PROCEEDINGS

works of the participants of the scientific seminar
of doctoral studies
Faculty of Informatics and Statistics
Prague University of Economics and Business

Abstracts

The scientific seminar took place on 31 January 2024
under the auspices of the Dean of FIS
prof. Ing. Jakub Fischer, Ph.D.
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Compilation of the proceedings
Mgr. Lea Nedomová

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Preface

As it is a long tradition at the Faculty of Informatics and Statistics of the University of Economics in Prague, the seminar "Doctoral Students' Day" took place this year as well. This year it was the twenty-ninth edition. The seminar was held on 31 January 2024 under the auspices of the Dean of the Faculty of Informatics and Statistics prof. Ing. Jakub Fischer, Ph.D.

The seminar was attended by a total of 14 FIS PhD students. The program of the meeting was enriched by the presentation of Mr. Zekeri Adams, a PhD student of Comenius University in Bratislava, who is currently on a fellowship at FIS. This year, the contributions of the registered participants from all doctoral study programmes were divided into two sections - Applied Computer Science and Quantitative Methods - Econometrics and Operations Research and Statistics.

An integral part of the "Doctoral Students' Day" is the work of the evaluation committees, whose members carefully monitor individual presentations and then select the best papers for awards. The main criteria for their evaluation were mainly the quality and topicality of the topic, the approach to solving the selected problem, the way of applying the methodology, the level of work with real data and, last but not least, the ability to present and argue their results in the discussion. The best participants are awarded the prestigious "FIS Dean's Award", which also includes a symbolic financial reward. I would like to thank all its members for their work in the evaluation committee of the study programme Applied Informatics - prof. Ing. Vojtěch Svátek, Dr. (KIZI), Ph.Dr. Jan, Černý Ph.D. (KIT) and Mgr. et Mgr. Ing. František Sudzin, Ph.D. (KSA). For the work in the evaluation committee for Quantitative Methods, common for the study programmes Econometrics and Operations Research and Statistics, I would like to thank prof. Ing. Josef Jablonský, CSc. (KEKO), prof. Ing. Hana Řezanková, CSc. (KSTP) and prof. RNDr. Ing. Michal Černý. PhD. Both committees did their work and tasks very well.

This year the following students received prizes for the best papers:

Study Programme - Applied Informatics
1st place: Ing. Peter Vajdečka: Enhancing of LLMs in Generating Abstracts and Titles within the Research Domain
2nd place: Ing. Karel Maršálek: Designing a test for measuring digital literacy in companies
3. place: Ing. Adam Krbušek: Towards a Comprehensive Taxonomy of Frameworks and Methodologies Used in Software Product Management

Study Programs - Econometrics and Operations Research and Statistics
1st place: Ing. Jindřich Lacko: Comparing Physical and Socioeconomic Drivers of EV Adoption in Czechia
2nd place: Ing. Jakub Neugebauer: Portfolio optimization under stochastic dominance constraints: non-parametric stochastic dominance test statistic approach
3rd place: Ing. Tereza Frömmelová: Gender Dynamics in Czechia Household Fertility: Logistic Regression insight

I sincerely congratulate the awarded PhD students and I firmly believe that they will apply the acquired skills and experience in their further, especially scientific work. I would also like to acknowledge all the scientific and pedagogical staff of FIS - supervisors of PhD students, who participated in the "PhD Students' Day" and were helpful with their guidance and advice in the preparation of papers and their presentations. Special thanks go to the study officer of the doctoral degree, Mrs. Ing. Tereza Krajíčková, DiS, thanks to whom the seminar was excellently organized, Mrs. Ilona Polanecká for administrative support of the event and Mgr. Lee Nedomová for her work in editing and compiling this abstract book.

prof. Ing. Petr Doucek, CSc.

