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This issue of *Ekonomika preduzeća* starts with two remarkable papers in the *Economic Growth and Development* section. In the first paper, a trio of authors, *I. Nikolić*, *M. Kovačević* and *K. Stančić*, attempted to explain why early warning systems (EWSs) failed during the COVID-19 pandemic by analyzing a specific example, the determinants of currency crises episodes in the Republic of Serbia from January 2001 to December 2021. According to the authors, the complexity of the current rolling crisis calls for a shift in approach. Namely, EWSs can serve as one of the many tools in the assessment and identification of financial crises, but to be more effective they need to be put under the auspices of a more complex Decision-Making Support System (DMSS). The authors invite the academic community and policymakers to start discussing and developing this line of reasoning and to work together with the Statistical Office of the Republic of Serbia that has already laid the groundwork for such a system. In the second paper, *M. Stamenković*, *M. Milanović* and *P. Veselinović* undertook a challenging endeavor of quantifying the economic development level of local administrative territorial units (LAUs) in Serbia. To do so, they adopted an innovative and complex multivariate statistical approach, based on a statistically valid and combined application of FA and MANOVA. The resulting classification of LAUs confirms the presence of pronounced regional and intra-regional polarization in Serbia or a well-known gap between "developed north" and "underdeveloped south". Their findings can be a valuable input for the creation and successful implementation of national strategy of balanced regional development.

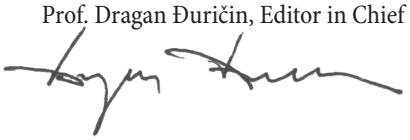
The first paper in the *Finance* section, written by *S. Stamenković, N. Stanišić* and *T. Radojević*, is dedicated to the telecommunications services sector as one of the most dynamic sectors and the greatest contributors to the global economy. Specifically, the authors investigated the impact of internal and external determinants of the capital structure of 46 European telecom operators in the period 2009-2020. The results of their research, which are mostly in line with both pecking-order theory and trade-off theory, show that the most relevant variables included annual sales growth, profitability, liquidity, assets turnover, non-debt tax shield, and cost of debt, while tangibility, firm size and annual GDP growth did not significantly affect the capital structure of these companies. In the next paper within this section, *D. Simović* and *T. Šutaković* observed the effects of the Euribor and risk premium on interest rates on foreign currency loans and FX-indexed loans approved in both corporate and retail lines in Serbia in the period from September 2010 to August 2020. They concluded that there is a statistically significant impact of Euribor and country risk premium on lending rates on new retail as well as on corporate investment FX and FX-indexed loans, with high pass-through coefficients.

In the *Labor Economics* section, a duo of authors, *L. Lebedinski* and *D. Pavlović*, examined the outcomes of the largest program of the National Employment Service of the Republic of Serbia targeting youth – Professional Traineeship Program (PTP), which was conducted from 2017 to 2018 assigning 9,561 participants to workplace training based on their educational background with the aim of easing the transition from education to work. The authors provide some very interesting facts and statistics on Serbia's labor market. Overall, they found this program very useful as it gives young people an opportunity to get the first professional training, acting as a stepping stone toward regular employment. Also, by taking part in this program, companies get an opportunity to train labor market entrants at a relatively low cost and improve their talent management practices.

In the *Marketing* section, a multidisciplinary team of authors, including *Lj. Bojić*, *M. Mitrović Dankulov* and *N. Pantelić*, addressed quite an interesting and lively topic in the era of social media. More precisely, they applied combined methods from statistics, psychology, machine learning, and complex networks theory to explore the influence of weather parameters on different psychological categories of Twitter users in ten different countries. The results show that the level of activity of Twitter users, described as Post Count, is strongly connected to changes in temperature and humidity in all observed countries, but the strongest correlation was found for the USA, Italy, and Portugal. So, weather parameters can be used to predict Twitter users' activity, and marketing and advertising experts should bear this fact in mind when crafting their strategies.

This issue of *Ekonomika preduzeća* closes with the paper in the *Logistics* section, written by *B. Stojanović-Višić*, *S. Jelisavac Trošić* and *M. Simić,* in which they presented an overview of the projects implemented in Serbia through China's Belt and Road Initiative. It is obvious that the location of Serbia plays an important role in China's strategic plans and choices. Chinese companies mainly invest in large-scale transport infrastructure projects, energy sector, heavy industry and manufacturing. Despite the tangible results and benefits of this fruitful cooperation with China, Serbia should also be aware of the pitfalls and potential geopolitical risks arising from such close ties with China that might jeopardize its EU accession prospects.

Prof. Dragan Đuričin, Editor in Chief



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WHY EWSs FOR FINANCIAL CRISES FAILED DURING THE COVID-19 PANDEMIC: THE EXAMPLE OF SERBIA

Zašto su tokom pandemije kovida 19 zakazali modeli ranog upozorenja – primer Srbije

Abstract

Early warning systems (EWSs) are designed to anticipate future crises, giving policymakers optimism that they would be able to make proactive management decisions. The demonstration of EWSs effectiveness in the economy was clear throughout the Asian financial crisis at the end of the 1990s, the financial crisis of 2007-2008, the Great Recession, and the European sovereign debt crisis of 2008-2012. However, EWSs failed during the COVID-19 pandemic. Using Eichengreen et al. [13], Kaminsky et al. [23], and Sachs et al. [33] methodology, the paper explains this phenomenon by analyzing the determinants of currency crises episodes in the Republic of Serbia from January 2001 to December 2021. The complexity of the current crisis required a change of approach. As reflected by the Statistical Office of the Republic of Serbia, one of the solutions is to develop a Decision-Making Support System (DMSS). EWSs presented here could serve as one of the many inputs in the assessment and identification of financial crises. However, these models are not accurate enough to be used as the sole method to anticipate crises. Like other crisis models, they bring benefits but obviously have their drawbacks. That is why it would be good to put them under the auspices of a more complex DMSS. Again, for now DMSS should be seen just as a better alternative to earlier practice. This is neither a final nor an almighty option, but it must be further worked on in the future.

Keywords: *early warning system, financial crisis, COVID-19 pandemic, Serbia's economic recovery, DMSS*

Sažetak

Modeli ranog upozorenja (EWSs) dizajnirani su u cilju predviđanja budućih kriza, a kreatorima politika pružaju optimizam u pogledu ishoda proaktivnih upravljačkih odluka. Demonstracija efikasnosti EWS u ekonomiji je nedvosmisleno potvrđena za vreme finansijske krize u Aziji krajem devedesetih, finansijske krize od 2007. do 2008, Velike recesije i evropske krize državnog duga od 2008. do 2012. Međutim, EWS je zakazao tokom pandemije kovida 19. Koristeći metodologiju autora Eichengreen et al. [13], Kaminski et al. [23] i Sachs et al. [33], rad objašnjava pomenuti fenomen analizirajući determinante epizoda valutne krize u Republici Srbiji od januara 2001. do decembra 2021. godine. Kompleksnost aktuelne krize zahtevala je promenu pristupa. Prema oceni Republičkog zavoda za statistiku, jedno od rešenja je razvoj sistema za podršku donošenju odluka (DMSS). EWS mogu poslužiti kao dopunski input u proceni i identifikaciji finansijskih kriza. Međutim, ovi modeli nisu dovoljno precizni da bi se koristili kao isključivi alat za predviđanje. Poput nekih drugih kriznih modela, oni imaju prednosti, ali i nedostatke. Stoga je bolje da budu pod okriljem robusnijeg DMSS. Opet, DMSS bi za sada trebalo posmatrati samo kao bolju alternativu ranijoj praksi. To nije ni konačna ni svemoguća opcija, ali se na tome mora dalje raditi u budućnosti.

Ključne reči: *sistem ranog upozorenja, finansijska kriza, pandemija kovida 19, ekonomski oporavak Srbije, DMSS*

Introduction

Predictions are affected by uncertainty. Therefore, some kind of explicit disclaimer is always necessary to discuss serious risks. But we must also consider the economic system in all its complexity. The intertwined feedback loop produces expansions that can hardly be approximated by economists' typical forecasting models. Perhaps they cannot be approximated at all [34].

COVID-19 has affected the overall economic system in many ways [22], [16], [38], [30]. We like to say it is an unprecedented shock to the world economy since WWII. It is essentially a systemic crisis like the previous global financial crisis. Since the Asian financial crisis at the end of the 1990s, early warning systems (EWSs) have been designed to anticipate future fractures, giving policymakers optimism that they would be able to make proactive management decisions [6], [37], [35]. As the leading indicators of financial crisis, financial variables usually offer strong predictive power [15], [11]. Analytical efforts have generated a wide-ranging debate and uncovered numerous insights into their effectiveness [12], [7], [5], [24], [32]. However, the paper's findings suggest that pandemics may cause economic damages that differ from the past global crises. After the initial fears in the financial markets, this part of the economy remained spared until the end of 2021. EWS did not offer the clearest signals. Or rather, it failed.

The aim of the paper is to underline the experiences with EWSs in Serbia during the first two years of the pandemic and to suggest alternatives. It seems that the complexity of the current crisis required a change of approach.

The paper consists of two compatible parts. First, it underscores the specifics of the COVID-19 pandemic, which disavows (or even completely erases) the expected signals of early warning indicators. If this is a fact, in the second part of the paper it is suggested that it is more expedient to include these indices of crises in a more complex framework of crisis response. In Serbia, we call it a Decision-Making Support System (DMSS).

This paper contributes to the large literature on the early warning indicators of financial crisis, possible alternative responses to the crisis as well and is structured as follows: Section 2 presents different measurement approaches as well as the literature on EWSs; Section 3 outlines the data and methodology used to identify the financial crisis in Serbia since 2000 and during the first two years of the pandemic; Section 4 shows the results; Section 5 presents a DMSS. Finally, Section 6 concludes the paper with policy implications.

Literature review

EWSs are designed to anticipate future crises, giving policymakers optimism that they would be able to make proactive management decisions. Given the lagged impact of policy, timely crisis detection can provide room for regulatory and supervisory adjustment and preparation for potential fallout. Good EWSs require an ongoing examination and revision combined with actual economic and financial operations.

Early warning systems for financial crises have improved over the course of ongoing regional financial crises, providing a wealth of empirical data at the end of the last century. However, predicting the timing of a crisis has widely been considered to be challenging, and crisis models have a weak record in this regard. For example, none of the crisis early-warning models correctly predicted the global financial crisis in 2008 [36]. Against the uncertainty of still-evolving research, a cautious approach would be to look at a range of indicators, look for early signs of a reversal and widen gaps in financial variables.

Vast empirical studies on the identification and measurement of financial crises have been published. The studies vary in the following aspects: countries that are investigated, modeling approach, variables used, methodology, and estimation techniques.

It is evident that the importance of EWS has been acknowledged in the available literature, but there is a lack of consistency [17]. In general, EWS models can be divided into three categories:

1. *The signals (nonparametric) models* are created to track the number of variables that tend to behave abnormally before a currency crisis. When a variable exceeds a predefined threshold, an alert is sent. A crisis is

defined as the period in which a crisis index is significantly different from its mean [23], [13], [33]. Each variable is considered in isolation, and thresholds can be country and variable-specific, based on a standard reference percentile. Variations of this EWS approach are widely used in the IMF work on crisis vulnerabilities, whose staff was tracking several EWS models by 2003 [7].

2. *Probit/Logit approach*: These are limited dependent variable regression models, where the probability of a crisis is estimated as a function of several variables [14], [19]. The chance of crisis incidence takes the value of one if a crisis occurs or zero if it does not happen. The benefit of the technique is that it allows one to assess the relative importance of variables jointly, but this also makes it challenging to examine several signs at once.

3. *More recent new techniques:* (a) multinomial models [9]; (b) non-parametric clustering methods, such as the binary recursive tree approach [3], [20], [18]; (c) machine learning based on decision trees, like the artificial neural networks [3], [21], [28], [4], [8]; (d) Markov switching model - focuses on finding transitions from "tranquil periods" to "speculative times", allows the transition probability between states as a function of fundamentals and expectations [1], [27], etc.

This balance between accuracy and interpretability determines whether to use machine learning alternatives or traditional linear approaches. In scenarios and applications where predicted accuracy is valued, machine learning may be more advantageous than classical regression. The decision is based more on practical than on quantitative factors. Machine learning can play a small role in environments where the scale and sign of regression coefficients emphasize clarity of interpretation. Machine learning may produce outstanding results if prediction accuracy is crucial or when heteroscedasticity or high dimensionality might impair the clarity of linear approaches [10].

