



BOOK OF ABSTRACTS

of the 22nd **AMSE**

Applications of Mathematics and Statistics in Economics

2019





BOOK OF ABSTRACTS

of the 22nd **AMSE**

Applications of Mathematics and Statistics in Economics

2019



- Organizers: Matej Bel University in Banská Bystrica, Faculty of Economics, Slovakia
Wrocław University of Economics, Faculty of Management, Computer Science and Finance, Poland
University of Economics in Prague, Faculty of Informatics and Statistics, Czech Republic
- Title: Book of abstracts of the 22nd AMSE – Applications of Mathematics and Statistics in Economics 2019
- Publisher: Občianske združenie Financ, Banská Bystrica, Slovakia
- Editors: Mária Grausová, Martin Boďa
- Reviewers: Rudolf Zimka, Emília Zimková, Richard Hindls, Stanislava Hronová, Joanna Dębicka, Walenty Ostasiewicz, Martin Boďa, Kristýna Vltavská, Beata Zmyšlona

FOREWORD

Dear participants of the conference AMSE 2019,

This year 100 years have passed since statistics was officially institutionalised by the establishing of the Czechoslovak State Statistical Office in the young Czechoslovakia. After the formation of the Czech and Slovak Republics this institution was continuously transformed into the Czech Statistical Office and Statistical Office of the Slovak Republic. During this period, statistics has made a considerable progress not only in the field of scientific domain but also in the field of its applications in the national economy. Both these fields are dignifiedly represented by the contributions of participants at the conference AMSE 2019.

The book of abstracts gives a survey of all contributions planned to be delivered at the conference. Dear participants, I hope that each of you will find a contribution from your professional domain of interest that will inspire you in your further work.

Dear participants, I wish you a pleasant stay in the town Nižná in Orava, one of the nicest regions of Slovakia.

Rudolf Zimka
Chairman of the Scientific Committee

22nd International Scientific Conference

AMSE 2019

Applications of Mathematics and Statistics in Economics

28 August 2019 – 1 September 2019

Nižná, Slovakia

PURPOSE OF THE CONFERENCE

The conference aims to acquaint its participants with the latest mathematical and statistical methods that can be used in solving theoretical and practical problems and challenges of economics. The conference gives a unique chance to present research results achieved in the area where mathematics and statistics border with economics.

SECTIONS

- Macroeconomics, Public Economics & Methodological Issues of Economics
- Social Economics, Economic Sustainability & Demographic Economics
- Financial Markets, Risk Measurement & Insurance
- Microeconomic Issues
- Multidimensional Statistics in Economics

DEDICATION OF THE 22ND AMSE

- To the 100th anniversary of statistics in Czecho-Slovakia
- To honour professional activities of the Czech Statistical Office
- To honour professional activities of the Statistical Office of the Slovak Republic

SCIENTIFIC COMMITTEE

Prof. RNDr. Rudolf Zimka, CSc. (chairman)

Matej Bel University in Banská Bystrica, Slovakia

Prof. Ing. Emília Zimková, PhD.

Matej Bel University in Banská Bystrica, Slovakia

Prof. Ing. Richard Hindls, CSc., dr. h. c.

University of Economics in Prague, Czech Republic

Prof. Ing. Stanislava Hronová, CSc., dr. h. c.

University of Economics in Prague, Czech Republic

Dr hab. prof. UE Joanna Dębicka

Wrocław University of Economics, Poland

Prof. dr hab. Walenty Ostasiewicz

Wrocław University of Economics, Poland

Doc. Mgr. Ing. Martin Boďa, PhD.

Matej Bel University in Banská Bystrica, Slovakia

Ing. Kristýna Vltavská, Ph.D.

University of Economics in Prague, Czech Republic

Dr Beata Zmyślona

Wrocław University of Economics, Poland

ORGANIZING COMMITTEE

Ing. Peter Laco, PhD. (chairman)

Ing. Zuzana Rigová, PhD. (secretary)

Ing. Alena Kaščáková, PhD. (accommodation and budget manager)

Ing. Viera Mendelová, PhD. (conference proceedings administrator)

RNDr. Mária Grausová, PhD. (technical proceedings editor)

Ing. Petra Cisková (technical proceedings editor)

RNDr. Miroslav Hužvár, PhD. (social program organizer)

Ing. Igor Kollár, PhD. (webmaster)

PREVIOUS AMSE CONFERENCES

Year	Date	Place	Organizer
1998	3 – 4 Sep	Liptovský Trnovec	Matej Bel University in Banská Bystrica
1999	2 – 3 Sep	Liptovský Trnovec	Matej Bel University in Banská Bystrica
2000	31 Aug – 1 Sep	Poprad	Matej Bel University in Banská Bystrica
2001	13 – 14 Sep	Zadov	University of Economics in Prague
2002	4 – 7 Sep	Kudowa-Zdrój	Wrocław University of Economics
2003	4 – 5 Sep	Banská Bystrica	Matej Bel University in Banská Bystrica
2004	3 – 4 Sep	České Budějovice	University of Economics in Prague
2005	1 – 2 Sep	Wrocław	Wrocław University of Economics
2006	31 Aug – 1 Sep	Trutnov	University of Economics in Prague
2007	29 Aug – 1 Sep	Poprad	Matej Bel University in Banská Bystrica
2008	27 – 29 Aug	Wisła	Wrocław University of Economics
2009	27 – 28 Aug	Uherské Hradiště	University of Economics in Prague
2010	25 – 29 Aug	Demänovská Dolina	Matej Bel University in Banská Bystrica
2011	31 Aug – 3 Sep	Łądek-Zdrój	Wrocław University of Economics
2012	30 – 31 Aug	Liberec	University of Economics in Prague
2013	28 Aug – 1 Sep	Gerlachov	Matej Bel University in Banská Bystrica
2014	27 – 31 Aug	Jerzmanowice	Wrocław University of Economics
2015	2 – 6 Sep	Jindřichův Hradec	University of Economics in Prague
2016	31 Aug – 4 Sep	Banská Štiavnica	Matej Bel University in Banská Bystrica
2017	30 Aug – 3 Sep	Szklarska Poręba	Wrocław University of Economics
2018	29 Aug – 2 Sep	Kutná Hora	University of Economics in Prague