Vice Dean for Creative Activities and International Relations

STUDY PROGRAM
APPLIED INFORMATICS

Reasoning in Ontological Meta-Modeling and Higher-Order Description Logics

Zekeri Adams

zekeri.adams@fmph.uniba.sk

Ph.D. student of Applied Informatics, UK Bratislava, Slovakia

Supervisor: doc. RNDr. Martin Homola, PhD., Slovakia (homola@fmph.uniba.sk)

Metamodeling allows us to represent universal entities (such as concepts and roles) as if they were individuals. This proves useful in complex domains with a multitude of universal entities, where further categorization into meta concepts and the use of meta roles help express relationships among them. Drawing an analogy to biological taxonomy, organisms are classified into taxa, where giraffes, for instance, are categorized as the species G. camelopardalis. An example involves a well-known preserved specimen of a giraffe named Zarafa: Zarafa: G. camelopardalis. Giraffes are part of larger taxa, such as G. camelopardalis Giraffa, and in turn, Giraffa Giraffidae. Biological taxonomy is inherently complex, requiring the sorting of taxa into a hierarchy of ranks. In a Description Logic (DL)-like syntax, we can represent this hierarchy as follows: G. camelopardalis: Species, Giraffa: Genus, and Giraffidae: Family. All taxa belong to the concept Taxon (e.g., G. camelopardalis: Taxon), and all ranks are classified into the concept Rank (e.g., Species: Rank).

This capability of classification of concepts into “meta-concepts” and roles into “meta-roles” proves valuable in modelling complex domains or when reasoning about ontology entities to verify methodological constraints. However, many proposed

metamodeling languages lack the ability to model instantiation and subsumption (that is, the relationship between an instance and the concept to which it belongs and the relationship between a class whose instances are contained in another class).

In our investigation, we explore a variant of higher-order description logics that integrates several desired metamodeling features, comprising: (a) a fixedly interpreted instanceOf role that establishes connections between instances and their concepts, providing flexibility in modelling; (b) a fixedly interpreted Subclassof role that establishes relationship between two classes where the instances of one are contained in the other instances ;(c)promiscuous concepts that can have individuals, other concepts, and roles as instances simultaneously; and (d) strictly typed concepts that permit only a specific type of instances. We investigate the decidability of expressive fragments of the higher order DL, SROIQ for set theoretical subsumption of all concepts through reduction and other techniques.

Keywords: description logics, higher-order logics, ontology, meta-modeling, constraints, reasoning

JEL Classification: C60

Detecting the path of the zero-day attack against AI algorithms

Marie Kovářová

marie.kovarova@vse.cz

Ph.D. student of Applied Informatics

Supervisor: doc. Ing. Miloš Maryška, Ph.D.,
(milos.maryska@vse.cz)

This article provides a comprehensive analysis of zero-day attacks in the context of ML and DL, exploring their nature, impact, and emerging strategies for mitigation. In the rapidly evolving field of Machine Learning (ML) and Deep Learning (DL), the advent of zero-day attacks presents a formidable challenge. These attacks exploit unknown vulnerabilities, posing a threat not only to network infrastructures but also directly to ML/DL algorithms.

The concept of a zero-day attack is first delineated, underlining the urgency and unpredictability associated with these threats. The article highlights how such attacks occur when hackers discover and exploit vulnerabilities before developers have a chance to address them. The discussion then pivots to the implications of these attacks on ML/DL algorithms, emphasizing the dual necessity of protecting both the network infrastructure and the algorithms themselves.

In an insightful exploration, various forms of zero-day attacks are examined. This includes data poisoning attacks, where malicious data compromises the integrity of learning models, adversarial input attacks, which deceive models through manipulated inputs, and model stealing techniques, posing threats to the intellectual property inherent in ML/DL models. Each of these attack types is discussed in depth, drawing on recent research and real-world examples.

To address these challenges, the article reviews and proposes several defensive strategies. These include anomaly detection techniques to identify suspicious patterns indicative of an attack, rigorous model verification and validation protocols to ensure the ongoing integrity of ML/DL algorithms, and the implementation of federated learning and differential privacy to enhance data security during the model training process.

Methodologically, the article employs a comprehensive literature review, qualitative research, discourse analysis, simulations, and experimental approaches. The literature review provides a thorough background on the current state of knowledge regarding zero-day attacks, their types, and their impact on ML/DL systems.

Qualitative research approaches and discourse analysis forms the basis of article, focusing on understanding how attackers manipulate ML/DL models and the impact of these manipulations. It involves analyzing the discourse to understand the intersection of various themes and practices related to cyber threats in ML/DL.