Methodology

This section presents several approaches to testing the signals models and highlights their unique features. Indices abbreviations refer to the author's acronym - [13], [23], and [33]. The financial crises studied in this paper include currency, debt, banking, and systemic crisis. Thereby, the signaling procedure takes the following stages: dating the currency crises; determining the leading variables as indicators of crises; applying a statistical method to test and measure the effectiveness of those variables; and selecting an optimal cut-off threshold to receive a clear signal on crises.

The empirical analysis is based on monthly data for the Republic of Serbia, collected from January 2001 to December 2021.

The first ERW index assumes that speculative attacks are manifested in an extreme pressure on the FX market resulting in a weakening currency. Monetary authorities respond to this by raising interest rates and/or interventions from FX reserves. Accordingly, the index by which such disturbances would be expressed contains the weighted average of standard changes in the exchange rate, the ratio of FX reserves and the monetary aggregate M1 and the interest rate. All variables in the observed country are placed in a relative relationship with the country whose currency serves as the anchor currency (in this case it is the EU, i.e. the euro). The ERW index for Serbia would take the form:

$$ERW_{RS,t} = \frac{1}{\sigma_e}\frac{\Delta e_{RS,t}}{e_{RS,t}} - \frac{1}{\sigma_r}\left(\left(\frac{\Delta rm_{RS,t}}{rm_{RS,t}} - \frac{\Delta rm_{EU,t}}{rm_{EU,t}}\right) - \frac{\Delta rm_{EU,t}}{rm_{EU,t}}\right) + \frac{1}{\sigma_i}\Delta\left(i_{RS,t} - i_{EU,t}\right)$$

where: $e_{RS,t}$ is RSD/EUR exchange rate; $rm_{RS,t}$ coverage of money supply by FX reserves; $i_{RS,t}$ weighted average interest rate on securities used in open market operations by the National Bank of Serbia (NBS); $i_{EU,t}$ interest rate in the EU; while σ_e, σ_r, σ_i are the standard deviation of the relative change in the exchange rate, the standard deviation of the difference between the relative change in the ratio of FX reserves and the money supply M1 in Serbia and the EU, and the standard deviation of the interest rate differential, respectively.

The second KLR index probably belongs to the most prominent tools for predicting currency crises. The KLR index omits the calculation's reference country and the interest rate differential. The initial assumption is that interest rates are under the direct control of monetary

authorities and that they only multiply the right side of the equation by the standard deviation of the relative change in the exchange rate. The currency crisis here is a period of pronounced domestic currency depreciation and/or reduction of FX reserves in euros. Therefore, the KLR index is given as a weighted average of the growth rate of the exchange rate and the growth rate of FX reserves expressed in euros, in monthly dynamics:

$$KLR_t = \frac{\Delta e_t}{e_{RS,t-1}} - \frac{\Delta R_t}{R_{t-1}}$$

where: $e_{RS,t}$ is RSD/EUR exchange rate; R_t is FX reserves expressed in euros; and $w = \sigma e/\sigma R$, i.e. the ratio of the standard deviation of the rate of change of the exchange rate and the standard deviation of the rate of change of FX reserves, respectively.

Finally, the so-called *STV* index, can be expressed in the following form:

$$STV_{RS,t} = \left(\frac{1/\sigma_e}{\left(\left(\frac{1}{\sigma_e}\right) + \left(\frac{1}{\sigma_r}\right) + \left(\frac{1}{\sigma_i}\right)\right)} \right) \frac{\Delta e_{RS,t}}{e_{RS,t}}$$
$$- \left(\frac{1/\sigma_r}{\left(\left(\frac{1}{\sigma_e}\right) + \left(\frac{1}{\sigma_r}\right) + \left(\frac{1}{\sigma_i}\right)\right)} \right) \frac{\Delta r_{RS,t}}{r_{RS,t}} + \left(\frac{1/\sigma_i}{\left(\left(\frac{1}{\sigma_e}\right) + \left(\frac{1}{\sigma_r}\right) + \left(\frac{1}{\sigma_i}\right)\right)} \right) \Delta r_{RS,t}$$

where $r_{RS,t}$ is FX reserves of Serbia, while the description of the other symbols is the same as before.

When the value of the index exceeds a certain threshold value, it means that the country has a currency crisis. The threshold value, in this study, is determined as the mean of the index plus 1.5 standard deviations. The selected cut-off point rests on an ad hoc decision as to which type of error is preferred. In this case, it is certainly a conservative approach.

Results and discussion

The result of all the above is directly reflected in the value of the three crisis indices. Their values in the two years of the COVID-19 pandemic (2020-2021) are far below the calculated threshold. So, unequivocally, there was no need for further calculation of the composite probability of a crisis outbreak.

In contrast, as we can see, early warning indices have worked well during previous crises. Although this is not explicitly the subject of this research, Serbia did not differ from other European countries, except for Turkey, which recorded a strong currency crisis in early autumn 2021.

All three indices indicate that Serbia was successively going through crisis periods until the first quarter of 2013 [29]. Since then full currency stability has been established and later successfully maintained. The amplitude and frequency of oscillations of the observed indices indicate huge problems, particularly in the period 2008-2012 when the critical threshold was repeatedly breached, which is represented on the graphs by a dashed line (see Figure 1).

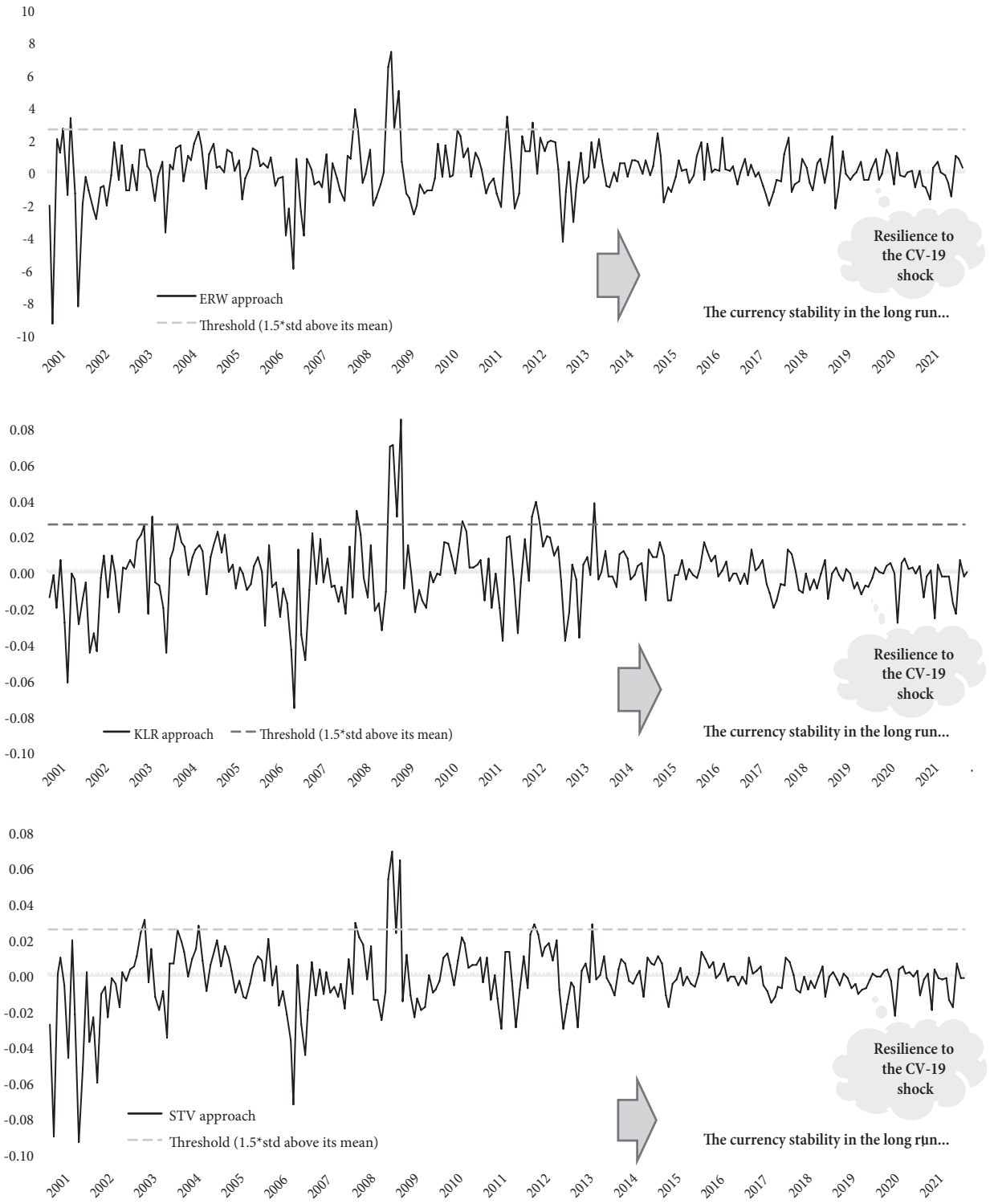
For example, from January 2008 to August 2012, the FX reserves of the NBS stagnated, and the value of the dinar against the euro fell from 81.8 to 117.9, with an increase in monetary policy restrictions. From that moment until December 2021, the NBS's FX reserves increased from EUR 9.9 billion to EUR 16.4 billion, the exchange rate stagnated, while the interest rates from the double-digit zone dropped to a level close to zero. In this period, the NBS appears as a net buyer of foreign exchange in the amount of EUR 3.1 billion, thus compensating for the excess supply of foreign exchange.

In total, the background of all episodes of the currency crisis in Serbia until 2013 can be grouped from the previous one into two groups.

The first group concerns political instability, and inadequate and uncoordinated macroeconomic policies. The closest approach to this group is to predict currency crises based on rational expectations and the credibility of economic policymakers, which are crucial for currency stability.

Consequently, the second group consists of the unsustainability of fundamental variables. Above all, external positions - the exceptional balance of payments deficit against GDP and investments (CA deficit amounted to 17.3% of GDP in 2007 and 20% of GDP in 2008); critically endangered external liquidity (debt-service ratio in that period reached as much as 37% of goods and services

Figure 1: Results of three signals models of the financial crisis in Serbia, 2001-2021



Source: Authors' calculation

exports, while external debt exceeded the total value of exports by 2.2 times); low export competitiveness and import dependence (coverage of imports by exports of goods and services in this period was only 52%), etc.

Fiscal policy relied on the erroneous assessment that privatization proceeds will flow forever [31] and that a scenario of interruption of capital inflows from abroad, even its sudden withdrawal from the country, is

not possible; in addition, fiscal irresponsibility culminates in late 2011 when public sector wages and social benefits increased well above economic opportunities.

The country also had a problem with its financial positions – as a result of a loose control of the banking sector, reduced and incomplete financial stability was created, etc. The global financial crisis, which manifested itself in September 2008, only exposed and deepened all the mentioned weaknesses of the Serbian economy. It can never be an excuse or an excuse for the problems Serbia had, but only their trigger. This analysis again showed that Serbia was falling into a serious currency crisis a few months before its outbreak.

Moreover, a better confirmation of this thesis is the testimony and legacy of the current COVID-19 pandemic. If the economy had experienced the crisis in the state we found ourselves in 2008, it could not have avoided or minimized its negative effects.

It should be emphasized that the negative effects of the pandemic have been avoided by the huge pumping of liquidity by states. When the Covid shock occurred, several central banks significantly increased the quantity of assets on their already massive balance sheets. They were accompanied by a comprehensive variety of macroprudential and fiscal short-term initiatives [30].

The monetary authorities in the majority of the EU-27 nations, as well as in Serbia, took quick and extraordinary action, both in terms of standard and non-standard monetary policy instruments. The European Central Bank approved non-regular open market operations: pandemic emergency purchase program, pandemic emergency longer-term refinancing operations, targeted longer-term refinancing operations, and asset purchase program [26]. New swap and repo lines were established with central banks worldwide. This entails reducing all base interest rates, giving banks access to more liquidity resources, enhancing credit conditions under the Guarantee Program, and enabling borrowers to postpone paying their debts, etc. The interventions gave an immediate result, calming the market and displacing negative expectations. Banks profited from government credit guarantees, temporary easing of some capital restrictions, and flexible financial funding. Corporate lending expanded very rapidly across the EU. Even though the majority of lending was directed towards working capital and liquidity, investment lending declined. Similar trends are also observed in Serbia.

The arsenal of fiscal measures consisted of the so-called automatic stabilizers (direct government subsidy payments to businesses or households, tax cuts, or refunds, and extraordinary expenditures, where a significant portion had incentives to access to healthcare) and discretionary measures of fiscal policy (above all, it is about measures of expansive fiscal policy, such as, for example, spending on public works construction that increase employment).