CONTENTS

FOREWORD	i
PURPOSE OF THE CONFERENCE	iii
SECTIONS	iii
DEDICATION	iii
SCIENTIFIC COMMITTEE	iv
ORGANIZING COMMITTEE	v
PREVIOUS AMSE CONFERENCES	vi
ABSTRACTS OF INVITED LECTURES	1
FRANTIŠEK BERNADIČ	
Statistics in Slovakia: History and the present time	2
MAREK ROJÍČEK	
Official statistics for evidence-based decision-making	3
ABSTRACTS OF PLENARY LECTURES	5
MIKULÁŠ LUPTÁČIK	
Efficiency vs. equity as a multi-objective optimization problem	6
EMMANUEL THANASSOULIS	
The use of data envelopment analysis in regulation	7
ABSTRACTS OF PRESENTATIONS	9
PETR BERKA, LUBOŠ MAREK, MICHAL VRABEC	
Modelling student dropout using statistical and data mining methods	10
MAREK BIERNACKI, WOJCIECH GUZEK	
Assessment of socio-economic development of selected European countries with the use of a modified HDI	11
DAGMAR BLATNÁ	
Time series analysis of the poverty rate for low-educated people in the Czech Republic, Slovakia and Poland over the period 2005 – 2017	12

MARTIN BOĎA, MARIANA POVAŽANOVÁ	
Validity of regional estimations of Okun's law	13
JANA CIBULKOVÁ, RICHARD NOVÁK, ZDENĚK ŠULC	
Multivariate methods for survey evaluation: A case study of Big Data and the New Digital Divide	14
PETRA CISKOVÁ, EMÍLIA ZIMKOVÁ, RUDOLF ZIMKA	
On dynamics of a two-country Kaldorian model of business cycles with fixed exchange rates: A case of Slovakia and the Czech Republic	15
ADAM ČABLA, FILIP HABARTA	
Distribution of the wealth of the richest persons in the world	16
MICHAL DEMETRIAN, RUDOLF ZIMKA	
On dynamics of a three-country model of business cycles with fixed exchange rates	17
DANIEL DUJAVA, RICHARD KALIŠ, MIKULÁŠ LUPTÁČIK	
Decomposition of potential gains from mergers: The harmony effect revealed	18
TOMÁŠ FIALA, JITKA LANGHAMROVÁ	
Differences in relative prospective age determined by cohort and period life tables	19
ALBERT GARDÓN	
Arguments for modification of the jump identification method in the jump-diffusive model	20
KATEŘINA GAWTHORPE, KAREL ŠAFR	
Maintaining the well-being of ageing population in Czechia .	21
MÁRIA GRAUSOVÁ, MIROSLAV HUŽVÁR	
Application of DEA to efficiency assessment of national health systems in European countries	22
MÁRIA GRAUSOVÁ, MIROSLAV HUŽVÁR, RUDOLF ZIMKA	
On dynamics in a four-dimensional model of a small open economy	23
STANISLAW HEILPERN	
Application of fuzzy random variables in insurance	24
PATRIK JANKOVIČ, EDUARD NEŽINSKÝ, MIKULÁŠ LUPTÁČIK	
Human capital accumulation, output growth and income distribution: A DEA-based decomposition	25
ALENA KAŠČÁKOVÁ, ZUZANA RIGOVÁ, KATARÍNA SÝKOROVÁ	
Efficiency of Slovak municipalities' expenditure on services for senior citizens	26
RADOSLAV KOVÁŘ, FILIP HABARTA, IVANA MALÁ, LUBOMÍR ŠTĚPÁNEK	
Joint modelling of risk of default and of early repayment	27

CYPRIAN KOZYRA	
Economic growth and income inequality: Panel regression models for Central and Eastern European countries	28
PAVOL KRÁL, PETER LACO	
Corporate website evaluation using partial least squares path modelling	29
JANA KRAMULOVÁ, JAKUB VINCENC, HELENA HOUŽVIČKOVÁ	
How to value equity in national accounts?	30
AGNIESZKA MARCINIUK	
Equity release contracts with varying payments	31
EDYTA MAZUREK, JOANNA DĘBICKA, KATARZYNA SZALONKA	
Correlation between lifestyle and health of people with disabilities	32
PETR MUSIL, JANA KRAMULOVÁ	
Development of regional price levels in the Czech Republic . .	33
EDUARD NEŽINSKÝ, MIKULÁŠ LUPTÁČIK	
Impact of automation on labour use: A decomposition approach	34
MARIANA POVAŽANOVÁ, JÁN KOLLÁR, MARIÁN KIKA, GABRIELA NEDELOVÁ	
Unpaid work performed by younger members of household up to 26 years in Slovakia	35
VERONIKA PTÁČKOVÁ , LUBOMÍR ŠTĚPÁNEK, VÍT HANZAL	
Is one time-series in the business tendency survey able to predict another one? Granger causality between time series	36
HANA ŘEZANKOVÁ, RICHARD NOVÁK	
Effect of ordinal variable transformations on hierarchical clustering results: A case study on the Big Data phenomenon	37
MÁRIA STACHOVÁ, PAVOL KRÁL	
Panel data clustering in financial distress prediction	38
KAREL ŠAFR, KRISTÝNA VLTAVSKÁ, JAKUB FISCHER	
Effects of structural changes in intermediate use on employment using the input-output analysis and the index theory	39
MARTINA ŠIMKOVÁ, JAROSLAV SIXTA	
Influence of population ageing on macroeconomic productivity	40
ANNA VALLUŠOVÁ, ŽANETA LACOVÁ	
Adding unpaid work value to income inequality measures in Slovakia	41
PROKOP ZÁVODSKÝ, ONDŘEJ ŠIMPACH	
Origin of the state statistical service in Czecho-Slovakia	42

BEATA ZMYŚLONA

Co-payment of patients for medical services: A survey for
the populace of Wrocław 43

AUTHOR INDEX 45

ABSTRACTS OF INVITED LECTURES

in alphabetical order
of the presenters

Statistics in Slovakia: History and the present time

František Bernadič

Statistical Office of the Slovak Republic, Slovakia

The presentation is focused on the main and most important milestones in the history of Slovak statistics, starting with the Austrian-Hungary monarchy, the first population census, which was done by means of statistical reconciliation already in the first half of the 18th century and continuing up to the key aspects of the present time. It concentrates on statistical peculiarities typical of the first Czecho-Slovak Republic and on World War II statistics, when Czech and Slovak statistics were developing independently. A significant part is devoted to the period of the centrally planned economy when statistics was reduced only to monitoring of the state plan's fulfilment. After changing the political system and introducing the market economy, together with the inception of the independent Slovak Republic in January 1993, a new concept of statistics was formed and the Statistical Office of the Slovak Republic started to act as a sovereign national body responsible for complete performance of state statistics in the Slovak Republic. The presentation also pays attention to other key moments such as the harmonisation of statistics within the framework the European Statistical System after joining the European Union and adopting the euro, and touches the current strategic priorities of the Statistical Office of the Slovak Republic.