Through experiments and simulations, the thesis demonstrates the practical implications of these attacks in controlled environments, providing insights into their mechanics and potential damage. Experimental approaches are used to evaluate the effectiveness of various defense strategies. This includes testing anomaly detection techniques to identify suspicious patterns, verifying and validating ML/DL models to ensure their integrity, and implementing federated learning and differential privacy to secure data during model training.

The expected results to be achieved from these methods will indicate a range of effective strategies for mitigating the risks posed by zero-day attacks. The current findings suggest that a multi-layered defense approach, combining proactive detection and robust model validation, alongside advanced data security practices, is essential for protecting ML/DL systems.

This article contributes to a greater understanding of the security challenges in the ML/DL landscape. It underscores the necessity

for continued research and development of advanced protective measures against zero-day attacks. As ML/DL technologies increasingly integrate into various domains, the provided insights are crucial for developing more resilient and secure AI systems.

Keywords: Zero-Day Attacks, Machine Learning, Deep Learning, Cybersecurity, Data Poisoning, Adversarial Attacks, Model Stealing

JEL Classification: C45, C88, K42

Towards a Comprehensive Taxonomy of Frameworks and Methodologies Used in Software Product Management

Adam Krbušek
adam.krbusek@vse.cz
Ph.D. student of Applied Informatics
Supervisor: prof. Ing. Alena Buchalcevová, Ph.D.
(alena.buchalcevova@vse.cz)

Software Product Management is a strategic discipline that plays a crucial role in a software product's short-term success and long-term viability. Numerous observations indicate that the competence and skills of Product Managers often determine whether a company introducing software products to the market will eventually succeed or fail. To help Product Managers in their roles, various frameworks and methodologies have emerged from within the software product management domain. This paper aims to identify, analyze, and categorize the frameworks and methodologies used in Software Product Management to develop a comprehensive taxonomy. Using a Systematic Mapping Study, 57 relevant researched papers were identified and reviewed. One hundred and three distinct frameworks and methodologies were identified that were then analyzed using Thematic Analysis. As a result, 27 granular activities performed by Software Product Managers were defined. Drawing on the previous work of authors who conducted complementary research, the granular activities have been grouped into eight sub-categories and three core categories. These were subsequently organized in a hierarchical tree structure to present the proposed taxonomy. The findings reveal a diverse array of frameworks and methodologies, in which

the most supported activities were Roadmapping, Product Requirements Engineering, and Product Development.

Keywords: Software Product Management, Product Manager, Framework, Methodology, Taxonomy, Systematic Mapping Study

JEL Classification: M12, M15, C02, C61, O32

Designing a test for measuring digital literacy in companies

Karel Maršálek

karel.marsalek@vse.cz

Ph.D. student of Applied Informatics

Supervisor: doc. Ing. Ota Novotný, Ph.D.
(ota.novotny@vse.cz)

In today's digital age, digital transformation has become an indispensable requirement for numerous companies in order to stay competitive. The effectiveness and overall outcome of such transformation processes heavily depends on various key factors, with the digital literacy of employees being a crucial one. To ensure a sufficient level of digital literacy of their employees, however, companies first need to be able to effectively and reliably measure the employees' current level of digital literacy. This paper, therefore, highlights the importance of measuring the digital capabilities within companies and outlines the design of a test for its measurement. Although multiple frameworks and models for digital literacy assessment have already been designed, they often fall short in addressing the unique needs of a company setting. Additionally, although these frameworks and models provide a decent basis for grasping individual competencies and breaking them down into more manageable components, their assessment tools are – in general – rather superficial and insufficient for a reliable assessment of a person's digital literacy. This paper builds on the basis of these frameworks, mainly the European Commission's DigComp 2.2. Each competence in DigComp is assessed for its relevance to companies, which serves to narrow down its overall scope. The relevant competencies are then broken down into specific skills and knowledge examples, which are then translated into test questions. The next step is to finalize the test

scope and to perform qualitative and quantitative validation of the designed test.