The policy pursued in the first two years of the pandemic, as well as the policy of quantitative easing that has been in force since the middle of the last decade and the interventionism in a market economy, apart from its benefits also generates systemic risk. Such measures have built up vulnerabilities and accumulated risks of uncertainty, which, together with geopolitical troubles, are reflected in record inflation at the global level as early as 2022.

DMSS

Official statistics are in charge of creating and disseminating official statistical data. This 'raw' data material, however, cannot be used directly for policy making. Statistical systems must filter critical statistical knowledge from raw data streams, refine it, and transform it into politically usable information. Therefore, the purpose of statistical systems is to discover relevant but often hidden or overlooked relationships between various indicators, to extract important information from large amounts of data, and to improve the effectiveness and efficiency of decision-making. It is also about defining key metrics to improve reliability.

To offer users enough accurate information so they can determine the state of the economy, including potential imbalances, a forward-looking vulnerability assessment with statistically significant predictors of crises, the Statistical Office of the Republic of Serbia (SORS) formed a section devoted to catalyzing data and changing it into easy, trustworthy, and broadly applicable indicators. The

institutional transformation started in early 2017. The Council for Coordination of Activities and Measures for GDP Growth was formed with the aim of monthly monitoring of the entire economy in Serbia. In the work of the Council, it quickly became clear that SORS is an extremely important part of its work, acting not only as a data provider but also as an active member of the analytics crew. The Council's primary responsibility is to create an analytical framework for tracking GDP growth and analyzing changes in the trends of individual growth factors. As a result, prospective growth support measures are also taken into account. Each month, the updating of a specifically chosen collection of indicators and data on recent events marks the beginning of the monitoring of predictions and suitable feedback on specific activities and macroeconomic domains. Thus, an image is created of the direction (wrong, neutral or right) of the movement during certain activities.

The DMSS is meant to serve as a toolkit. Some were always included in the official statistics system, while others were later accepted and created to more effectively illustrate and explain a specific occurrence. These tools are intended to describe the nation's economic situation, mathematically illustrate the relationship between key economic indicators and encourage effective decision-making [25].

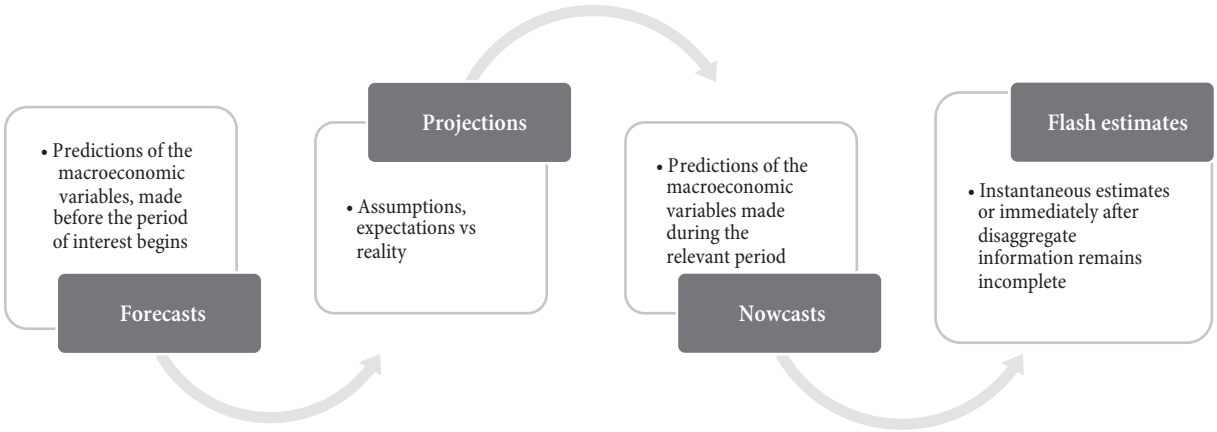
The toolbox also includes new risk assessment models and aids in the generation of a relevant summary of main unresolved hazards. It includes, for example, a monthly projection update system, a system of leading indicators, a system for quarterly GDP nowcasting, predictions, and an Economic Sentiment Indicators (ESI) system, among other things.

Scenario analysis, policy implementation risk, and a variety of different crisis risk models are some new indications. For example, a helpful technique for outlining specific coordinated threats is scenario analysis, which simulates the materialization of significant global dangers. It also provides a forward-looking element to the review. The risk associated with the effective execution of policies assesses this capacity while taking into consideration potential obstacles including political impasse and a lack of technical expertise (see Figure 2).

Many government agencies have recognized the importance of the complex link between the producer of official statistics, the needs of users, and many current challenges, which ultimately leads to a holistic approach suitable for decision making and management, and policy formulation. Consistent with this, SORS works closely with each of them.

The Chamber of Commerce and Industry of Serbia (CCIS) in particular plays an important role in DMSS. Through industry associations and readily available data sources, it collects information and data of general and specialized interest. CCIS's Department for Strategic Planning, Development and Analysis primarily focuses on analysis to identify and limit problems at the micro and macro levels of a homogenous group of producers and exporters. The specialized skills of this department are complemented by outside experts.

Figure 2: The key outputs of DMSS



Source: Authors' illustration

Incorporating CCIS into the system of planning, predictions, recognizing constraints, and deriving remedies completes the shown system of forecasting and monitoring GDP growth and economic activity. It also makes it possible to establish policies that support growth and remove impediments to growth.

At lower levels of business entity groupings, such as areas or categorization categories, all the way up to an individual business entity, CCIS has developed its own DMSS. The system is one of many analytic databases structured around different levels of aggregation of data from a variety of sources.

Conclusion

The results in this paper endorse the general conclusion that the pandemic has caused different economic damages from the past global crises - the Asian financial crisis at the end of the 1990s, the financial crises of 2007-2008, the Great Recession, and the European sovereign debt crisis of 2008-2012. According to historical evidence, crises are the result of single triggering events colliding with economic or financial weakness. Fundamental weaknesses are thus a necessary but insufficient condition for a catastrophe [2].

Although it is impossible to predict when a crisis will emerge, the extent of underlying vulnerabilities can be used to predict worst-case scenarios and assess the likelihood of a crisis occurring. Furthermore, the variety of potential hazards in the complex global economy is virtually limitless.

Due to the COVID-19 pandemic's impact on worldwide commerce and consumption, the expansion of the world economy has been severely hampered. But after the initial fears in the financial markets, this part of the economy remained spared until the end of 2021. In contrast to market and political instability, the COVID-19 pandemic is a true external economic disturbance. Accordingly, EWS does not offer the clearest signals. Or rather, it failed.

The complexity of the current crisis required a change of approach. Creating a DMSS that can accommodate an EWS is one of the alternatives, as suggested by the Statistical Office of the Republic of Serbia. The DMSS's operation has strengthened government surveillance efforts by focusing attention on hazards and distributing novel assessment techniques. Equally important, it ensures efficiency of action and timely response to challenges.

EWSs presented here can serve as one of the many inputs in the assessment and identification of financial crises. However, these models are not precise enough to be the only tool used to predict catastrophes. Like other crisis models, it brings benefits but obviously has its drawbacks. That is why it would be good to put it under the auspices of a more complex DMSS.

Again, for now DMSS should be seen just as a better alternative to earlier practice. This is neither a final nor an almighty option, but it must be further developed in the future. This fact is an additional contribution to the paper that emphasizes the importance of a better understanding of its toolkit and accelerating the process of improving the methodology. At the same time, such an approach could be a motive for spreading a fruitful discussion on this topic among the academic community and individuals.

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STATISTICAL ESTIMATION OF ECONOMIC DEVELOPMENT INEQUALITIES AT MUNICIPALITY LEVEL: THE CASE OF SERBIA

Statistička ocena ekonomskih razvojnih nejednakosti na nivou opština u Srbiji

Abstract

Starting from its importance, as a valuable source of information in strategic planning of balanced regional development, the issue of measurement of achieved economic development level of local administrative territorial units (i.e. LAUs), represents the subject of this research. Using municipalities in the Republic of Serbia as a working basis, the following objectives are formulated: first, the creation of factor analysis based statistical model, in the form of composite indicator (i.e. Index of Economic Development – IED) for measuring the economic development level of LAUs within state, and second, the creation of a MANOVA evaluated IED-based classification of observed municipalities into internally homogeneous and externally heterogeneous groups, for identifying the extent of present regional economic disparities. The main contribution of this research is reflected in a clear and detailed demonstration of statistically valid, combined application of selected multivariate methods in regional economic development research. Created classification of LAUs confirms the well-known statement regarding the presence of pronounced regional and intra-regional polarization in Serbia, primarily in direction "developed north – underdeveloped south". Proposed composite indicator and, on its values based, classification of LAUs can provide information useful for decision makers and experts in the field of planning and implementation of regional development strategy.

Keywords: *factor analysis, MANOVA, composite indicator, economic development level, regional inequalities, municipalities, Serbia*

Sažetak

Polazeći od njegovog značaja kao dragocenog izvora informacija u strateškom planiranju ravnomernog regionalnog razvoja, pitanje merenja dostignutog nivoa ekonomske razvijenosti jedinica lokalne samouprave (JLS) predstavlja predmet ovog istraživanja. Korišćenjem opština u Republici Srbiji kao radne osnove, formulisani su sledeći ciljevi: prvi, kreiranje statističkog modela zasnovanog na primeni faktorske analize, u formi odgovarajućeg kompozitnog indikatora (Indeks ekonomske razvijenosti – IER) za merenje nivoa ekonomske razvijenosti opština u sastavu države, i drugi, kreiranje, MANOVA metodom evaluirane, IER zasnovane klasifikacije posmatranih opština u interno homogene i eksterno heterogene grupe, namenjene identifikavanju razmera prisutnih regionalnih ekonomskih dispariteta. Glavni doprinos sprovedenog istraživanja ogleda se u jasnoj i detaljnoj demonstraciji statistički validne, kombinovane primene odabranih multivarijacionih metoda u istraživanju regionalne ekonomske razvijenosti. Predložena klasifikacija jedinica lokalne samouprave potvrđuje dobro poznatu konstataciju o prisustvu izražene regionalne i unutar-regionalne polarizacije u Srbiji, primarno na relaciji "razvijeni sever – nerazvijeni jug". Predloženi kompozitni pokazatelj i, na njegovim vrednostima zasnovana, klasifikacija JLS-a mogu obezbediti informacije korisne za donosioce odluka i eksperte u domenu planiranja i sprovođenja strategije regionalnog razvoja.

Ključne reči: *faktorska analiza, MANOVA, kompozitni indikator, nivo ekonomske razvijenosti, regionalne nejednakosti, opštine, Srbija*

Introduction

One of the most important, but also complex socio-economic problems, that development policymakers face today is related to inequalities in the development of regional (RAU) and local (LAU) administrative territorial units within a particular state.[1] This statement stems from the fact that pronounced disparities in development level of RAUs/LAUs can have a serious (negative) impact on socio-political stability of particular state [5] and performance of the national economy. Since economic development of regions is a basis for realization of national economic goals [10], achieving intensive growth and sustainable economic development of the country necessarily implies respect for the concept of regional equality, i.e. undertaking activities aimed at balancing the level of development of all its regions, and thus the well-being of all its inhabitants [8]. Creating conditions for the establishment of balanced regional development is a priority task of every state and a key step in efforts to ensure the successful integration of the national economy into global economic flows. In this context, objective assessment and "measurement" of the achieved development level and categorization of RAUs/LAUs, with consideration of different dimensions of their development potentials and limitations, is an important source of information in strategic planning of balanced regional development and effective implementation of formulated measures and policies. In the relevant literature, as the main and most frequently used, for quantifying the extent of regional disparities, the following development dimensions are highlighted: economic, infrastructural, social, environmental, demographic and educational. Each of these dimensions can be considered as a separate multidimensional latent variable, whose "measurement" is usually performed indirectly, based on simultaneous analysis of values and relationships between several, in terms of specific dimensions, representative, directly measurable, numerical indicators [15]. Without diminishing the importance of other dimensions, when assessing the level of regional development, it is necessary to emphasize the dominant role of economic dimension [25], which best illustrate the extent of regional/local inequalities, because "without economic parity there is no national and regional equality" [27]. Also, quantitative research conducted at lower levels of territorial aggregation provides the best insight into the magnitude of development asymmetry and regional (under)development [16]. According to the emphasized multidimensionality of regional development concept and individual development dimensions, the quantification of achieved development level of territorial units is a demanding and difficult task. Due to multiple-multidimensionality, its realization has led to the shift of analytical framework from monitoring a large number of individual indicators of different development dimensions to the development and implementation of various methodological procedures based on exploitation of application potentials of multivariate analysis methods. Used individually or combined, these statistical methods enable measurement of the degree of development of specific territorial units (mainly through the development of adequate composite indicators) and their classification into internally homogeneous and externally heterogeneous clusters, according to the available potentials and development constraints.