Official statistics for evidence-based decision-making

Marek Rojíček

Czech Statistical Office, Czech Republic

The motto of modern management, at the level of both business and economic policy, is that you cannot manage what you cannot measure. This principle represents the essence of the modern evidence-based decision-making concept. The role of official statistics in this process as of the dashboard of economic and social development is undisputable. In order to be a reliable source of information for a decision-making process official statistics producers should be dependable, independent and trustworthy. Issues of trust in official statistics have been actively discussed over the last decades. The presentation will focus on the development of the concept of official statistics independence and will provide some reflections on the position of official statistics in the Czech Republic.

ABSTRACTS OF PLENARY LECTURES

in alphabetical order
of the presenters

Efficiency vs. equity as a multi-objective optimization problem

Mikuláš Luptáčík

Vienna University of Economics and Business, Institute for Macroeconomics,
Department of Economics, Austria

In recent years there has been increasing interest in the question of how inequality affects economic growth. This growing interest has recently stimulated new theoretical as well as empirical research. Some existing theoretical models propose that income inequality is detrimental to growth, but alternative theoretical models point to inequality as a determinant furthering economic growth. The main goal of this presentation is to provide deeper insights into the so-called efficiency-equity trade-off. Recently the Stiglitz report [Stiglitz, J. 2010. The Stiglitz report: Reforming the international monetary and financial systems in the wake of the global crisis. New York: New Press, 2010] revealed several limits of GDP as an indicator of economic performance and social progress and recommended to shift the emphasis towards measuring people's well-being. Following this recommendation we develop a new multiple criteria decision making model coupled with an extended Leontief input-output model taking into account the social dimension and obtain deeper insights into the so-called efficiency-equity trade-off. Using the Kuhn-Tucker conditions for a multi-objective mathematical programming problem the first qualitative results are presented.

The use of data envelopment analysis in regulation

Emmanuel Thanassoulis

Aston University in Birmingham, Aston Business School, Operations and Information Management Department, United Kingdom

Regulation of utilities such as water, energy, telecommunications has been instituted in order to simulate 'market' conditions in cases where such organisations have virtually monopoly power in relation to clients. There is a prevailing view that markets either do not exist or are not competitive enough in the case of utilities. Thus the regulator in essence is there to protect the consumer from excessive costs for the services provided by utilities. The need for utilities to make large capital-intensive infrastructure investments coupled with the absence of substitutes and inelastic demand tends to generate natural monopolies. Given this market structure, governments have set up regulatory systems in order to control prices and incentivise investment, continuity of supply and improvement in the quality of service. The regulatory systems have largely developed in tandem with the privatisation of previously publicly owned and managed utilities such as gas, electricity, water and telecommunications. The presentation will begin with a brief introduction to DEA as a general purpose method for assessing efficiency and productivity change over time. It will then outline how DEA has been integrated into regulatory systems. The talk will end with an extension of DEA to improve the incentives aspect of regulation.

ABSTRACTS OF PRESENTATIONS

in alphabetical order
according to the first author

Modelling student dropout using statistical and data mining methods

Petr Berka^{a,b}, Luboš Marek^c, Michal Vrabec^c

^aUniversity of Economics in Prague, Faculty of Informatics and Statistics,
Department of Information and Knowledge Engineering, Czech Republic

^bUniversity of Finance and Administration, Department of Computer Science and
Mathematics, Czech Republic

^cUniversity of Economics in Prague, Faculty of Informatics and Statistics,
Department of Statistics and Probability, Czech Republic

Not completing the study by a large portion of students is a serious problem at universities worldwide. Regardless of the country, numbers are very similar: about one-half of students who enrolled for the bachelor study leave university before obtaining the degree. To deal with this problem, we create models to distinguish between students who successfully completed their study and students who dropped out of university. Models created using traditional statistical analysis techniques (logistic regression) are compared with models created using data mining methods (decision trees, association rules). We use data about students who enrolled for their bachelor study at the University of Economics in Prague in the academic year 2013/2014 in our analysis.

Assessment of socio-economic development of selected European countries with the use of a modified HDI

Marek Biernacki, Wojciech Guzek

Wroclaw University of Economics, Faculty of Management, Computer Science and Finance, Department of Mathematics and Cybernetics, Poland

The aim of the paper is to analyse the socio-economic development of selected European countries represented by various social policies, and to verify the hypothesis of different speeds of development within the groups into which these countries divide. The following groups are considered in the analysis: Post-Communist countries (the Visegrad Group countries, Lithuania, Latvia, Slovenia and Estonia); Scandinavian countries (Denmark, Finland and Sweden); so-called welfare states and "Old Europe" countries (Germany, France, Spain and Italy along with Great Britain and Portugal); and "small but affluent" countries: (Austria, Switzerland and the Netherlands). For the measurement, a modified HDI index is employed, based on a number of sources, including the PISA (Program for International Student Assessment) assessment and the EHCI (Euro Health Consumer Index). The period of analysis covers the years 2006 – 2015. The analysis shows that GDP dynamics of Post-Communist countries is significantly higher than the other countries' dynamics. Dynamics of social development measured by HDI is also more rapid compared to the other groups. However, dynamics measured by the modified HDI does not give a clear indication. Affluent and large European countries are not those with the most prominent socio-economic development. Speaking the language of physics, these countries have a big momentum, equal to the product of mass and speed, compared to other European countries.

**Time series analysis
of the poverty rate for low-educated people
in the Czech Republic, Slovakia and Poland
over the period 2005 – 2017**

Dagmar Blatná

University of Economics in Prague, Faculty of Informatics and Statistics,
Department of Statistics and Probability, Czech Republic

The at-risk-of-poverty rate indicates the proportion of people with disposable income under the poverty threshold. The aim of the present study is to examine the development of the poverty rate indicator in the Czech Republic, Slovakia and Poland over the period 2005 – 2017 in the group of people with no better than lower secondary education. A comparison of the results shows that the lowest poverty rate throughout the period in question is recorded in the Czech Republic. The paper analyses multivariate stationary and non-stationary time series and estimates a regression relationship between the poverty rate and some relevant macroeconomic factors.

Validity of regional estimations of Okun's law

Martin Boďa^a, Mariana Považanová^b

^aMatej Bel University in Banská Bystrica, Faculty of Economics, Department of Quantitative Methods and Information Systems, Slovakia

^bMatej Bel University in Banská Bystrica, Faculty of Economics, Department of Economics, Slovakia

The presentation highlights the economic specification, and equally the statistical model under which Okun's law could be at the levels of geographic regions that form an economy. Whilst focusing upon the difference version of Okun's law only, the presentation demonstrates that if this empirical law is to hold on an economy-wide level, a completely different specification of Okunian equations must be undertaken for regions than is currently considered in research studied on the topic. This is a consequence of the standard aggregation problem that arises when an economy is split into regions, which necessitates a specific econometric approach to supply reliable estimates of Okunian equations compliant with the disaggregation model. The severity of the issue is demonstrated for regions of Italy.

