-age pension product with increasing annuity payments. In our model we consider a monthly paid annuity increasing yearly in geometric progression. Just the determination of the geometric progression quotient is a crucial task, especially when we consider valuation of the future cash-flows based on risk-free bond yield curves. On the basis of actuarial formulas we point out on a mutual relationship between the risk free bond yields and the yearly increase rate of the pension payments. In our contribution we also examine the impact of the increase rate on the overall benefit of the pensioner.

*Keywords:* old-age pension saving scheme, increasing annuity, geometric progression, increase rate, risk-free yields

## **TOMÁŠ VIRDZEK**

Matej Bel University, Faculty of Economics,  
Research and Innovation Centre,  
Tajovského 10, Banská Bystrica, Slovakia  
e-mail: [tomas.virdzek@umb.sk](mailto:tomas.virdzek@umb.sk)

## **PETER KUBAŠKA, PETRA CISOVÁ**

Matej Bel University, Faculty of Economics,  
Department of Quantitative Methods and Information Systems,  
Tajovského 10, Banská Bystrica, Slovakia  
e-mails: [peter.kubaska@umb.sk](mailto:peter.kubaska@umb.sk), [petra.ciskova@umb.sk](mailto:petra.ciskova@umb.sk)

---

# **PORTFOLIO PERFORMANCE: AN ACTIVE APPROACH TO WEIGHTING ASSETS IN THE PORTFOLIO VERSUS NAIVE DIVERSIFICATION**

Modern portfolio theory represents the approach to constructing an optimal portfolio based on the weighting of individual assets in the portfolio. We can call this approach as an active, because the investor assigns higher weights to the assets that are able to achieve higher performance on the basis of past performance. In addition to the active investment approach, we also know the passive investment approach, through which the investor seeks to evenly distribute capital among other assets (naive diversification). The aim of this paper is to evaluate the performance of the active approach to weighting in the portfolio versus naive diversification. For the purpose of this work, we divide the data sample into two parts. The first part will serve to determine weights in the portfolio (training set) and in the second part we will test the performance of this portfolio versus the approach of naive diversification (testing set).

*Keywords:* Markowitz, weigh of assets in investment portfolio, benchmarking, active diversification, naive (passive) diversification

## **PROKOP ZÁVODSKÝ, ONDŘEJ ŠIMPACH**

University of Economics, Prague, Faculty of Informatics and Statistics,  
Department of Statistics and Probability,  
W. Churchill Sq. 4, Prague 3, Czech Republic  
e-mails: prokop.zavodsky@vse.cz, ondrej.simpach@vse.cz

---

### **SCIENTIFIC AND PUBLISHING ACTIVITIES OF THE LAND STATISTICAL OFFICE IN BOHEMIA**

Land Statistical Office (LSO) in Prague started its activity 120 years ago. In year 1898 and year 1919 it was overtaken by State Statistical Office of new Czechoslovakian state. During the first two decades the number of workers of statistical chair of LSO increased almost four times and its scientific and publication activities significantly broaden.

Land Statistical Office annually published (in Czech and German) several volumes of *Zprávy/ Mittheilungen* (Reports) that contained mainly the results of analysis of meteorological observations and data of agricultural statistics and also the results of land self-government statistics, statistics of inhabitants, education and several branches of economy statistics (all for Bohemia). Methods of agricultural statistics and statistical graphs used by LSO, evoked recognition at the Conference for land statistics in the Austrian part of the monarchy and at meetings of the International Statistical Institute (ISI).

Future university professors D. Krejčí, K. Engliš, V. Mildschuh, F. Weyr and W. Winkler underwent statistical practice in LSO similarly as the leaders of Czechoslovakian state statistics D. Krejčí, F. Weyr, J. Auerhan and J. Mráz.

*Keywords:* history of statistics, Land Statistical Office in Bohemia, agriculture statistics, Dobroslav Krejčí

## **PUBLICATION ETHICS AND MALPRACTICE STATEMENT**

The following statement bases on the publishing ethics guidelines of Elsevier (<https://www.elsevier.com/about/company-information/policies/publishing-ethics>) and on the code of conduct by COPE (<http://publicationethics.org/resources/code-conduct>). It is compiled fully in compliance with Elsevier recommendations.