Accordingly, as the main scientific motives for the realization of this research, the following stand out: (1) demonstration of the application potential of multivariate statistical methods in researching the structure and modelling of relations between indicators of regional economic inequalities, as a specific multidimensional economic phenomenon; (2) overcoming the immanent limitations of composite indicators of regional development present in the case of their application to territorial units of LAU level (e.g. poor data quality, data unavailability); (3) "demystification" of the analytical procedures used in the development of composite indicator, primarily initiated by deficiencies mainly present in the studies of a similar type.

Having these in mind the issue of measurement of achieved economic development level of LAUs represents the subject of this research. Using municipalities in the

1 According to the Nomenclature of Territorial Units for Statistics (NUTS), as a specific methodology for the statistical hierarchical classification of sub-national territorial units of the Member States of the European Union, created by the Statistical Office of the EU (EUROSTAT), the state territory is divided into three basic regional levels (NUTS 1, NUTS 2, NUTS 3) and an additional LAU level (Local Administrative Units).

Republic of Serbia as a working basis, in the context of a defined subject, the following objectives have been formulated: first, the creation of a multivariate statistical model, in the form of a composite indicator (i.e. Index of Economic Development – IED) for measuring the achieved level of economic development of LAUs within the state; and second, the creation of a statistically evaluated IED based classification of the observed municipalities into internally homogeneous and externally heterogeneous groups, for identifying the extent of the present regional economic disparities. The main contribution of the research is reflected in a clear, detailed demonstration of statistically valid application of selected multivariate methods in economic development research. The proposed composite indicator and, on its values based, the classification of LAUs provide information useful for decision makers and experts in the field of planning and implementation of regional development strategy.

Research background

The search for quantitative approaches intended for an objective assessment of achieved development level of RAUs/LAUs and consideration of efficiency of the proposed measures for mitigating present disparities belongs to those research topics whose applicative value and social significance are self-evident. In that sense, a particularly attractive research niche of scientific community is the analysis of development level of territorial units within a particular country or group of countries using different combinations of representative indicators of one or more development dimensions and creation of resulting classifications of the observed territories into relatively homogeneous groups [27]. Having in mind their indisputable application potential it is not surprising that the authors rely predominantly on the methods of multivariate statistical analysis in the realization of previously specified research goals. In accordance with the defined objectives of this paper, in Table 1, the key methodological determinants of selected relevant approaches of similar research character are presented. The common denominator of presented studies is the expressed variability, present in terms of the following analytical issues: spatial-temporal scope of analysis, selection of individual indicators and dimensions of development and, finally, applied multivariate method(s).

By analyzing the methodological characteristics of presented studies, it can be noticed that only a small number of authors approach the issue of regional disparities

Table 1: Comparative overview of relevant multivariate research studies

Author(s) / [reference number]	Temporal scope	Territorial units (NUTS / LAU)	State(s)	Development dimension(s)	Multivariate method(s)
Research objective – Classification					
Maletić & Bucalo-Jelić [13]	2012	LAU	SRB	Ec/S/A	FA/CA
Rašić-Bakarić [23]	2001	LAU	CRO	Ec/D/Ed	FA/CA
Rovan & Sambt [25]	2001	LAU	SLO	Ec/D/S/Ed	CA
Brauksa [1]	Mixed	LAU	LVA	Ec/S	CA
Pastor et al. [19]	Mixed	LAU	ESP	Ec/D/S	FA/CA/DA
Mazzocchi & Montresor [14]	1990	LAU	ITA	Ec/D/S/A	PCA/CA
Perišić [20]	'06–'08	LAU / NUTS 3	CRO	Ec/D/S/Ed	CA/DA
Polednikova [22]	2010	NUTS 2	V4	Ec/S	CA
del Campo et al. [3]	2003	NUTS 2	EU–25	Ec/D/Ed	FA/CA
Kurnoga-Živadinović [11]	2006	NUTS 3	CRO	Ec/S	CA/FA/DA
Kvičalova et al. [12]	2011	NUTS 3	CZE	Ec/S	CA
Istrate & Horea-Serban [8]	2014	NUTS 3	ROU	Ec	CA
Research objective – measuring development level & classification					
Rovan et al. [24]	2005	LAU	SLO	Ec/D/S/En	PCA/CA
Winkler [30]	2009	LAU	SRB	Ec/D/Ed/S/H	FA
Soares et al. [26]	1995	LAU	POR	Ec/D/S/Ed	FA/CA
Goletsis & Chletsos [5]	'95/'00/'07	NUTS 2	GRE	Ec/S/Ed/H	FA/CA
Stamenković & Savić [27]	2013	NUTS 3	SRB	Ec	FA/CA

Notes: (Ec) economic, (S) social, (D) demographic, (Ed) education, (En) environment, (A) agricultural, (H) health, (CA) cluster analysis, (PCA) principal component analysis, (FA) factor analysis, (DA) discriminant analysis.

only from the perspective of the economic dimension of development. However, it is important to note that the analysis of a number of different dimensions and related indicators may result in a classification that is strongly influenced by the effects of compensation between individual dimensions, thus preventing a clear view of their individual contribution to the identified position of specific RAUs/LAUs. More precisely, the simultaneous observation of several development dimensions can result in a blurred multidimensional image of the situation in a certain territory in terms of the observed aspects of development. This methodological issue is of particular importance in studies aimed at quantitative assessment of development levels through the construction of appropriate composite indicators (e.g. [5], [24], [26], [27], [30]). A detailed critical review of this, but also other methodological issues of importance in the implementation of composite approach in the analysis of regional disparities was presented by Perišić and Wagner [21] and Cziraky et al. [2].

Data and Methodology

In this section, aspects of the conducted research in terms of the selected variables, sources used, temporal–spatial data coverage, and used methodology framework are presented.

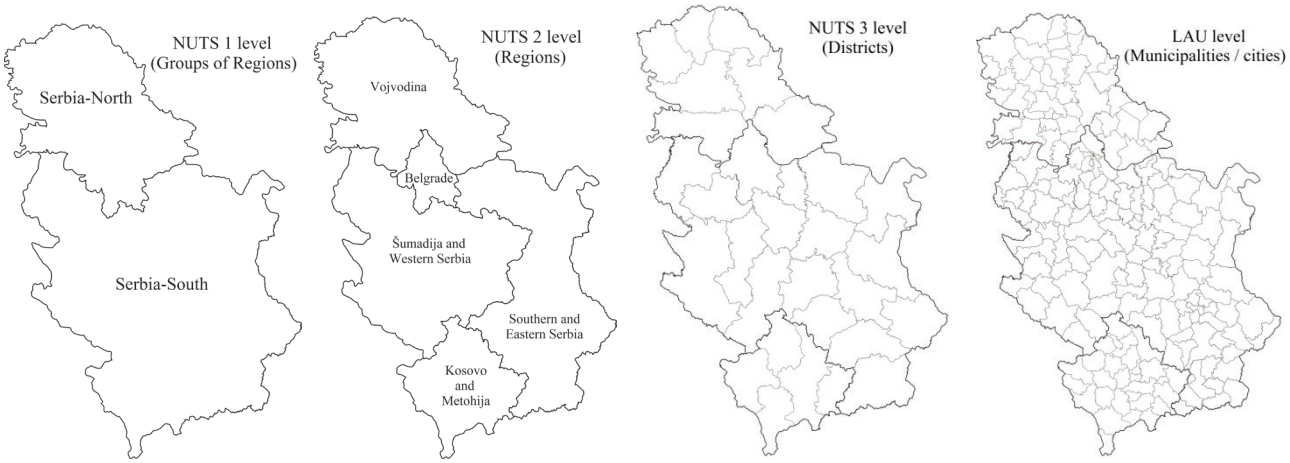
Variables, sources of data and temporal-spatial scope of research

Using the official statistical organization of territory of the Republic of Serbia (RS), based on the NUTS classification (Figure 1), secondary, at the time of realization of the empirical research last available, data for selected four indicators of different aspects of economic development (Table 2) were collected for each of 165 territorial units of LAU level (i.e. municipalities and cities) within the following four (out of a total of five) regions (NUTS-2 level) in the RS, namely: Belgrade Region, Vojvodina Region, Region of Šumadija and Western Serbia, and Region of Southern and Eastern Serbia. Data were obtained from the electronic database of *the Serbian Business Registers Agency* [*http://www.apr.gov.rs/*] and thematic publication of the Statistical Office of the RS (SORS) entitled *Municipalities and Regions of the Republic of Serbia 2016* [28]. All data refer do the year 2015. Since 1999 SORS provides no data for LAUs within the Kosovo and Metohija Region, they are not included in the research.

Table 2: List of used indicators of LAUs' economic development

Symbols	Economic indicators	Measurement units
X_1	Number of enterprises per 1000 inhabitants	number of enterprises
X_2	Employment rate	in %
X_3	Unemployment per 1000 inhabitants	number of unemployed
X_4	Average wage per employee	in RS Dinar

Figure 1: Cartographic representation of territorial organization of the RS



Instead of using the absolute values of selected indicators of economic development, their expression in the form of values (or numbers) per 1000 inhabitants or percentage is performed, in order to neutralize / mitigate the impact of total demographic mass of territorial units on the outcome of multivariate analysis and resulting classification. Besides respecting the research objectives and availability of data for a given level of territorial coverage, the additional justification of the selection of variables is supported by the fact that they represent the most commonly used economic indicators in relevant studies aimed at analyzing regional development level (e.g. [9], [27]).

Research methodology framework

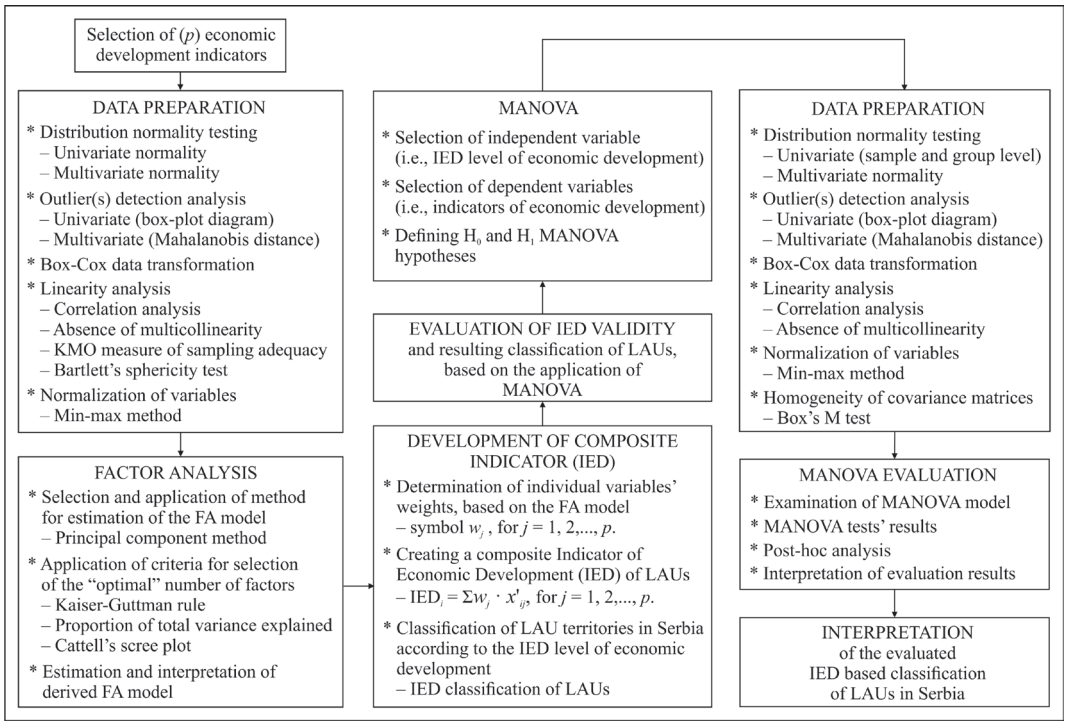
A comprehensive methodology framework, used as a basis for development of a composite (multivariate) model for measuring the degree of economic development of the observed LAUs and, consequently, the realization of formulated research objectives, is presented in Figure 2. It is based on a combined and complementary usage of factor analysis (FA) and one-way multivariate ANOVA method (MANOVA), aimed at examination of interdependencies between individual economic indicators and discovery of "natural", but hidden, latent structure (i.e. economic development level) within the analyzed set of multivariate observations. The application of exploratory FA is based on the assumption that there is at least one non-observable dimension in the basis of quantitative interrelationships of carefully selected indicators of economic development of LAUs, which can be considered as the main "cause" or "most responsible" factor of correlations present between them.