Multivariate methods for survey evaluation: A case study of Big Data and the New Digital Divide

Jana Cibulková^a, Richard Novák^b, Zdeněk Šulc^a

^aUniversity of Economics in Prague, Faculty of Informatics and Statistics,
Department of Statistics and Probability, Czech Republic

^bUniversity of Economics in Prague, Faculty of Informatics and Statistics,
Department of Systems Analysis, Czech Republic

The paper evaluates the results of a survey regarding challenges connected to the Big Data phenomenon and the New Digital Divide. Following the authors' previous research, these challenges consist of issues such as business advantage, privacy intrusion, or big brother effect. Perception of these challenges by respondents (IT students and IT professionals) is studied in the paper, and multivariate methods are applied to the survey data to obtain a deeper insight and to discover hidden patterns in the data. The goal of the study is to identify groups of challenges based on respondents' judgment. For this purpose, cluster analysis and factor analysis are used. Results obtained using these methods are compared and evaluated.

On dynamics of a two-country Kaldorian model of business cycles with fixed exchange rates: A case of Slovakia and the Czech Republic

Petra Cisková^a, Emília Zimková^b, Rudolf Zimka^a

^aMatej Bel University in Banská Bystrica, Faculty of Economics, Department of Quantitative Methods and Information Systems, Slovakia

^bMatej Bel University in Banská Bystrica, Faculty of Economics, Department of Finance and Accounting, Slovakia

Asada set up a two-dimensional nonlinear model describing the dynamic interaction of two regions connected through inter-regional trade and inter-regional capital movements with fixed exchange rates. He investigated the question of the existence of a stationary point, its stability and instability and also indicated the existence of a bifurcation point, which in some cases gives rise to business cycles. Maličký and Zimka later analyzed rigorously the question of the existence of business cycles in Asada's model. In this paper, we apply Asada's model on conditions of Slovakia and the Czech Republic. On the basis of quarterly data for these countries spanning the period 2005 – 2018, the functions of consumption, investment, taxes, government expenditure and net export are constructed and supplied for the model. A stationary point is found and the conditions on parameters are established to guarantee the occurrence of business cycles.

Distribution of the wealth of the richest persons in the world

Adam Čabla, Filip Habarta

University of Economics in Prague, Faculty of Informatics and Statistics,
Department of Statistics and Probability, Czech Republic

The aim of this paper is to examine the probability distribution of wealth of the richest persons in the world based on estimates from the CEOWORLD magazine's rich list for March 2019. Since one can safely assume that there are a tiny number of people out of the whole world's population in this list, we basically deal with the very right tail of the wealth distribution, which should according to the Pickands-Balkema-de Haan theorem follow a generalized Pareto distribution. We discuss in this paper not only different estimates of this distribution with an emphasis on the shape parameter per se but also their behavior throughout bootstrap samples. Among the main findings is the observation based on the maximum to sum plot and parametric estimates that there is high probability of infinite variance. This could have a serious impact on estimates of inequality measures. The whole distribution follows nearly a Pareto distribution, whereas the very right tail is closer to an exponential. The bootstrap technique confirms that maximum likelihood estimates are almost normally distributed, but they overestimate variance. Estimates via the method of L-moments diverge from the normal distribution. The correlation of the parameter estimates is moderately negative, which is demonstrated in a simultaneous confidence region.

On dynamics of a three-country model of business cycles with fixed exchange rates

Michal Demetrian^a, Rudolf Zimka^b

^aComenius University in Bratislava, Faculty of Mathematics, Physics and Informatics, Department of Real Functions, Slovakia

^bMatej Bel University in Banská Bystrica, Faculty of Economics, Department of Quantitative Methods and Information Systems, Slovakia

In this paper, we construct and analyse a five-dimensional three-country model of business cycles with fixed exchange rates that describes the dynamic interaction of three countries connected through international trade and international capital movement. The model depicts the development of real national income and nominal money stock in the considered countries. An emphasis is put on the existence of a stationary point of the model and the existence of business cycles in its neighbourhood. Business cycles can arise in the case if Jacobian of the model has a pair of purely imaginary eigenvalues with others having negative real parts, which is guaranteed by Liu's criterion. Conditions on parameters of the model satisfying this criterion are found. The model is transformed to its normal form on center manifold. The bifurcation equation of the model, which gives full information on the existence of business cycles and their character, is derived and the formulae for the calculation of its coefficients are presented.

Decomposition of potential gains from mergers: The harmony effect revealed

Daniel Dujava^a, Richard Kališ^b, Mikuláš Luptáčik^c

^aUniversity of Economics in Bratislava, Faculty of National Economy, Department of Economic Theory, Slovakia

^bUniversity of Economics in Bratislava, Faculty of National Economy, Department of Economic Policy, Slovakia

^cVienna University of Economics and Business, Institute for Macroeconomics, Department of Economics, Austria

The existing model of potential gains from mergers provides a useful decomposition into technical, size and harmony effects. While the technical and size effects are well-understood, the interpretation of the harmony effect remains unclear. The paper provides an analytical insight into the above-mentioned decomposition. The Cobb-Douglas production function is used for an illustrative purpose. The harmony effect is expressed as a function of the relative difference in structures of the firms and of the relative difference in their size. These factors can play an important role and in some cases they can even outweigh a potential negative (positive) outcome of the merger due to decreasing (increasing) returns to scale. Furthermore, the sign of the harmony effect is not dependent on the specific form of the production function, but on its shape. For the case of concave production function the harmony effect can be proven to contribute in a positive sense to the gains from the merger. In the case of multiple inputs and multiple outputs potential effects are illustrated for the Slovak hospital sector and provide a detailed view into the reallocation process.

Differences in relative prospective age determined by cohort and period life tables

Tomáš Fiala, Jitka Langhamrová

University of Economics in Prague, Faculty of Informatics and Statistics,
Department of Demography, Czech Republic

Increasing the pension age above the usual threshold of 65 years is very often recommended to ensure financial sustainability of old-age pension systems, especially of those based on the PAYG principle. At the same time, a closer and clearer relation between the pension age threshold and the level of mortality is required. A possible way may be using the concept of so-called “relative” prospective age, which would ensure that the average proportion of the time of receiving an old-age pension to the total life span would remain approximately constant. It seems to be natural to determine the relative prospective age using not period, but cohort life tables. But cohort life tables are not as widely available as period ones. Moreover, it is proven that in some cases cohort and period prospective ages are almost identical. The paper presents a comparison of differences in retirement ages based on the relative prospective age concept derived by cohort life tables and by period ones separately for Czechia, Slovakia, Poland and Spain. Computations are based on the latest available Eurostat data and population projection.