Keywords: Digital literacy, Digital competencies, Digital transformation, DigComp

JEL Classification: M53, O31

Implementation of Barcode Medication Administration in Hospitals

Kateřina Švandová

svak01@vse.cz

Ph.D. student of Applied Informatics

Supervisor: doc. Ing. Mgr. Zdeněk Smutný, Ph.D.,
(zdenek.smutny@vse.cz)

Healthcare facilities have long focused on improving the safety of providing care using information technology. Current hospital medication administration practices are based on five principles: giving the right drug to the right patient in the right dose by the right route at the right time. These principles are reflected in relevant hospital processes that directly or indirectly ensure the administration of medicines to patients. Due to (financial and technological) affordability, barcodes are most commonly used for labelling and related Barcode Medication Administration (BCMA) processes. The main expected effect of the introduction of BCMA is to reduce medication errors and healthcare costs. To successfully implement BCMA and achieve the expected results, prior identification of constraints, barriers to BCMA implementation, and subsequent preparation including, for example, process redesign, preparation of a database for master data, and ensuring of drug labelling within internal logistics is necessary. However, as some previous studies have shown, postimplementation evaluation and addressing gaps in the BCMA process is also important. These include non-compliance with designed processes, unwanted workarounds and their resolution. An example is the use of Bluetooth Low Energy to verify the physical proximity of a patient while scanning his/her barcode, where completing the scan during BCMA is only possible if the server assesses the correctness of the location based on the localization.

This paper focuses on identifying the limitations and barriers to the use of BCMA in hospitals and provides an overview of the current state of research on the implementation and post-implementation phases. The presented review is conducted according to PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. The findings from this overview will subsequently be used as a basis for the preparation of individual parts of the draft methodology for the gradual implementation of the tracking and recording of medicines and medical devices, which will support the development of the digitalization of healthcare in the context of Czech hospitals. The result is an overview of workarounds and deviations from the BCMA process, their causes and consequences, including a proposal of possible solutions. The types of unwanted workarounds and their frequency also vary, for example, depending on other technologies used. BCMA can be affected by the use of Computer on Wheels, Automated Dispensing Cabinets or closed-loop Electronic Medication Management Systems. Elimination or reduction of unauthorized BCMA process steps, omission of process steps can be achieved by replacing barcodes with another technology, such as Radio frequency identification tags or Ultra-wideband tags.

Keywords: medication administration error, safety, barcode scanning, electronic health solutions, nurses' workflow, BCMA, RFID, UWB

JEL Classification: I18, L15

Enhancing of LLMs in Generating Abstracts and Titles within the Research Domain

Peter Vajdečka

vajp02@vse.cz

Ph.D. student of Applied Informatics

Supervisor: prof. Ing. Vojtěch Svátek, Dr. (svatek@vse.cz)

In this comprehensive study, we explore advanced methodologies for enhancing language model capabilities in generating academic abstracts and titles. Our focus lies in two distinct areas: firstly, the strategic modulation of stylistic elements in text generation to align with specific author styles, and secondly, the innovative combination of SciBert and linguistic rules to improve the quality of academic title generation from abstracts.

In addressing the challenge of opaque natural language generation systems for users without specialized linguistic expertise, first study proposes an advanced approach for controlled text generation. This research emphasizes the strategic modulation of stylistic elements in generated texts. We innovatively utilize a concatenation of quantitative-stylistic metrics, indicative of diverse stylistic features, extracted from texts authored by the targeted individual. These metrics are integrated into the input of our NLG model, thereby decreasing diversity between the model-generated output and the target text. The methodology presented herein not only surpasses existing baselines in aligning stylistic attributes but also marks a significant advancement in reconciling the intricacies of explainable AI with the general absence of specialized linguistic knowledge. Our proposed method successfully improves this alignment, surpassing the baseline, and represents a promising first step towards striking a balance between explainable AI and lack of specialized knowledge

Second study addresses the challenge of generating academic titles from paper abstracts as a high-level text summarization problem. We propose a novel post-processing method combining a predictive model with linguistic rules to improve title generation quality. After evaluating three Natural Language Generation models (BART, T5, Flan T5) and identifying the most effective model, we configure it to produce varied titles. Experimenting with different post-processing strategies involving SciBERT and linguistic rules, we select the best title from machine-generated options. Our methods, assessed against human evaluations, show significant advancements in academic title generation.