The estimated FA model is used as a basis for development of a composite indicator that provides "indirect measurement" of latent variable of interest. Starting from the estimated one-factor FA model, the isolated common factor is expressed in the form of a linear combination of p indicators and corresponding weight coefficients. The general mathematical expression of the created composite index, called the Index of Economic Development (acronym, IED), is:

$$IED_{(i)} \rightarrow F_{1(i)} = \sum_{j=1}^{p} w_j x'_{ij} = w_1 x'_{11} + w_2 x'_{12} + ... + w_p x'_{1p}, \quad (1)$$

where used symbols denote: x'_{ij} – normalized value of j^{th} variable X_j for i^{th} observation unit (for $j = 1, 2, ..., p$, and $i = 1, 2, ..., n$); $F_{(i)}$ – "estimated value" of extracted common factor (i.e. the IED value) for i^{th} observation; w_j – relative weight of j^{th} variable in the context of the common factor.

Figure 2: Schematic representation of the research methodology framework



The presented composite indicator aggregates the weighted values of individual indicators that represent different aspects of latent target dimension, in order to determine the "estimated values" of a single common factor for each i^{th} observation. This ensures the summarization and conversion of the original multidimensional research problem into a specific and, for understanding, much simpler one-dimensional form, which, as a rule, is "worth" (something) more than a simple sum of constituent parts. The determination of the weight coefficients (w_j) assigned to the individual indicators in expression (1) is based on the structure analysis of the proportion of total sample variance explained by the retained (single-factor) FA solution. The relative importance of indicators is equivalent to the proportion of estimated values of communalities in the explained share of total sample variance (i.e. the eigenvalue λ_1, which corresponds to the extracted common factor F_1), symbolically [4]:

$$w_j = \frac{communality_j}{\sum_{j=1}^{p} communality_j} = \frac{communality_j}{\lambda_1}. \qquad (2)$$

This methodological procedure, used in determining the weights, as opposed to the mostly present subjective approach of researchers in the literature, is considered as an objective approach since it is based on a specific statistical model [17], according to the evident connection with the estimated values of parameters of derived FA model. Consequently, the calculated values of the IED composite indicator represent a suitable basis for ranking and initial classification of analyzed LAUs, regarding the achieved economic development level. The classification of LAUs in RS was conducted on the basis of a comparison of individual IED values and their (adequate) mean value at the level of analyzed sample (i.e. national central tendency value). By testing the validity of the MANOVA assumption regarding the statistical significance of differences between the vectors of average values of selected economic indicators at the level of different groups of LAUs, created within the IED-based classification, the final verification of practical significance of the proposed IED indicator is performed. In accordance with the presented methodology, before applying the selected parametric multivariate methods, a detailed examination of the fulfilment of statistical assumptions on which their valid implementation is based, is conducted. The importance of this activity comes from the fact that neglect or incomplete implementation of preliminary data preparation phase is one of the key shortcomings of most previously conducted studies of a similar character. Since the analyzed variables are expressed in different measurement units, within the last step of data preparation, the procedure of normalization of their values was conducted aimed at eliminating differences in units and conversion to the same comparative basis.

Normalization of the original or previously transformed variables (marked as, *Xj* and *T-X*$_j$) is performed using the *min–max* method. The values of corresponding normalized variables (marked as, X_j') range from 0 to 1 [18]. For the purpose of precise comparison of the obtained IED values, the range of normalized values is expanded by converting the initial scale to the scale from 1 to 10, using expressions [27]:

$$\text{positive coding: } x'_{ij} = 9 \times \frac{x_{ij} - x_j^{min}}{x_j^{max} - x_j^{min}} + 1 \qquad \text{and}$$

$$\text{inverse coding: } x'_{ij} = -9 \times \frac{x_{ij} - x_j^{min}}{x_j^{max} - x_j^{min}} + 10 \qquad (3)$$

where, x'_{ij} is normalized value of *j*th indicator for i^{th} LAU (for $i = 1, 2,\ldots, n$, and $j = 1, 2,\ldots, p$), *xij* denotes original *i*th value of *j*th variable, while x_j^{min} and x_j^{max} represent minimum and maximum original value of j^{th} variable. Inverse coding was performed only for the variable *X*3, since a higher value of this indicator implies a lower level of economic development and vice versa. Data analysis and all necessary statistical calculations were carried out using the IBM SPSS Statistics, version 20, and SYSTAT, version 13.1.

Results of the research

In this Section, the results of FA-based construction of IED composite indicator, IED-based classification of observed LAUs and MANOVA-based evaluation of IED indicator validity are presented, with detailed verification of underlying statistical assumptions.

Examination of FA assumptions

In order to ensure valid application of FA, a complex iterative procedure for verifying the fulfilment of underlying statistical assumptions, presented in Figure 3, is conducted.

Since the Box–Cox data transformation process did not sufficiently mitigate the impact of all atypical values, a total of 20 observations identified as univariate (6 LAUs) and multivariate outliers (14 LAUs) were excluded from the initial sample ($n = 165$). In the newly formed, reduced sample ($n = 145$) there are no univariate (Figure 4), nor multivariate outliers, since the values of Mahalanobis distance, calculated for individual municipalities, are less than the corresponding critical value of χ^2 distribution ($\chi^2_{(4;\,0.975)} = 11.143$).

The results of testing hypotheses about univariate and multivariate normality of transformed variables' distribution are shown in Table 3.

The calculated values of Pearson's correlation coefficients (r) and results of testing their statistical significance (Table 4), suggest that there is a statistically significant linear relationship at population level between all pairs of economic indicators, thus confirming the fulfilment of linearity assumption. The presence of direct correlation is dominant. The exception is $T\text{-}X_3$, which is negatively correlated with the remaining indicators. The coefficient values higher than 0.80 or 0.90 are not recorded, since they, in absolute value, range from $|r_{min}| = 0.233$ to $|r_{max}| = 0.541$, thus confirming the absence of multicollinearity.

Figure 3: Schematic representation of the multivariate assumptions verification procedure

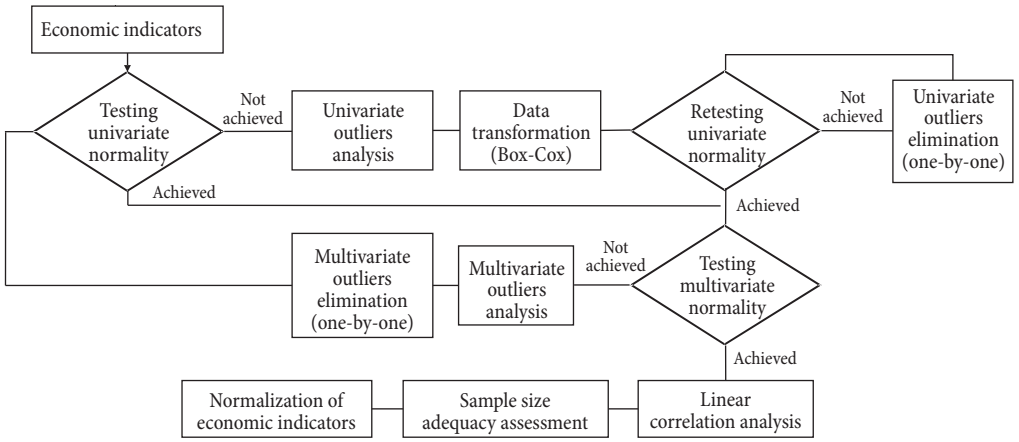


Figure 4: Box-plots of transformed variables

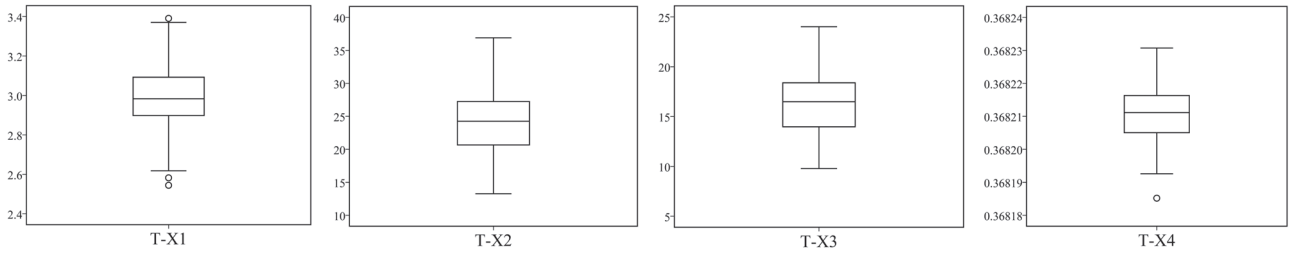


Table 3: The results of statistical tests for univariate and multivariate distribution normality

Variables	Anderson–Darling test[1]		Multivariate distribution	Mardia skewness test[2]		Mardia kurtosis test[3]	
	Statistics	p-value		Statistic	p-value	Statistic	p-value
$T\text{-}X_1$	0.591	0.121	Joint distribution of four variables	27.066	0.133 (H_0)	-1.315	0.189 (H_0)
$T\text{-}X_2$	0.388	0.383					
$T\text{-}X_3$	0.322	0.525					
$T\text{-}X_4$	0.251	0.737					

[1] Anderson-Darling normality test → H0: The analyzed variable is normally distributed;
[2] Mardia skewness test → H0: The multivariate distribution of p variables is symmetric;
[3] Mardia kurtosis test → H0: The multivariate distribution of p variables has normal kurtosis.

Table 4: Correlation matrix

Variables	$T\text{-}X_1$	$T\text{-}X_2$	$T\text{-}X_3$	$T\text{-}X_4$
$T\text{-}X_1$	1.000	-	-	-
$T\text{-}X_2$	0.475 [**]	1.000	-	-
$T\text{-}X_3$	−0.405 [**]	−0.541 [**]	1.000	-
$T\text{-}X_4$	0.233 [**]	0.446 [**]	−0.353 [**]	1.000

Note: Symbol [**] indicates the statistical significance of the calculated estimates at α = 0.01 level of significance.

For the purpose of additional assessment of the degree of interrelationship of variables and adequacy of their selection in context of FA application, the interpretation of values of Kaiser–Meyer–Olkin measure of sampling adequacy, calculated for complete correlation matrix (*Overall KMO–MSA*) and individual variables (*KMO–MSA*$_j$), is performed. The *overall KMO–MSA* is 0.732 and suggests an average level of adequacy of the selection of four variables, viewed from the perspective of the overall "strength" of correlation present between them. Table 5 contains individual *KMO–MSA*$_j$ values. The obtained approximate values, evidently above the minimum acceptable level of 0.50, indicate that the correlation of each individual variable with the remaining variables is, in general, at an average, satisfactory level, which unequivocally confirms and justifies their selection as FA input components.

Table 5: KMO–MSA values for individual indicators

Variables	*KMO–MSA*$_j$ values	Correlation strength
$T\text{-}X_1$	0.760	middling
$T\text{-}X_2$	0.687	mediocre
$T\text{-}X_3$	0.751	middling
$T\text{-}X_4$	0.764	middling

For testing the assumption that sample correlation matrix comes from population in which the analyzed variables are not statistically significantly correlated with each other (i.e. H_0: $|R| = |I| = 1$), the Bartlett's sphericity test statistic, $\chi^2_{(6;\,0.95)} = 125.788$, is calculated. Since resulting *p*-value (0.000) is less than test significance level $\alpha = 0.05$, it can be concluded that there is enough evidence to accept the alternative hypothesis, which claims that population correlation matrix R is different from the identity matrix I. This confirms the justification of FA application on elements of the analyzed matrix. Finally, since the sample size can significantly affect the accuracy of statistical procedures for the evaluation of FA model, it is necessary to emphasize that the (reduced) sample size satisfies general recommendations regarding the "desirable" number of observations. Available sample ($n = 145$) contains more than 100 observations, while the number of LAUs per each variable is greater than 30 (i.e. $n / p = 145{:}4 \approx 36{:}1$).