Arguments for modification of the jump identification method in the jump-diffusive model

Albert Gardoń

Wrocław University of Economics, Faculty of Management, Computer Science and Finance, Department of Statistics, Poland

There are several methods for identification of jump returns when applying the jump-diffusive model to data. One of them is the so-called threshold method. It is based on the law of the iterated logarithm for the standard Brownian motion. Even though the method is formally proven to be convergent when the time discretization diameter tends to 0, it does not work satisfactorily in practice. Usually either all returns or none return are recognized as a jump. The paper sketches a possible explanation of the phenomenon, proposes a modification and discusses some arguments for the convergence of the modification presented.

Maintaining the well-being of ageing population in Czechia

Kateřina Gawthorpe^a, Karel Šafr^b

^aUniversity of Economics in Prague, Faculty of Business Administration,
Department of Managerial Economics, Czech Republic

^bUniversity of Economics in Prague, Faculty of Informatics and Statistics,
Department of Demography, Czech Republic

This study analyses the problem of ageing which is currently one of the biggest concerns for central authorities in the Czech Republic. The rapidly changing demographic structure has affected the fiscal policy framework. The focus here is on the economic impact of the ageing phenomenon with respect to the well-being of individuals in the Czech economy. The paper aims to reveal the size of technological progress but also government expenditures necessary to keep the current well-being unaltered to the dynamics of demographic prognosis. The applied method reposes upon a New Keynesian general equilibrium model. This model is disaggregated with the so-called bottom-up approach to capture the nuanced differences among three selected ageing cohorts.

Application of DEA to efficiency assessment of national health systems in European countries

Mária Grausová, Miroslav Hužvár

Matej Bel University in Banská Bystrica, Faculty of Economics, Department of Quantitative Methods and Information Systems, Slovakia

Besides natural heterogeneity of health systems, a crucial difficulty of their efficiency assessment lies in the fact that health outcomes are influenced by a large number of factors that are not under control of health systems and their impact may be rather different in individual countries. It implies that an assessment of health system efficiency should be considered in a wider socio-economic and environmental context. The paper provides an overview of different approaches to capture the production technology of health systems by DEA models that can be found in the literature. Based on a critical review of this research, a DEA model is designed to assess efficiency of national health systems of European countries.

On dynamics in a four-dimensional model of a small open economy

Mária Grausová, Miroslav Hužvár, Rudolf Zimka

Matej Bel University in Banská Bystrica, Faculty of Economics, Department of Quantitative Methods and Information Systems, Slovakia

In the paper, a four-dimensional nonlinear macroeconomic model of a small open economy describing the development of net real national income, real physical capital stock, nominal interest rate and nominal money stock is analysed. The functions of investment, savings, real income tax, liquidity preference and net exports that are included in the model are set up in accordance with economic theories. Therefore, the dependence of investments on net real national income is captured through an S-shaped curve, and the dependence of investments on nominal interest rate is modelled by an inverse of S-shaped curve. The Hopf bifurcation is applied to determine the bifurcation parameter of the model, to formulate the bifurcation equation, and to make a statement on the existence of business cycles.

Application of fuzzy random variables in insurance

Stanisław Heilpern

Wroclaw University of Economics, Faculty of Management, Computer Science and Finance, Department of Statistics, Poland

The paper is devoted to random variables with uncertain parameters. Such parameters are modelled by fuzzy numbers, and variables by fuzzy random variables. The paper presents uncertain versions of the exponential, Pareto, normal and binomial distributions, alongside some applications in insurance and finance. Among other things, the paper investigates a risk process in which claim and the inter-claim times are treated as fuzzy random variables and the fuzzy probability of ruin is computed for this process. Marriage insurance contracts are studied with these applications as well.

Human capital accumulation, output growth and income distribution: A DEA-based decomposition

Patrik Jankovič^a, Eduard Nežinský^a, Mikuláš Luptáčík^b

^aUniversity of Economics in Bratislava, Faculty of National Economy, Department of Economic Policy, Slovakia

^bVienna University of Economics and Business, Institute for Macroeconomics, Department of Economics, Austria

Impact of accumulation of human capital on economic growth has been intensively elaborated from both a theoretical and an empirical point of view. As shown by Galor and Moav, accumulation of physical and human capital is fundamentally asymmetric. With increasing income inequalities, the question of its implications for human capital accumulation arises. The newly available structured back-projected dataset on education attainment from Lutz et al. from 2007 allows analyses of changes in knowledge-intensive labour use in European countries and of its association with income inequality measured by Gini index. Modifying the methodology by Färe et al. from 2018 the paper decomposes human capital accumulation into factors capturing technical efficiency, technology change, input mix and output mix encompassing economic performance and income distribution.

Efficiency of Slovak municipalities' expenditure on services for senior citizens

Alena Kaščáková^a, Zuzana Rigová^a, Katarína Sýkorová^b

^aMatej Bel University in Banská Bystrica, Faculty of Economics, Department of Quantitative Methods and Information Systems, Slovakia

^bMatej Bel University in Banská Bystrica, Faculty of Economics, Department of Public Economics and Regional Development, Slovakia

Efficiency in using resources to achieve desired results at the lowest possible cost is not important only for profit-making subjects, but also for non-profit subjects. Economic efficiency of public administration is a permanent topic in Slovakia. Local self-government, represented by municipalities, is an important part of public administration and deals with questions of local importance. In the context of population ageing, the issue of funding care needs of the elderly is addressed in this paper. The paper describes and analyzes social-related expenditures in Slovakia, especially those for taking care of older people in municipalities. It studies the efficiency of Slovak municipalities in allocating financial resources to satisfy potential needs of their seniors by using appropriate mathematical and statistical methods.

Joint modelling of risk of default and of early repayment

Radoslav Kovář, Filip Habarta, Ivana Malá, Lubomír Štěpánek

University of Economics in Prague, Faculty of Informatics and Statistics,
Department of Statistics and Probability, Czech Republic

Credit scoring models often focus either on risk of default or on risk of early repayment. The paper presents several possibilities of modelling both events simultaneously and compares their performance. First, usual statistical measures of discrimination and calibration are extended from the binomial to the multinomial case. Losses resulting from both events are summarised in a utility function which also takes account of censored data. Second, the motivation is explained for comparing modelling frameworks of multinomial regression, parametric survival analysis and the mixture cure approach. Several analytical relations among these models are derived. Third, the methodology is applied on a publicly available loan dataset. After presenting the data, the respective performance of the models is assessed with regard to several criteria. Finally, a possibility of modelling the dependence between both events is demonstrated.