Keywords: NLG, LLMs, Transformers, Controlled Text Generation, Text Summarization, Title Generation, Abstract Generation, T5, SciBERT

JEL Classification: C5, C8

STUDY PROGRAM ECONOMETRICS AND OPERATIONS RESEARCH

Predictive analysis of sports data

Jakub Hruška

Hruj04@vse.cz

Ph.D. student of Econometrics and Operations Research

Supervisor: doc. Ing. Jan Zouhar, Ph.D., (zouharj@vse.cz)

This work deals with the prediction of match winners based on the statistics from previous matches, namely hockey NHL and ELH, and football FNL, Premier League, Serie A, La Liga and Ligue 1. The variables entering the model for predicting winners consist of historical statistics before the match and information that the bettor sees before the match starts. Using different variations of the XGBoost and Logistic Regression models and then evaluating them and describing the differences between the accuracy of the models across leagues/sports. Subsequently, and thanks to historical information on the odds for a given match, the thesis tries to answer the question whether betting according to the predictions of the established models is a profitable activity in the long run. Or whether there is a particular strategy in betting where betting would be profitable. Then this thesis deals with the evaluation of these strategies based on the identified criteria, thus the output of this part of the thesis is the top 10 strategies that a bettor should follow when betting.

Keywords: XGBoost, Logistic Regression, Bets, Prediction, Sport

JEL Classification: C51, C52, C53

Reasons to Precommit: A Unifying Framework of the Stackleberg model

Petr Krautwurm

Petr.krautwurm@vse.cz

Ph.D. student of Econometrics and Operations Research

Supervisor: prof. RNDr. Ing. Michal Černý, Ph.D., (cernym@vse.cz)

This article proposes an innovative, unifying framework of the Stackleberg model, adjusted for path dependency, to encapsulate the mathematical reality of precommitments. The article proposes a novel classification of consumer attitudes in regard of precommitments. It discusses, how altruism, malevolence, or selfishness toward future selves can affect the consumer's reasons to precommit. Two important reasons to precommit are introduced. First reason is characterized as precommitments against adverse preferences, which stems from a traditional motivation of disrespect toward preferences of subsequent selves. Second reason is characterized as precommitments against adverse path dependency, and stems from less examined motivation to avoid uncertainty about consequences of one's own actions. It is proven that both reasons can be described by indistinguishable models and lead to the same results. The article illustrates each of these insights mathematically. Furthermore, it establishes that current models of precommitments are, in fact, subsets of this unifying framework of the Stackleberg model. The article proceeds to analyze various scenarios involving diverse consumer attitudes towards their future selves, exploring the conditions that prompt or dissuade consumers from precommitting. The article concludes with an analysis of the implications of these precommitment incentives on the broader understanding of consumer behavior.

Keywords: Precommitments, Path dependency, Stackleberg model, Altruism, Paternalism

JEL Classification: D11, D15, C73

Comparing Physical and Socioeconomical Drivers of EV Adoption in Czechia

Jindra Lacko

jindra.lacko@vse.cz

Ph.D. student of Econometrics and Operations Research

Supervisor: doc. Ing. Tomáš Formánek, Ph.D. (formanek@vse.cz)

In an effort to reduce transportation-related CO_2 emissions to levels below those of 1990, the European Union and the Czech Republic are prioritizing the transition from internal combustion engines to battery-operated and hybrid propulsion vehicles.

This study examines Czech vehicle registration data in the retail sector from 2019 to 2023. The project leverages advanced linear regression modelling of EV adoption (share of EV over total personal vehicle registrations) as driven by socioeconomic and physical characteristics. The set of socioeconomic variables considered builds on Czech Census data, while physical characteristics were obtained using Open Street Map and Open Charge Map data.

Various machine learning techniques are applied for variable selection and evaluation (including penalized and stepwise methods). Physical characteristics of the regions analyzed were obtained using GIS toolset, while modelling and data handling work was performed within the framework of the statistical programming language R.

The resulting model finds five significant socioeconomic predictors, shows a robust goodness of fit, and effectively mitigates the spatial autocorrelation initially observed in the data.

Compared to impact of the socioeconomic characteristics only limited contribution was found as result of physical characteristics of the region.

The project brings two main types of benefits: first, central authorities and other relevant stakeholders will be able to assess the location/allocation efficiency of diverse types of public chargers with respect to the location and charging stations. Second, this analysis can be used to compare population density, road (traffic) types and EV charging infrastructure to highlight possible inefficiencies in EV infrastructure. As a result, more efficient allocation of public and private resources will help to remove potential hurdles in EV charging accessibility that may be expected as EV adoption rates increase in Czechia.