FA results and IED construction

Using correlation matrix data as input elements and principal components method, the estimation of FA model parameters was performed. The initial form of the estimated *p*-dimensional FA model is:

$$\begin{aligned} X'_1 &= (0.700)F_1 - (0.546)F_2 + (0.421)F_3 + (0.184)F_4 \\ X'_2 &= (0.843)F_1 - (0.001)F_2 - (0.041)F_3 - (0.536)F_4 \\ X'_3 &= (0.782)F_1 - (0.082)F_2 - (0.559)F_3 + (0.264)F_4 \\ X'_4 &= (0.656)F_1 + (0.682)F_2 + (0.270)F_3 + (0.178)F_4 \end{aligned} \quad (4)$$

Characteristic roots (i.e. λf, for $f = 1, 2,..., p$ where $p = 4$) in the basis of the presented model, and their corresponding shares of variables' total sample variance explained by each common factor (*Ff*), are shown in Table 6. Since there is only one characteristic root, specifically λ_1, whose value is greater than trace of analyzed correlation matrix (i.e. the average of four characteristic roots, $\bar{\lambda}=1$), according to Kaiser-Guttman rule, in order to redefine initially developed model and reduce its dimensionality, the decision to keep only the first common factor (F_1) in the reduced FA model is made.

Table 6: Results of the common factors extraction procedure

Common factors	Eigenvalues	Explained proportion of total initial variability	Cumulative proportions
F_1	2.242	56.053	56.053
F_2	0.771	19.267	75.320
F_3	0.564	14.110	89.430
F_4	0.423	10.570	100.00

The selection of a single-common factor solution as "optimal", in terms of the number of extracted factors, is confirmed by the criteria based on Cattell's scree plot and explained proportion of total sample variance, since more than half of total sample variability of analyzed variables (≈ 56%) is explained by F_1. Table 7 shows estimated values of parameters of the reduced single-factor model.

Table 7: Estimated (reduced) FA model*

Reduced FA model	Variables	Factor loadings	Communalities	Proportion of the explained variance	Specific variance
$X'_1 = 0.700\ F_1 + e_1$	X'_1	0.700	0.490	49.10	0.510
$X'_2 = 0.843\ F_1 + e_2$	X'_2	0.843	0.711	71.10	0.289
$X'_3 = 0.782\ F_1 + e_3$	X'_3	0.782	0.611	61.10	0.389
$X'_4 = 0.656\ F_1 + e_4$	X'_4	0.656	0.430	43.00	0.570
Total	/	/	$2.242 = \lambda_1$	≈ 56.053%	1.758

* In third column, the un-rotated factor loadings are presented, since only one common factor was extracted.
Note: Initial variability of each variable is 1.

Estimated values of factor loadings range from 0.656 to 0.843, indicating the presence of a moderate (in case of X'_4), or strong (for other variables) linear correlation between individual variables and the common factor F_1. Hence, they can be considered practically significant, in terms of providing an adequate approximation of interrelationship of selected indicators of economic development of LAUs. Since the sample size is 145 LAUs, it can be stated that the estimates of factor loadings are also statistically significant [7]. Comparing the estimated values of common and specific variance at the level of individual indicators, it is noticeable that variables X'_2 and X'_3 represent, in general, better and more reliable measures of extracted factor, as it explains ≈ 71% and 61% of their initial variability, respectively. The proportion of variability that remaining two variables "share" with other indicators is evidently lower, which can also be seen based on the size of estimates of their specific variances, but still at an acceptable level (≈ 50%). Factor F_1 is named the level of economic development, since all four variables measure one particular of several different aspects of LAUs' economic development.

Considering the factor F_1 as a non-observable multidimensional phenomenon of interest, and indicator-variables as "auxiliary means" necessary for indirect "measurement" of its level, using expression (1), a composite indicator, named *Index of Economic Development* (IED), is created. The weights (w_j) assigned to variables were determined using expression (2). The form of created indicator IED*i* (for $i = 1, 2,..., n$) is:

$$IED_{(i)} = 0.219 \cdot x'_{i1} + 0.317 \cdot x'_{i2} + 0.272 \cdot x'_{i3} + 0.192 \cdot x'_{i4}. \quad (5)$$

The greatest relative importance in calculating aggregate value of extracted common factor was given to the variable X_2, since it is characterized by the highest factor loading, followed by indicators X_3, X_1 and X_4.

Since the IED was developed using a reduced sample (145 LAUs), its application on all 165 LAUs, requires re-implementation of *min-max* transformation of indicators on initial sample in order to ensure comparability of their normalized values, x'_{ij}. IED values were calculated for each of 165 LAUs and, in accordance with performed normalization, range from 1 to 10, with higher values

Figure 5: Histogram of frequencies (left) and Box-plot (right) of IED values for 165 LAUs

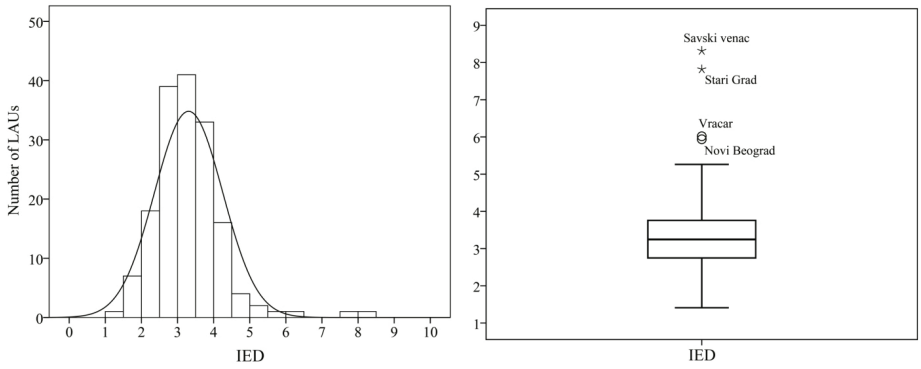


Table 8: Descriptive statistical measures of IED values for 165 LAUs

Average	Median	Mode interval	Minimum	Maximum	Standard deviation	Coefficient of variation
3.31	3.25	3.00–3.99	1.41	8.31	0.95	28.70%

indicating a higher economic development level and vice versa. The key characteristics of IED values' distribution are shown in Figure 5 and Table 8.

IED–based classification of the observed LAUs

The classification of LAUs in RS, according to "measured" level of economic development, is conducted on the basis of a comparison of individual IED values and adequate sample mean (i.e. national mean value). Since the results of descriptive analysis confirmed the presence of two real outliers, as a more appropriate measure of central tendency for the role of comparative basis, the median was chosen instead of the commonly used national average. This approach requires expression of absolute IED values as percentage of median, i.e. as achieved percent of national median level of economic development, $(\%m_e)_i$, using:

$$IED_i \rightarrow (\%\, m_e)_i = \frac{IED_i}{m_e} \cdot 100. \qquad (6)$$

By comparative analysis of series of converted values $(\%m_e)_i$ of individual LAUs, the specific classification criteria are defined, as the basis for allocating LAUs into one of six separate categories. Classification rules are given in Table 9, in the form of corresponding intervals of $(\%m_e)_i$ values.

The limit values of these intervals were determined taking into account certain aspects of the manner of classifying LAUs according to their level of development, which is specified by the Law on Regional Development in RS [6], as well as the characteristics of IED values' distribution. The results of the classification of 165 LAUs in the RS are presented in Appendix.

MANOVA–based estimation of IED validity

The verification of validity and practical significance of the IED indicator is performed by testing the assumption of statistical significance of differences between the vectors of average values of selected economic development indicators for different groups of proposed IED classification of LAUs. To achieve this goal, a one-way MANOVA was implemented, based on the following set of variables: (1) the level of economic development of LAUs is an independent (categorical) variable X_k, with six modalities (for $k = 1, 2,\ldots, 6$) that correspond to the formed groups of LAUs in the IED classification; and (2) four indicators of LAUs' economic development (used for construction of IED indicator) are dependent (numerical) variables (Y_j, for $j = 1, 2, 3, 4$), whose averages ($\bar{y}_j$) are compared by created groups.

Table 9: IED-based classification of LAUs

Category		Number of LAUs	Classification rules	IED intervals by groups
Name	Code			
Group-1	G-1	2	$(\%\, m_e)_i \geq 200\%\, m_e$	> 6.500
Group-2	G-2	2	$200\%\, m_e > (\%\, m_e)_i \geq 180\%\, m_e$	[5.850–6.500)
Group-3	G-3	3	$180\%\, m_e > (\%\, m_e)_i \geq 150\%\, m_e$	[4.875–5.850)
Group-4	G-4	75	$150\%\, m_e > (\%\, m_e)_i \geq 100\%\, m_e$	[3.250–4.875)
Group-5	G-5	77	$100\%\, m_e > (\%\, m_e)_i \geq 60\%\, m_e$	[1.950–3.250)
Group-6	G-6	6	$60\%\, m_e > (\%\, m_e)_i$	< 1.950

Table 10: Average values of dependent variables per created groups of LAUs

Independent X_k / Dependent variables		Number of enterprises per 1000 inhabitants	Employment rate	Unemployment per 1000 inhabitants	Average wage per employee
Category (k)	Size (n_k)	$\bar{y}_1$	$\bar{y}_2$	$\bar{y}_3$	$\bar{y}_4$
G-1	2	161.00	314.86	58.50	56.17
G-2	2	96.50	93.47	53.50	62.87
G-3	3	41.67	48.24	56.57	65.75
G-4	75	43.40	37.56	81.05	39.26
G-5	77	33.42	29.28	140.92	33.47
G-6	6	29.33	25.47	223.00	32.93
Total	165	40.27	37.49	113.10	37.30

Before checking the fulfilment of MANOVA assumptions, the number of initially defined modalities of independent variable was reduced. Namely, because they are characterized by a very small number of LAUs, the first three groups do not meet the experiential recommendations regarding the minimum number of elements per group [29]. In Table 10, clear differences can be seen in terms of average values of each indicator for the first three groups compared to the remaining groups, among which these differences are less pronounced. Since their size (n_k) is less than number of used dependent variables, they are excluded from further analysis, and attention is focused on testing the MANOVA hypotheses for remaining three larger groups. An additional argument for eliminating these groups is that LAUs in their composition represent outliers that would certainly be removed from the sample during the assumption verification process. Thus, the reduced sample size used in MANOVA is 158 LAUs.

The fulfilment of MANOVA assumptions was checked by implementing the iterative procedure already described in Figure 3. The obtained results can be sublimated as follows:

- A total of 16 municipalities, identified as univariate (2 LAUs) and multivariate outliers (14 LAUs) were excluded from the available sample of observations;
- The one-dimensional normality of dependent variables' distribution, both at the level of reduced sample (142 LAUs) and by selected categories of independent variable, was confirmed. Also, the normality of multivariate joint distribution of four dependent variables was confirmed;
- The results of correlation analysis suggest that there is a statistically significant linear relationship between all pairs of dependent variables at population level;
- The correlation coefficients, in absolute values, range from 0.220 to 0.515, which confirms that analyzed indicators are not highly correlated.

Finally, the calculated value of Box's M test statistic ($M = 15.884$) and, based on it, the value of approximate F statistic ($F_{(\alpha;\ 10;\ 82540.845)} = 1.537$) suggest that there is not enough empirical evidence to reject the null hypothesis of homogeneity of covariance matrices of three groups of multivariate observations, since the resulting level of significance (p-value = 0.119) is greater than $\alpha = 0.05$. Based on decomposing the total variability of four dependent variables into factor and residual variability respectively, estimated MANOVA model, in matrix form is:

$$\begin{bmatrix} 447.73 & 235.01 & 198.41 & 96.81 \\ 235.01 & 549.38 & 238.84 & 192.99 \\ 198.41 & 283.84 & 551.97 & 151.16 \\ 96.81 & 192.99 & 151.16 & 434.34 \end{bmatrix} = \begin{bmatrix} 97.50 & 139.79 & 182.37 & 105.56 \\ 139.79 & 201.20 & 261.79 & 148.80 \\ 182.37 & 261.79 & 341.25 & 196.39 \\ 105.56 & 148.80 & 196.39 & 122.64 \end{bmatrix} + \begin{bmatrix} 350.23 & 95.22 & 16.04 & -8.75 \\ 95.22 & 348.18 & 22.05 & 44.19 \\ 16.04 & 22.05 & 210.72 & -45.23 \\ -8.75 & 44.19 & -45.23 & 311.70 \end{bmatrix} \quad (7)$$

The estimation of MANOVA model with one factor (X_k, for k = G-4, G-5, G-6) was performed using normalized values of dependent variables (Y_j' for j = 1, 2, 3, 4) in a sample of 142 LAUs. The results of MANOVA null hypothesis testing are given in Table 11.