Economic growth and income inequality: Panel regression models for Central and Eastern European countries

Cyprian Kozyra

Wrocław University of Economics, Faculty of Management, Computer Science and Finance, Department of Statistics, Poland

The relationship between economic growth and inequality was expressed in 1950 for contemporary modern economy countries by Kuznets as follows: in the first stage of economic growth inequality grows, but in the next stage it decreases. Many Central and Eastern European (CEE) countries experienced this “Kuznets curve” after transition from a socialistic system, although some more-developed Western countries experienced “inverted Kuznets curve” at that time. The research hypothesis is that this process is similar in CEE countries, but the change point of Kuznets curve is different among countries, very often connected with the dating of entry to the European Union. This hypothesis is verified with panel regression models.

Corporate website evaluation using partial least squares path modelling

Pavol Král, Peter Laco

Matej Bel University in Banská Bystrica, Faculty of Economics, Department of Quantitative Methods and Information Systems, Slovakia

Almost all businesses and organizations use the World Wide Web in the form of corporate websites. In today's highly innovative and competitive environment, the level of corporate internet presentations is one of the key success factors. Approaches to corporate website evaluation are very variable. To the best knowledge of the authors, there is no universally accepted and recommended methodology of corporate website evaluation that could be, without any caveats, used in conditions of Slovak small and medium-sized enterprises. The aim of the paper is to fill this gap and propose a methodology tailored to evaluation of websites of Slovak small and medium-sized enterprises. The proposed methodology builds on the previous work of the authors and its core element is a model fitted using partial least squares path modeling.

How to value equity in national accounts?

Jana Kramulová^{a,b}, Jakub Vincenc^b, Helena Houžvičková^b

^aUniversity of Economics in Prague, Faculty of Informatics and Statistics, Department of Economic Statistics, Czech Republic

^bCzech Statistical Office, Financial Accounts Unit, Czech Republic

The objective of national accounts is to present a model of the real economy in the most accurate way. It means that not only officially recorded data from business accounting are included, but also model computations are used (e.g. in estimating the size of the shadow economy or correcting a phenomenon that may be biased in data sources). This is the reason why there sometimes exist vast differences between national accounts and business accounts. One of those most challenging fields is financial item AF.51, equity, whose valuation is considered differently in national and business accounts. Moreover, equity has close relationship with net worth of enterprises and this topic has recently been broadly discussed among national compilers. The aim of this paper is to show and compare possible methods of equity valuation and to emphasize its relationship to revaluation of non-financial assets made in national accounts under the ESA 2010 manual. The paper highlights the worldwide initiative of the Czech Statistical Office in the field of equity valuation that results in the proposal of a new methodology of equity valuation, with an effort to stir up a debate about this topic. It also makes a comparison of preliminary results in order to demonstrate potential changes in recognizing equity in national accounts.

Equity release contracts with varying payments

Agnieszka Marciniuk

Wrocław University of Economics, Faculty of Management, Computer Science and Finance, Department of Statistics, Poland

Equity release contracts allow property owners to receive a monthly benefit in exchange for surrendering their real estate to a company, established especially for this purpose. First of all, benefits depend on the future lifetime of spouses, the real value of properties and the rate of interest. These characteristics are not the same throughout years, therefore their changes should be included in the calculation of the benefit. Two other factors are the frequency of paying benefits and the need to valorise their amounts. The aim of the paper is to analyse varying payments of equity release contracts that have been in offer to clients in Poland for several years. Calculations are made on the basis of real Polish market data. Since the Solvency II directive requires the spot interest rate of the European Central Bank, the Svensson model is employed. In addition, the rate of return of equity release contracts is calculated.

Correlation between lifestyle and health of people with disabilities

Edyta Mazurek, Joanna Dębicka, Katarzyna Szalonka

Wroclaw University of Economics, Faculty of Management, Computer Science and Finance, Department of Statistics, Poland

According to the World Health Organization (WHO), health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. In contrast, lifestyle typically reflects an individual's attitudes towards the way of living and values, or the world outlook. It is thus defined as a specific set of behavioural traits that appear as differences in the functioning of households or people. Lifestyle includes day-to-day behaviour and functions of individuals at work, activities, entertainment and diet. According to the WHO, 60% of factors related to an individual's health and quality of life are correlated with his lifestyle. Therefore, lifestyle is an important factor of health that has a significant influence on the physical and mental health of a human being. The purpose of this study is to provide an answer to what extent the state of health affects lifestyle and whether lifestyle of disabled people depends on the type of dysfunction. The study is based on primary research using a face-to-face questionnaire technique carried out in 2014 – 2016 in Lower Silesia. Using statistical methods based on analysing structural diversity and similarity and on assessing correlation intensity, the conclusions are that physical, visual and psychological dysfunctions to a certain extent determine lifestyle in terms of spending free time (sport, culture) and in the area of interpersonal relations.

Development of regional price levels in the Czech Republic

Petr Musil^{a,b}, Jana Kramulová^{a,c}

^aUniversity of Economics in Prague, Faculty of Informatics and Statistics, Department of Economic Statistics, Czech Republic

^bCzech Statistical Office, Government and Financial Accounts Department, Czech Republic

^cCzech Statistical Office, Financial Accounts Unit, Czech Republic

Regional price levels attract attention of researchers as well as of general public due to the fact that regional price differences influence the interpretation of regional indicators. The current international approach reflects just price differences among countries, and regional disparities are excluded from the calculation. Official statistics is not able to capture them mainly due to the lack of detailed regional data sources. However, in several countries including the Czech Republic, researchers estimated regional price levels using various approaches. This activity has been widely appreciated and the results have been applied in wage analyses, doctoral theses, further research, etc. The research team of the University of Economics in Prague first developed the methodology and estimated regional price levels in the Czech Republic for the year 2007. The next estimate for the year 2012 considered changes brought by the new standard of national accounts, new methods of data collection, etc. The aim of this paper is to assess the ongoing applicability of the existing methodology and estimate regional price levels for the year 2017 in Czech NUTS 3 regions. The main contribution is to answer the demand for updated estimates. Longer time series permit analyzing changes in regional price levels and in the trends of real indicators that are adjusted to price levels. The analysis also provides a useful tool for the research community for assessing the convergence of Czech regions.