The publication of an article in the peer-reviewed proceedings from the conference Applications and Mathematics and Statistics in Economics 2018 (AMSE 2018) is an essential building block in the development of a coherent and respected network of knowledge. It is a direct reflection of the quality of the work of the authors and the institutions that support them. Peer-reviewed articles support and embody the scientific method, and therefore the following standards of expected ethical behavior for all parties involved in the act of publishing are adopted. The adopted standards concern the author, the proceedings editor, the peer reviewer and the publisher. The Editorial Board of AMSE 2018 is committed to ensuring that advertising, reprint or other commercial revenue has no impact or influence on editorial decisions.

### **DUTIES OF AUTHORS**

Reporting standards Authors of reports of original research should present an accurate account of the work performed as well as an objective discussion of its significance. Underlying data should be represented accurately in the paper. A paper should contain sufficient detail and references to permit others to replicate the work. Fraudulent or knowingly inaccurate statements constitute unethical behavior and are unacceptable. Review and professional publication articles should also be accurate and objective, and editorial ‘opinion’ works should be clearly identified as such.

Data access and retention Authors may be asked to provide the raw data in connection with a paper for editorial review, and should be prepared to provide public access to such data, if practicable, and should in any event be prepared to retain such data for a reasonable time after publication.

Originality and plagiarism The authors should ensure that they have written entirely original works, and if the authors have used the work and/or words of others, that this has been appropriately cited or quoted. Plagiarism takes many forms, from ‘passing off’ another’s paper as the author’s own paper, to copying or paraphrasing substantial parts of another’s paper (without attribution), to claiming results from research conducted by others. Plagiarism in all its forms constitutes unethical publishing behavior and is unacceptable.

Multiple, redundant or concurrent publication An author should not in general publish manuscripts describing essentially the same research in more than one journal or primary publication. Submitting the same manuscript to more than one journal or conference proceedings concurrently constitutes unethical publishing behavior and is unacceptable. In general, an author should not submit for consideration in another journal or for conference proceedings a previously published paper. The authors and editors of the journals concerned must agree to the secondary publication, which must reflect the same data and interpretation of the primary document. The primary reference must be cited in the secondary publication.

Acknowledgement of sources Proper acknowledgment of the work of others must always be given. Authors should cite publications that have been influential in determining the nature of the reported work. Information obtained privately, as in conversation, correspondence, or discussion with third parties, must not be used or reported without explicit, written permission from the source. Information obtained in the course of confidential services, such as refereeing manuscripts or grant applications, must not be used without the explicit written permission of the author of the work involved in these services.

Authorship of the paper Authorship should be limited to those who have made a significant contribution to the conception, design, execution, or interpretation of the reported study. All

those who have made significant contributions should be listed as co-authors. Where there are others who have participated in certain substantive aspects of the research project, they should be acknowledged or listed as contributors. The corresponding author should ensure that all appropriate co-authors and no inappropriate co-authors are included on the paper, and that all co-authors have seen and approved the final version of the paper and have agreed to its submission for publication.

Hazards and human or animal subjects If the work involves chemicals, procedures or equipment that have any unusual hazards inherent in their use, the author must clearly identify these in the manuscript. If the work involves the use of animal or human subjects, the author should ensure that the manuscript contains a statement that all procedures were performed in compliance with relevant laws and institutional guidelines and that the appropriate institutional committee(s) has approved them. Authors should include a statement in the manuscript that informed consent was obtained for experimentation with human subjects. The privacy rights of human subjects must always be observed.

Disclosure and conflicts of interest All authors should disclose in their manuscript any financial or other substantive conflict of interest that might be construed to influence the results or interpretation of their manuscript. All sources of financial support for the project should be disclosed. Examples of potential conflicts of interest which should be disclosed include employment, consultancies, stock ownership, honoraria, paid expert testimony, patent applications/registrations, and grants or other funding. Potential conflicts of interest should be disclosed at the earliest stage possible.