Keywords: Battery Electric Vehicles, Hybrid Vehicles, Technology Adoption and Diffusion, Czechia

JEL Classification: Q54, C31, R42

Portfolio optimization under stochastic dominance constraints: non-parametric stochastic dominance test statistic approach

Jakub Neugebauer

Neuj05@vse.cz

Ph.D. student of Econometrics and Operations Research

Supervisor: prof. RNDr. Ing. Petr Fiala, MBA, CSc., (petr.fiala@vse.cz)

This work presents a novel approach to portfolio optimization in the context of inflation and income protection. It challenges the traditional mean-risk models by integrating stochastic dominance into portfolio optimization, replacing subjective risk or return level selection. The key contribution is the development of a genetic algorithm (GA) to solve a portfolio optimization model with a general order stochastic dominance constraint, leveraging a statistical test at a specific critical value, which is bootstraped and stochastic dominance constraint in the model is therefore robust against data sample choice.

Initially, the paper reviews modern portfolio optimization theory, highlighting limitations in mean-variance models and exploring alternatives like machine learning techniques. It then shifts focus to stochastic dominance, an approach that compares entire probability distributions of random variables, offering a more comprehensive analysis than traditional mean or variance comparisons.

The core of the paper lies in the formulation of a stochastic dominance constraint portfolio optimization problem (SDCPO). This involves maximizing the expected return of a portfolio subject

to stochastic dominance over a benchmark. The paper introduces a robust statistical test for stochastic dominance, offering flexibility and precision in portfolio optimization. Big advantage of this approach is a flexibility in a selection of an order of a stochastic dominance. This serves as a parameter of a model and one can easily compute given model for any given, finite order of stochastic dominance.

To solve this complex optimization problem, the paper develops a GA. This algorithm is preferred for its ability to handle the non-linear and non-convex nature of the problem, where traditional gradient methods fall short. The GA uses a population-based approach, simulating natural selection, and adapts specifically to the needs of portfolio optimization.

The methodology is tested using assets from the S&P index, demonstrating the effectiveness of the proposed model. The model is compared to a classic linear programming interpretation of stochastic dominance model as well as to its robust version. The paper concludes that the integration of stochastic dominance with genetic algorithms offers a promising new direction for portfolio optimization, particularly in uncertain economic times.

Keywords: portfolio optimization, stochastic dominance, genetic algorithm, financial decision making

JEL Classification: C15, C44, C58

Comparison of Python metaheuristic libraries

Vojtěch Vávra

vojtech.vavra@vse.cz

Ph.D. student of Econometrics and Operations Research

Supervisor: prof. Ing. Josef Jablonský, CSc., (jablon@vse.cz)

It is well-established that finding optimal solutions for NP-hard problems poses a considerable challenge. Consequently, metaheuristics are employed to identify sub-optimal solutions instead of exact methods and optimal solutions. However, how do we select the implementation approach for a given metaheuristic? This article aims to address this crucial question. The predominant language at VŠE department KEKO is language R. Despite its prevalence, the language exhibits suboptimal performance in cyclic operations. As an alternative, Python, one of the most widely used programming languages globally, is employed. Numerous options are available for implementing metaheuristics ranging from developing algorithms from scratch to leveraging pre-existing implementations. The list of Python libraries is presented with comparison between them. There are several targets to accomplish. Firstly, healthiness of libraries is identified to highlight potential deficiencies. Secondly, documentation inspection is done to understand functionality and user friendliness. Thirdly, conduct algorithm execution to ensure functionality of the library. Fourthly, comparison of codes and its complexity for users is determined. Fifthly, mathematical experiments are done to evaluate the effectiveness of libraries. This evaluation involves the calibration of methods for enhanced efficiency. For computational experiment are used popular optimization functions such as Rastrigin, Ackley and Rosenbrock functions. Finally, this study concludes by presenting findings

from experiments and exploring the integration of libraries. The goal is to determine which of the proposed libraries will be utilized in future research endeavours.