Impact of automation on labour use: A decomposition approach

Eduard Nežinský^a, Mikuláš Luptáčik^b

^aUniversity of Economics in Bratislava, Faculty of National Economy, Department of Economic Policy, Slovakia

^bVienna University of Economics and Business, Institute for Macroeconomics, Department of Economics, Austria

Automation has recently been in the focus of theoretical and empirical research. Empirical studies on the firm level show its positive effect on productivity. Besides that, automation is considered a driver of wage and income inequalities as well as of changes in the labour market. On the country level, the paper concentrates on determination of the effect of automation on labour use. Utilizing number of robots as an input in the production process and adopting the decomposition technique by Färe et al. from 2018 performance in two periods is decomposed to present the labour use ratio as a product of four terms attributable to changes in efficiency, technology, input mix as well as the output. As DEA models allow for multiple inputs and outputs, the methodology can be extended to technologies encompassing other aspects of welfare or input use such as ecological damage and income inequalities or digitalization.

Unpaid work performed by younger members of household up to 26 years in Slovakia

Mariana Považanová^a, Ján Kollár^a, Marián Kika^a, Gabriela Nedelová^b

^aMatej Bel University in Banská Bystrica, Faculty of Economics, Department of Economics, Slovakia

^bMatej Bel University in Banská Bystrica, Faculty of Economics, Department of Quantitative Methods and Information Systems, Slovakia

The paper deals with unpaid work in Slovak households whilst focusing upon unpaid work performed by younger members of the household. Studies of unpaid work of people up to 26 years is still not well documented in literature. The aim of this paper is twofold: First, it seeks to answer the question whether people with a lower-income status in Slovakia spend more time performing unpaid work in households in comparison to people with a higher-income status, and hence whether household income is an important determinant of unpaid housework performed by younger members of Slovak households. Second, the paper aims to determine also other factors that influence the volume of unpaid housework performed by younger members of Slovakia households. The results suggest that people in lower-income households in Slovakia spend more time in household labour than people in higher-income households. This applies to routine, non-routine as well as care household work. According to the results from a regression analysis, factors different from income are important determinants of household labour of younger members of Slovak households.

Is one time-series in the business tendency survey able to predict another one?

Granger causality between time series

Veronika Ptáčková^{a,b}, Lubomír Štěpánek^c, Vít Hanzal^c

^aUniversity of Economics in Prague, Faculty of Informatics and Statistics, Department of Economic Statistics, Czech Republic

^bCzech Statistical Office, Department of Business Tendency Survey, Czech Republic

^cUniversity of Economics in Prague, Faculty of Informatics and Statistics, Department of Statistics and Probability, Czech Republic

A Business Tendency Survey (BTS) is one of popular instruments used for providing rough forecasts of future conditions of the national economy. Economists, journalists and analysts are not the only ones interested in the future development of the economy; ordinary citizens are also attentive to such forecasts. The Czech Statistical Office publishes results of the BTS in two forms: balance, and basic indices, respectively. The paper focuses on the base of basic indices, and investigates why the base is different for different European countries and protracts attention to a related question whether a point estimate such as a base year or long-term average is suitable for the Czech Republic. The aim of the paper is to find the most suitable base for the Czech Republic in terms of getting the tightest match between the obtained and predicted values of economic indicators. Findings from this study should be important for obtaining better predictions and enhancing capabilities of the BTS.

**Effect of ordinal variable transformations
on hierarchical clustering results:
A case study on the Big Data phenomenon**

Hana Řezanková^a, Richard Novák^b

^aUniversity of Economics in Prague, Faculty of Informatics and Statistics,
Department of Statistics and Probability, Czech Republic

^bUniversity of Economics in Prague, Faculty of Informatics and Statistics,
Department of Systems Analysis, Czech Republic

The aim of the paper is to show some possible transformations of ordinal variables in cluster analysis and discuss their effect on hierarchical clustering results. Although several papers comparing different approaches to clustering objects characterized by ordinal variables have been published, the comparisons are not complete and include also variables other than ordinal variables (e.g. nominal variables). The following possibilities are considered in this paper to capture ordinal variables in clustering: “original” values (from one to the number of categories), standardized values, transformed values based on the range, ranks of the original values (averaged in case of ties), standardized ranks, and transformed ranks based on the range (usually recommended). The results of the complete linkage method obtained by the Manhattan and Euclidean distances for different numbers of clusters are compared. Moreover, these results are compared with the results obtained by the TwoStep algorithm. The case study is based on the answers of 481 respondents concerning the awareness of problems related to the “Big Data phenomenon” and “New Digital Divide”.

Panel data clustering in financial distress prediction

Mária Stachová, Pavol Král

Matej Bel University in Banská Bystrica, Faculty of Economics, Department of Quantitative Methods and Information Systems, Slovakia

In general, financial distress is the financial state of an enterprise in which the enterprise cannot pay financial obligations or satisfies them with difficulty. Quite often it is assumed that being in financial distress is a dichotomous variable, e.g. an enterprise could expect future financial distress, or not. Alternatively, various severity levels of financial distress can be distinguished. Regardless of the definition, when building a predictive model to forecast the future financial status of an enterprise, an (implicit) assumption is usually used that it could be done using various pieces of information encoded in the past or current values of financial indicators. The paper focuses on identification how trends in various financial indicators can help to predict future financial status. The goal of the paper is to identify typical patterns in trajectories of financial indicators over time that could determine, via cluster analysis, whether a company tends to be in financial distress, or not, and also possibly the severity of this state. Such patterns can be then used to refine the definition of financial distress. For instance, they could indicate that using a dichotomous variable to label financially distressed enterprises is too restrictive for a problem at hand, or, on the contrary, that the assumption about various severity levels of financial distress is unsupported by data. The data set used comprises financial indicators of Slovak enterprises collected over several consecutive years and trajectories of financial indicators are clustered using three clustering methods applicable to panel data, namely model-based partitioning, K-means clustering and novel, two-step feature-based clustering method designed for micro panel partitioning.

**Effects of structural changes
in intermediate use on employment
using the input-output analysis and the index theory**

Karel Šafr, Kristýna Vltavská, Jakub Fischer

University of Economics in Prague, Faculty of Informatics and Statistics,
Department of Economic Statistics, Czech Republic

The aim of this paper is to investigate the effect of structural changes in intermediate use on employment in the Czech economy. We combine the input-output analysis with the index theory. For the analysis, we use input-output and employment data for the period between the years 2005 and 2015. We focus on the strength of the relationship between final use and employment through intermediate use and analyze how structural changes in intermediate use affect it. The results show that the structure of employment did not rapidly change and did not affect this relationship. However, changes in the structure of intermediate use have a significant effect on the relationship between consumption of national goods and Czech employment. We can state that Czech industries changed their intermediate consumption from goods that are highly dependent on employment to goods that are less dependent. This effect can be caused by the increasing price of manpower over time.