Fundamental errors in published works When an author discovers a significant error or inaccuracy in his/her own published work, it is the author's obligation to promptly notify the editor or publisher and cooperate with the editor to retract or correct the paper. If the editor or the publisher learns from a third party that a published work contains a significant error, it is the obligation of the author to promptly retract or correct the paper or provide evidence to the editor of the correctness of the original paper.

## **DUTIES OF EDITORS**

Publication decisions The proceedings editor is responsible for deciding which of the articles submitted to the conference should be published. The validation of the work in question and its importance to researchers and readers must always drive such decisions. The editor is guided by the policies of the Editorial Board of AMSE 2018 and constrained by such legal requirements as shall then be in force regarding libel, copyright infringement and plagiarism. The editor may confer with other editors or reviewers (or society officers) in making this decision.

Fair play The editor evaluates manuscripts for their intellectual content without regard to race, gender, sexual orientation, religious belief, ethnic origin, citizenship, or political philosophy of the authors.

Confidentiality The editor and any editorial staff must not disclose any information about a submitted manuscript to anyone other than the corresponding author, reviewers, potential reviewers, other editorial advisers, and the publisher, as appropriate.

Disclosure and conflicts of interest Unpublished materials disclosed in a submitted manuscript must not be used in the editor's own research without the express written consent of the author. Privileged information or ideas obtained through peer review must be kept confidential and not used for personal advantage. The editor should recuse oneself from considering manuscripts in which they have conflicts of interest resulting from competitive, collaborative, or other relationships or connections with any of the authors, companies, or (possibly) institutions connected to the papers. The editor should require all contributors to disclose relevant competing interests and publish corrections if competing interests are revealed after publication.



If needed, other appropriate action should be taken, such as the publication of a retraction or expression of concern. Non-peer reviewed sections of the proceedings should be clearly identified.

Involvement and cooperation in investigations An editor should take reasonably responsive measures when ethical complaints have been presented concerning a submitted manuscript or published paper, in conjunction with the publisher (or society). Such measures will generally include contacting the author of the manuscript or paper and giving due consideration of the respective complaint or claims made, but may also include further communications to the relevant institutions and research bodies, and if the complaint is upheld, the publication of a correction, retraction, expression of concern, or other note, as may be relevant. Every reported act of unethical publishing behavior must be looked into, even if it is discovered years after publication.

### **THIS IS HEADING ELEMENT**

Contribution to editorial decisions Peer review assists the editor in making editorial decisions and through the editorial communications with the author may also assist the author in improving the paper. Peer review is an essential component of formal scholarly communication, and lies at the heart of the scientific method. The Editorial Board of AMSE 2018 shares the view of many that all scholars who wish to contribute to publications have an obligation to do a fair share of reviewing.

Promptness Any selected referee who feels unqualified to review the research reported in a manuscript or knows that its prompt review will be impossible should notify the editor and excuse himself from the review process.

Confidentiality Any manuscripts received for review must be treated as confidential documents. They must not be shown to or discussed with others except as authorized by the editor.

Standards of objectivity Reviews should be conducted objectively. Personal criticism of the author is inappropriate. Referees should express their views clearly with supporting arguments.

Acknowledgement of sources Reviewers should identify relevant published work that has not been cited by the authors. Any statement that an observation, derivation, or argument had been previously reported should be accompanied by the relevant citation. A reviewer should also call to the editor's attention any substantial similarity or overlap between the manuscript under consideration and any other published paper of which they have personal knowledge.

Disclosure and conflict of interest Unpublished materials disclosed in a submitted manuscript must not be used in a reviewer's own research without the express written consent of the author. Privileged information or ideas obtained through peer review must be kept confidential and not used for personal advantage. Reviewers should not consider manuscripts in which they have conflicts of interest resulting from competitive, collaborative, or other relationships or connections with any of the authors, companies, or institutions connected to the papers.