The results, unequivocally and "unanimously" suggest the acceptance of an H1, which claims that there is a statistically significant difference between at least two groups of LAUs in terms of corresponding vectors of averages of four economic indicators, since the p-values of approximate F statistics, for all four MANOVA statistics, are less than error risk $\alpha = 0.05$. Also, the results of one-way ANOVA (Table 12) suggest that, in case of all dependent variables, there are enough arguments to accept H1, which

Table 11: Results of MANOVA tests

MANOVA tests	Statistics	F approximation	Degrees of freedom		p-value
			df_1	df_2	
Wilks's lambda	0.260	32.651	8	272	0.000
Pillai's trace	0.761	21.051	8	274	0.000
Lawley–Hotelling trace	2.760	46.577	8	270	0.000
Roy's largest root	2.730	93.495	4	137	0.000

claims that there is a statistically significant difference between at least two groups of LAUs in terms of average values of individual indicators, since the *p*-values, are less than Bonferonni corrected significance level, $\alpha^* = 0.0125$.

Table 12: One-way ANOVA results

Dependent variables	F-statistic	Degrees of freedom		*p*-value
		df_1	df_2	
Y_1'	19.347	2	139	0.000
Y_2'	40.162	2	139	0.000
Y_3'	112.551	2	139	0.000
Y_4'	27.344	2	139	0.000

By confirming the statistical significance of differences between averages of economic indicators of LAUs distributed within groups 4, 5 and 6, in ANOVA and MANOVA contexts, additional verification of practical significance of created IED indicator and, based on it, classification of LAUs is provided.

Discussion and interpretation of the obtained results

In this Section, the interpretation of proposed, and MANOVA–confirmed, IED–based classification of LAUs in RS according to the "measured" level of economic development (Table 9), is performed. The summary of numeric characteristics for created groups (Table 13) is supported by cartographic representation (Figure 6).

First three groups, G-1, G-2, and G-3, together comprise only 7 of a total of 165 LAUs, or approximately 4% of the sample. These groups include exclusively municipalities in the territory of the city of Belgrade, the capital of the RS, which represents the leading economic, administrative, cultural and university centre in the state, with exceptionally favourable geographical position and infrastructure preconditions (road and railroad nodes, Danube corridor, airport) for intensive economic development and attraction of domestic and foreign investments [27]. These municipalities are characterized by IED values that are above 150% of the national median value (IED ≥ 4.875). In that sense, it can be stated that their achieved level of economic development, "measured" by IED, is obviously higher compared to the members of remaining groups. This composition of groups that are characterized by the most favourable values of economic indicators is fully expected, since these municipalities were identified as outliers during the process of verifying statistical assumptions. Based on the results of intergroup comparison of their IED averages (Table 13), as well as with the corresponding national median value, the following descriptive names were determined: Group 1 – *extremely high level*, Group 2 – *high level*, and Group 3 – *above average level of economic development*.

Group 4 includes 75 LAUs (≈ 45% of the sample) whose IED values are ranging from 100% to 150% of the median value (3.250 ≤ IED < 4.875). According to the number of municipalities covered, the IED value interval that defines it, as well as slight positive differences between its IED average (3.77) and national IED median value (3.25), for this group can be said to represent "median & average" group, in statistical terms. Consequently, this group of LAUs was given the following descriptive name: Group 4 – *average level of economic development*. The ratio of average IED values of groups G-1 and G-4, which is approximately 2:1, in favour of G-1, indicates the presence of a pronounced gap in terms of their economic development.

Group 5 includes 77 LAUs (≈ 47% of the total number of LAUs), for which IED values were determined at the level of 60% to 100% of median (1.95 ≤ IED < 3.25). In Figure 6, it can be seen that these are mostly municipalities that, in comparison to the G-4, are generally more "distant" from

Table 13: Ratios of average IED values for each pair of groups of LAUs*

IED average	IED min-max values	Group	G-1	G-2	G-3	G-4	G-5	G-6
8.07	7.82 – 8.31	G-1	1:1	0.35:1	1.60:1	2.14:1	2.97:1	4.69:1
5.98	5.94 – 6.02	G-2	0.74:1	1:1	1.18:1	1.59:1	2.20:1	3.48:1
5.05	4.89 – 5.26	G-3	0.63:1	0.84:1	1:1	1.34:1	1.86:1	2.94:1
3.77	3.25 – 4.83	G-4	0.47:1	0.63:1	0.75:1	1:1	1.39:1	2.19:1
2.72	1.95 – 3.24	G-5	0.34:1	0.45:1	0.54:1	0.72:1	1:1	1.58:1
1.72	1.41 – 1.94	G-6	0.21:1	0.29:1	0.34:1	0.46:1	0.63:1	1:1

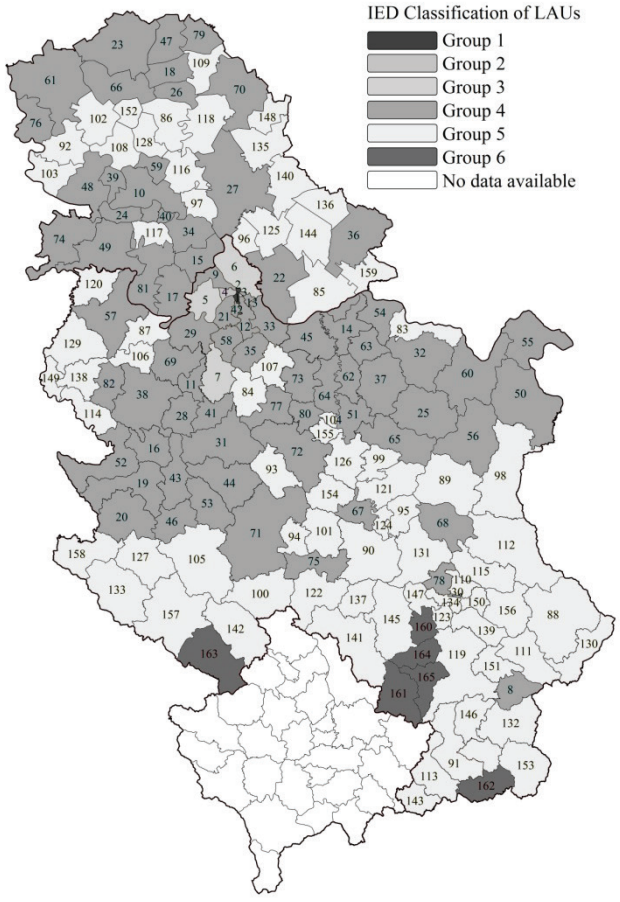
* National (republic) *IED* central tendency value: *median* = 3.25

the Belgrade region and its municipalities. Also, since it includes the largest number of LAUs compared to other groups, it can be said that G-5 is a "modal group" in the statistical sense of the word. In contrast to the situation in G-4, a comparison of national median IED value and corresponding IED average for G-5 shows a certain negative deviation, which is significantly smaller than in the case of G-6. This observation was confirmed by the ratio of IED averages for G-1 and G-5, which is approximately 3:1, in favour of G-1. Accordingly, this group was given the following descriptive name: Group 5 – *below average level of economic development*.

The structure of Group 6 includes only 6 municipalities (≈ 4% of the total number of LAUs), whose IED values are below 60% of median value (IED < 1.95). The pronounced negative difference between the IED average for this group (1.72) and national median value unequivocally indicates the worrying state of the overall economic situation in the respective municipalities. Consequently, it was given the following description: Group 6 – *extremely low level of economic development*. The ratio ≈ 4.7:1, obtained for IED average values of G-1 and G-6, clearly indicates the serious scale of economic disparities.

The above interpretation, unfortunately, confirms the presence of pronounced regional inequalities and asymmetries among the analyzed territorial units in the RS in terms of the achieved level of economic development, in 2015. This statement is best confirmed by the ratio of IED values of the most developed (Savski Venac, 8.31) and the least developed municipality (Lebane, 1.41), which is 5.89:1. In general, the proposed classification of LAUs confirms the well-known statement regarding the presence of pronounced regional and intra-regional polarization in the RS, primarily in direction of "developed north–underdeveloped south". Namely, approximately 91% of municipalities within the Region of Southern and Eastern Serbia belong to groups of extremely low and below average economic development (G-5 and G-6). On the other hand, approximately 55% of municipalities of the Vojvodina Region (located in the north of Serbia) are

Figure 6: Cartographic representation of IED classification of LAUs in RS*



*Used numbers represent IED ranks of municipalities, and their correspondent names are given in Appendix.

allocated within the G-4, while the remaining LAUs are members of the G-5, but predominantly with IED values above the corresponding average for that group. Also, 7 of the 17 Belgrade municipalities form Groups 1, 2 and 3, while the rest are in leading positions in the G-4.

Finally, it is important to emphasize that the comparability of presented results of measuring the level of economic development of LAUs in RS and their classification with the results of previously conducted studies of similar type and objectives is not possible, due to the presence of highly pronounced differences regarding the spatial and temporal coverage of data, the selected development dimension(s) and individual indicators, as well as the methodological approach used. Regardless of previous observation, the proposed IED classification of LAUs, can serve as a suitable basis for further and "deeper" analysis of situation and trends in other dimensions of regional development and for drawing conclusions about their interdependence.

Conclusion

Starting from indisputable importance of quantifying the economic development level of LAUs for planning and successful implementation of national strategy of balanced regional development, in this paper, an innovative and complex multivariate statistical approach, intended for objective assessment of apostrophized multidimensional economic phenomenon, is presented, using municipalities in the Republic of Serbia as a working basis. Based on a statistically valid and combined application of FA and MANOVA, the proposed methodological approach enables simultaneous analysis of four representative economic indicators, available for LAU level territories, and their objectively weighted aggregation in the form of IED composite indicator. This indicator is proven to be a very useful analytical tool for measuring the level of LAUs' economic development, their classification and, consequently, identifying the extent of existing economic disparities.

Contrary to the approaches based on monitoring the values of individual economic indicators and separate interpretation of numerous one-dimensional classifications of municipalities, the applied methodological framework enables multivariate compression of used economic indicators in the form of a described composite indicator, whose values represent a suitable basis for ranking and creating only one common classification of LAUs. The performed IED measurement and conducted classification enable a quite precise estimation of the extent of economic disparities between municipalities and monitoring the success of implemented measures of balanced regional development policy. Although demonstrated on the example of municipalities in RS, taking into account the high data availability of selected economic indicators, the proposed methodological approach can also be successfully applied on LAUs in territorial composition of other countries, which indirectly confirms its high application potential.

In addition, compared to most previously conducted studies of similar objectives in the literature, the key advantage of proposed analytical framework is a thorough verification of the fulfilment of statistical assumptions, as a crucial activity for ensuring the valid application of FA and MANOVA, but also the scientific basis of obtained results and conclusions. Taking into account the elaborated impossibility of direct comparability of presented results with the mentioned similar studies, the statistical validity and quality of developed IED indicator and created LAUs classification were verified by the MANOVA output. Additional, direct confirmation of the usage value of IED indicator arises from the fact that IED classification of LAUs confirmed the well-known official statement regarding the presence of pronounced regional and intra-regional polarization in the RS, primarily in direction of "developed north–underdeveloped south".

Although quite rigorous in statistical terms, the proposed multivariate methodological approach provides a clear, informative, objective, statistically valid and transparent quantification of the level of economic development and, consequently, an analysis of the present economic disparities between the observed territorial units, thus providing useful and reliable information input to the creators of balanced regional development strategy. Its immanent flexibility, conditioned by objective determination of the individual indicators' weights, significantly expands the range of possible ways and areas of application. Hence, its application on administrative units of the

same or higher level of territorial organization of other countries, using indicators of other important development dimensions, in addition to the economic one, either in individual or integral context, with different temporal coverage, may represent some of the possible directions of future research.

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Authors declare that they do not have any financial, professional, or personal interests from other parties.