Influence of population ageing on macroeconomic productivity

Martina Šimková^a, Jaroslav Sixta^b

^aUniversity of Economics in Prague, Faculty of Informatics and Statistics,
Department of Demography, Czech Republic

^bUniversity of Economics in Prague, Faculty of Informatics and Statistics,
Department of Economic Statistics, Czech Republic

Labour force of all European countries is ageing and this natural demographic process has its own consequences on economic output and productivity. This issue has been widely discussed in Western countries for several years, but a deep economic and social discussion is still absent in the Czech Republic. The paper studies the impact of ageing on the level of income of workers stratified by age, level of education or industry. The most challenging issue is the decomposition of growth into a general increase in productivity, the effect specific to a particular industry, and the effect of demographic ageing. All these effects have affected the development of Czech labour force in the last decade. The data for the analysis are sourced from the Labour Force Survey and Average Earnings Information System maintained by the Czech Statistical Office and are combined with national accounts figures. Specifics of the Labour Force Survey are taken into account, and data are transformed to be consistent with the methodology of contemporary macroeconomic indicators.

Adding unpaid work value to income inequality measures in Slovakia

Anna Vallušová, Žaneta Lacová

Matej Bel University in Banská Bystrica, Faculty of Economics, Department of Economics, Slovakia

Income inequality represents one of the central issues that are widely discussed by present-day economists. In Slovakia, significant income inequality linked to disparities between regions persists. The central aim of our paper is to offer an alternative insight into the issue of income inequality measurement by adjusting indicators of household income by the value of households' unpaid work. Our analysis combines data about Slovak households from the Luxembourg Income Study and from an original unpaid work study in Slovakia. Traditional inequality measures (Gini coefficient, Atkinson index and percentile ratios) are applied at the regional level. Our results show that income inequality and regional disparities measures become more favourable after incorporating the value of work done by households. Thus, a need to recognise the value of unpaid work in national accounting systems and in economic policy actions is underlined.

Origin of the state statistical service in Czecho-Slovakia

Prokop Závodský, Ondřej Šimpach

University of Economics in Prague, Faculty of Informatics and Statistics,
Department of Statistics and Probability, Czech Republic

This paper is dedicated to the 100th anniversary of establishing the State Statistical Office (an ancestor of today's Czech and Slovak statistical offices) in 1919. The paper first describes troubles with organization of the statistical service in Austria-Hungary where the Austrian and Hungarian parts of the monarchy had separate statistical services with different leaderships. In addition, separate land statistical offices with limited competencies operated in the lands of Cisleithanian. The paper also deals with preparations of the framework established by the Statistical Act, adopted in Czecho-Slovakia in January 1919, depicts lengthy negotiations concerning specifics of this law throughout the year 1919 and points out gradual development of the work of the State Statistical Office over 1919 – 1921.

Co-payment of patients for medical services: A survey for the populace of Wrocław

Beata Zmysłona

Wrocław University of Economics, Faculty of Management, Computer Science and Finance, Department of Statistics, Poland

Contemporary societies in many countries are affected by problems of an aging society and civilization diseases associated with higher age. Even the richest countries have problems with financing health care due to the growing demand for health services. Development of modern technologies in medicine also has an influence on the increase of treatment costs. Providing high-level medical services requires an introduction of mechanisms that allow patients to participate in financing treatment costs. An effective implementation of co-financing mechanisms requires social campaigns that are aimed at convincing the public to take responsibility for costs incurred in medical care. The study presents results of an empirical research on the attitude of Wrocław residents regarding co-payment for medical services. The goal of the research is to determine the features that affect the propensity to co-pay. Demographic characteristics such as age, gender, parents' education, number of children, material situation are taken into account together with attitudes towards health and illness.

AUTHOR INDEX

- Berka, Petr, 10
Bernadič, František, 2
Biernacki, Marek, 11
Blatná, Dagmar, 12
Boda, Martin, 13
- Cibulková, Jana, 14
Cisková, Petra, 15
Čabla, Adam, 16
- Dębicka, Joanna, 32
Demetrián, Michal, 17
Dujava, Daniel, 18
- Fiala, Tomáš, 19
Fischer, Jakub, 39
- Gardoń, Albert, 20
Gawthorpe, Kateřina, 21
Grausová, Mária, 22, 23
Guzek, Wojciech, 11
- Habarta, Filip, 16, 27
Hanzal, Vít, 36
Heilpern, Stanisław, 24
Houžvičková, Helena, 30
Hužvár, Miroslav, 22, 23
- Jankovič, Patrik, 25
- Kališ, Richard, 18
Kaščíková, Alena, 26
Kika, Marián, 35
Kollár, Ján, 35
Kovář, Radoslav, 27
Kozyra, Cyprian, 28
Král, Pavol, 29, 38
Kramulová, Jana, 30, 33
- Lacová, Žaneta, 41
Laco, Peter, 29
- Langhamrová, Jitka, 19
Luptáčik, Mikuláš, 6, 18, 25, 34
- Malá, Ivana, 27
Marciniuk, Agnieszka, 31
Marek, Luboš, 10
Mazurek, Edyta, 32
Musil, Petr, 33
- Nežinský, Eduard, 25, 34
Nedelová, Gabriela, 35
Novák, Richard, 14, 37
- Považanová, Mariana, 13, 35
Ptáčková, Veronika, 36
- Rigová, Zuzana, 26
Rojíček, Marek, 3
Řezanková, Hana, 37
- Sixta, Jaroslav, 40
Stachová, Mária, 38
Sýkorová, Katarína, 26
Szalonka, Katarzyna, 32
Šafr, Karel, 21, 39
Šimková, Martina, 40
Šimpach, Ondřej, 42
Štěpánek, Lubomír, 27, 36
Šulc, Zdeněk, 14
- Thanassoulis, Emmanuel, 7
- Vallušová, Anna, 41
Vincenc, Jakub, 30
Vltavská, Kristýna, 39
Vrabec, Michal, 10
- Závodský, Prokop, 42
Zimka, Rudolf, 15, 17, 23
Zimková, Emília, 15
Zmyslona, Beata, 43

Editors: Mária Grausová, Martin Boďa
Title: Book of abstracts of the 22nd AMSE – Applications
of Mathematics and Statistics in Economics 2019
Organizers: Matej Bel University in Banská Bystrica, Faculty of
Economics, Slovakia
Wrocław University of Economics, Faculty of
Management, Computer Science and Finance,
Poland
University of Economics in Prague, Faculty of
Informatics and Statistics, Czech Republic
Number of pages: 60
Number of copies: 100
Publisher: Občianske združenie Financ, Banská Bystrica,
Slovakia