Keywords: Python, metaheuristics, DEAP, MEALPY, Opytimizer, scikit-optimize, Optunity

JEL Classification: C61, C63

STUDY PROGRAM
STATISTICS

Impact of the coefficient of economic demand on the wages of employees of faculties of public universities in Czechia

Hana Flusková
fluh00@vse.cz
Ph.D. student of Statistics
Supervisor: prof. Ing. Jakub Fischer, Ph.D.
(jakub.fischer@vse.cz)

In the fall of 2023, there was considerable discussion regarding the disparity in average wage levels among academic staff of different types of faculties at public universities. This paper analyses the relationship between wages and the Coefficient of Economic Demand (CED). The aim of this study is to explore wages in higher education, with a particular focus on philosophy faculties. The article responds to a topical issue, highlighting not only the inequality in financial compensation of staff but also the issues related to the methodology of source data. Faculties with very low and high CEDs tend to pay significantly lower average wages compared to those with average CEDs.

Keywords: higher education, financing of public universities, coefficient of economic demand, Ministry of Education, Youth and Sports, wages of academic and scientific staff

JEL Classification: I22, I23, H52

Gender Dynamics in Czechia Household Fertility: Logistic Regression insight

Tereza Frömmelová

Tereza.frommelova@vse.cz

Ph.D. student of Statistics

Supervisor: doc. Ing. Jitka Langhamrová, CSc.
(jitka.langhamrova@vse.cz)

This article investigates the social and economic factors that shape and affect the fertility level in the Czech Republic. By employing a multidisciplinary approach to survey data from the Czech Household Panel Survey, the study explores the socio-cultural and economic dimensions that influence fertility decisions. To solve this problem, the method of logistic regression was applied. The approach allows us to define how chosen socio-cultural and economic variables change the odds of having children. This, as a representation of the fertility of the sample, is defined through the variable that defines the number of children living in a household. The effect of the socio-economic environment was examined for the total population, young people, and both genders separately. The data also allowed us to further specify the age of children. It was found that while the importance of marital status is no longer as influential in child-bearing decisions as it used to be in the past, men are significantly more likely to live in households with children if they are married. Municipality size in the case of the Czech Republic has no significant effect for either gender. On the other hand, economic status and the type of work contract have shown a crucial effect on the odds of living in households with children and thus fertility. This has been noted specifically in the case of the population of women, which illustrates the persistence of a strong gender division of parental roles in society.

Keywords: Total Fertility Rate, Logistic Regression, Reproduction behavior factors, Household Fertility.

JEL Classification: J13, Z13

Estimation of the share of people with tertiary education aged 25–34 up to 2030

Vladimír Hulík

xhulv01@vse.cz

Ph.D. student of Statistics

Supervisor: doc. Ing. Mgr. Petr Mazouch, Ph.D.,
(mazouchp@vse.cz)

The aim of this article is to estimate the share of people with tertiary education aged 25–34 in 2030 in relation to one of the EU's European Education Area targets – the share of people aged 25–34 with tertiary education should be at least 45%.

In the first phase, net and cohort entry rates into higher education were analysed, using around 4.5 million anonymised individual records in the SIMS database. The analysis confirms that the Czech higher education system remains universal (according to Trow's classification) despite a significant decline in the number of students in 2011–2019. While in 2001–2010 the share of people aged 30 and over contributed significantly to the entry rate, after 2010 there is a dramatic decrease in the higher age categories (saturation of deferred demand for higher education) and the first entry rate is driven by people entering higher education immediately or very shortly after completing upper secondary education. Based on the forecast of these rates by linear regression, it can be concluded that the number of first-time entry of students into the higher education sector is expected to increase over the next seven years, from the current level of around 61,000 to values exceeding 76,000 in 2028 and 2029.

In the second phase, the drop-out rates were analysed, which have been very stable over the long term. It shows that the Czech higher education sector is extremely inefficient, with an average of almost

40 % of those enrolled in their first higher education programme in a given year not completing their studies, even in another programme (i.e. leaving the higher education sector completely without a degree). These measures were used to estimate the number of graduates of public and private higher education institutions born between 1996 and 2005 and graduates from conservatories, higher professional schools and state universities in the same age group, thus covering the whole segment of tertiary education in the Czech Republic.

The share of people with tertiary education aged 25–34 was then estimated at 36 % in 2030. This is only 1–1,5 percentage points higher than the last known figures for 2021 and 2022, and quite far from the assumed Czech national target (40 %).

Keywords: EU benchmark, forecasting, tertiary education, net entry rate, cohort entry rate, drop-out rate

JEL Classification: I21, I23, C53, C55