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Appendix:
Overview of analyzed LAUs' distribution by IED classification categories

Category	Names of the local self-government units [IED value]		
G-1	1. Savski Venac [8,31]	2. Stari Grad [7,82]	
G-2	3. Vracar [6,02]	4. Novi Beograd [5,94]	
G-3	5. Surcin [5,26]	6. Palilula [5,00]	7. Lazarevac [4,89]
G-4	8. Crna Trava [4,83] 9. Zemun [4,77] 10. Novi Sad [4,71] 11. Lajkovac [4,46] 12. Vozdovac [4,37] 13. Zvezdara [4,36] 14. Pozarevac [4,34] 15. Stara Pazova [4,23] 16. Kosjeric [4,22] 17. Pecinci [4,22] 18. Senta [4,20] 19. Uzice [4,20] 20. Cajetina [4,19] 21. Cukarica [4,18] 22. Pancevo [4,16] 23. Subotica [4,11] 24. Beocin [4,08] 25. Zagubica [4,03] 26. Ada [4,00] 27. Zrenjanin [3,97] 28. Mionica [3,95] 29. Obrenovac [3,91] 30. Medijana [3,91] 31. Gornji Milanovac [3,90] 32. Kucevo [3,89]	33. Grocka [3,88] 34. Indjija [3,87] 35. Sopot [3,85] 36. Vrsac [3,80] 37. Petrovac na Mlavi [3,79] 38. Valjevo [3,79] 39. Backi Petrovac [3,78] 40. Sremski Karlovci [3,77] 41. Ljig [3,76] 42. Rakovica [3,76] 43. Pozega [3,75] 44. Cacak [3,74] 45. Smederevo [3,74] 46. Arilje [3,72] 47. Kanjiza [3,71] 48. Backa Palanka [3,69] 49. Sremska Mitrovica [3,66] 50. Negotin [3,66] 51. Svilajnac [3,62] 52. Bajina Basta [3,56] 53. Lucani [3,56] 54. Veliko Gradiste [3,54] 55. Kladovo [3,53] 56. Bor [3,52] 57. Sabac [3,51]	58. Barajevo [3,50] 59. Temerin [3,50] 60. Majdanpek [3,50] 61. Sombor [3,50] 62. Zabari [3,50] 63. Malo Crnice [3,50] 64. Velika Plana [3,50] 65. Despotovac [3,48] 66. Backa Topola [3,48] 67. Varvarin [3,46] 68. Sokobanja [3,44] 69. Ub [3,42] 70. Kikinda [3,38] 71. Kraljevo [3,36] 72. Kragujevac [3,35] 73. Smed. Palanka [3,34] 74. Sid [3,33] 75. Aleksandrovac [3,32] 76. Apatin [3,32] 77. Topola [3,32] 78. Crveni krst [3,31] 79. Novi Knezevac [3,30] 80. Raca [3,28] 81. Ruma [3,26] 82. Osecina [3,25]
G-5	83. Golubac [3,24] 84. Arandjelovac [3,24] 85. Kovin [3,23] 86. Becej [3,22] 87. Vladimirci [3,22] 88. Pirot [3,20] 89. Boljevac [3,18] 90. Krusevac [3,17] 91. Vranje [3,15] 92. Odzaci [3,13] 93. Knic [3,13] 94. Vrnjacka Banja [3,12] 95. Razanj [3,12] 96. Opovo [3,08] 97. Titel [3,07] 98. Zajecar [3,07] 99. Cuprija [3,03] 100. Raska [3,00] 101. Trstenik [2,99] 102. Kula [2,97] 103. Bac [2,96] 104. Lapovo [2,91] 105. Ivanjica [2,91] 106. Koceljeva [2,90] 107. Mladenovac [2,89] 108. Vrbas [2,88]	109. Coka [2,88] 110. Pantelej [2,87] 111. Babusnica [2,86] 112. Knjazevac [2,85] 113. Bujanovac [2,85] 114. Ljubovija [2,82] 115. Svrljig [2,81] 116. Zabalj [2,80] 117. Irig [2,80] 118. Novi Becej [2,79] 119. Leskovac [2,78] 120. Bogatic [2,77] 121. Paracin [2,77] 122. Brus [2,76] 123. Doljevac [2,75] 124. Cicevac [2,75] 125. Kovacica [2,74] 126. Jagodina [2,74] 127. Nova Varos [2,74] 128. Srbobran [2,70] 129. Loznica [2,70] 130. Dimitrovgrad [2,68] 131. Aleksinac [2,67] 132. Surdulica [2,66] 133. Prijepolje [2,66] 134. Palilula [2,64]	135. Zitiste [2,61] 136. Plandiste [2,59] 137. Blace [2,59] 138. Krupanj [2,58] 139. Gadzin Han [2,58] 140. Secanj [2,50] 141. Kursumlija [2,44] 142. Novi Pazar [2,42] 143. Presevo [2,42] 144. Alibunar [2,40] 145. Prokuplje [2,39] 146. Vladicin Han [2,35] 147. Merosina [2,33] 148. Nova Crnja [2,26] 149. Mali Zvornik [2,23] 150. Niska Banja [2,23] 151. Vlasotince [2,19] 152. Mali Idjos [2,15] 153. Bosilegrad [2,10] 154. Rekovac [2,10] 155. Batocina [2,09] 156. Bela Palanka [2,08] 157. Sjenica [2,03] 158. Priboj [1,99] 159. Bela Crkva [1,95]
G-6	160. Zitoradja [1,94] 161. Medvedja [1,93]	162. Trgoviste [1,86] 163. Tutin [1,61]	164. Bojnik [1,59] 165. Lebane [1,41]

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DETERMINANTS OF EUROPEAN TELECOM OPERATORS' CAPITAL STRUCTURE

Determinante strukture kapitala evropskih telekomunikacionih operatora

Abstract

In recent years, the telecommunications services sector has made a remarkable contribution to the global economy, thereby attracting the interest of researchers. This study aims to examine the relationship between total leverage and its main components (short-term and long-term leverage) and firm-specific and country-specific factors affecting the capital structure of European telecom operators during 2009-2020. The observed period, beginning right after the world economic crisis in 2008, was characterized by a stable economy and the expansion of mobile communications, and the Internet and multimedia services. We used dynamic panel regression models with 9 explanatory and three dependent variables and concluded that liquidity, profitability, sales growth, assets turnover, cost of debt, and non-debt tax shield had a significant influence on the capital structure of European telecom operators. We found that total leverage and long-term leverage significantly depend on their previous year's values. Tangibility, size of firm, and country GDP growth rate were not significantly associated with the capital structure of telecom operators within the observed period. The findings about a dominant negative impact of liquidity and profitability, and the positive impact of sales growth on leverage, are in line with the postulations of the pecking-order theory. This study can be helpful to managers and other stakeholders in improving their understanding of the factors affecting the capital structure of telecom operators.

Keywords: *telecom, capital structure, leverage, dynamic panel regression, GMM, Europe*

Sažetak

Sektor telekomunikacionih usluga je prethodnih godina pružio značajan doprinos svetskoj ekonomiji, čime je privukao pažnju istraživača. Ovo istraživanje ima za cilj da ispita vezu između ukupne zaduženosti i njenih osnovnih komponenti (kratkoročne i dugoročne zaduženosti), i faktora specifičnih za kompaniju i privredu koji su mogli uticati na strukturu kapitala evropskih telekomunikacionih operatora u periodu 2009-2020. Posmatrani period, koji počinje odmah nakon svetske ekonomske krize 2008. godine, karakteriše privredna stabilnost i ekspanzija mobilnih komunikacija, interneta i multimedijalnih usluga. U dinamičkim panel regresionim modelima koristili smo devet objašnjavajuć ih i tri zavisne varijable i zaključili da su likvidnost, profitabilnost, rast prodaje, obrt imovine, cena duga i nedužnički poreski štit imali značajan uticaj na strukturu kapitala evropskih telekomunikacionih operatera. Utvrdili smo da ukupna i dugoročna zaduženost značajno zavise od svojih prošlogodišnjih vrednosti. Struktura imovine, veličina kompanije i stopa rasta BDP-a države nisu značajno uticali na strukturu kapitala telekomunikacionih operatera u posmatranom periodu. Nalazi o dominantnom negativnom uticaju likvidnosti i profitabilnosti, kao i pozitivnom uticaju rasta prodaje na zaduženost, konzistentni su sa predviđanjima teorije hijerarhije (pecking-order). Ova studija može koristiti telekom-menadžerima i ostalima koji su zainteresovani za bolje razumevanje faktora koji mogu da utiču na strukturu kapitala telekomunikacionih operatora.

Ključne reči: *telekom, struktura kapitala, zaduženost, dinamička panel regresija, GMM, Evropa*

Introduction

Telecommunications has been one of the fastest growing and most capital-intensive industries in the past 15 years. At the same time, the telecommunications market has been one of the most competitive markets in the world. It is a consequence of technological development, which included, among other things, the implementation of 4G mobile technology (since 2009), the development and implementation of 5G technology (since 2019), the upgrading of the telecommunications infrastructure, and the construction of fixed optical networks for end users due to the incredible increase in Internet traffic and multimedia services. All these developments required telecommunication service providers to invest heavily in their telecommunication networks and services. The growing number of users proves that telecoms respond to all those business requirements and challenges by investing in networks, employees, and services.

This study investigates how telecoms have financed their investments, which sources have been used to finance their activities, how they managed their capital structure, and what affected their capital structure the most. The main research questions of our study are: (1) Which of the existing capital structure theories is most suitable to explain the European telecom companies' capital structure? (2) How do the selected internal and external factors determine/affect the capital structure of European telecom companies?

Capital structure can be defined as a share of debt in equity or total assets. As an important strategic decision, capital structure policy depends on a firm's performances, business models, and business environment conditions (country and industry characteristics). An optimal balance between the debt and equity means simultaneously minimizing costs and maximizing a firm's value. Despite the optimal capital structure being a moving target, management's constant pursuit of this target is important and desirable. Capital structure is influenced by internal (firm-specific) and external (macroeconomic) factors. Harris and Raviv [24, pp. 333-334] confirmed that capital structure is industry-specific and found that some production sectors, such as drugs, electronics, and food have low leverage, while the industries of steel, cement, paper, and textiles usually have high leverage.

Leverage implies an increase in long-term debt in the capital structure. The positive effect of leverage is reflected in the provisioning of funds for investments and the resulting increase in the firm's profit. The negative effect of leverage stems from an increase in financial risks and an eventual inability to repay the debt. Determining the optimal capital structure means finding a balance between the positive and negative effects of leverage to achieve maximal firm value. Capital structure indicates a firm's health or potential risk of financial distress. It affects a firm's performance, and, therefore, it is important to know which factors affect capital structure and how [21, p. 48].

There is a lack of capital structure research that studies companies from the telecommunications services sector. According to Kumar et al. [29] and their sample of 167 'capital structure determinants' papers from 1972 to 2013, about 50% of studies on capital structure from Europe examine small and medium-sized enterprises (SMEs). The number of studies on large enterprises is also significant. The authors concluded that less than 10% of the papers refer to individual industries, and about three-quarters of the papers deal with groups of different companies from different industries, i.e., a mix of companies from several industrial sectors. As most studies examined companies from single countries, their primary focus was on firm-specific factors rather than macroeconomic factors (e.g. GDP, inflation), which are assumed to have a similar effect on capital structure decisions for all companies. We observed that little research on the capital structure has an international approach and pertains to individual industries, which we identified as a research gap that we try to address with our research.

This study complements the collection of research on capital structure issues. To the best of our knowledge, this research is unique for European telecoms. There are no previous studies about the effects of different factors on telecoms' capital structure. All sampled telecom operators are multi-service operators that provide voice, internet, and multimedia (TV) services, which makes them directly comparable.

Our paper is organized as follows. The next section presents the theoretical background and previous relevant empirical research. The data sources, used variables, and empirical models are described and explained in the third section. The fourth section summarizes the results and discusses our findings, and the last section provides concluding remarks and elaborates on the limitations of the study, as well as suggestions for future research.

Literature review

Capital structure theory

With the assumption of a perfect capital market, without taxes, transaction and bankruptcy costs, conditions of information asymmetry, and the agency problem, Modigliani and Miller [33, p. 258] postulated the theorem that the value of a company is independent of its capital structure. Therefore, their theory is also called the theory of irrelevance, which states that, for the value of a company, it is irrelevant whether the company has debts or not. A company can increase its value even if the capital structure does not change. Realistic business conditions and criticism of their postulates forced Modigliani and Miller [34, p. 434] to include the existence of corporate taxes in their considerations. They corrected their original position – the introduction of taxes means that the value of a company depends on the capital structure. A higher indebtedness ensures the effect of a tax shield (tax reduction) and possibly a higher value for owners (higher profit margin on owner's capital). However, the increase in debt triggers financial risk, and there is often the need for appropriate risk premiums for capital lenders to compensate for the increased probability of the firm's bankruptcy. Modigliani and Miller's theory of irrelevancy was the initiator for further research and the development of theories about capital structure.

Trade-off theory (TOT) – Awareness of the necessity of debt–equity balance led to the initiation of the trade-off theory, which attempts to reconcile the advantages and disadvantages of debt. The convenience of debt is in the interest tax deductions (debt tax shield), and the inconvenience is in the potential costs of bankruptcy. The bottom of the trade-off theory is a balance (compromise) between them and an attempt to find an optimal capital structure. According to this theory, large companies can use their assets as collateral, such as how profitable companies with stable incomes lean towards debt financing. Using leverage is expected to increase returns.

Pecking order theory (POT) – Firm managers almost always have better and more accurate information about the firm's performance and capabilities than the firm's owners or investors. Such an assumption is called information asymmetry and is the basis of pecking order theory (POT). The POT was established by Myers and Majluf [38]. They state that firms prefer financing from internal sources (retained earnings) and try to avoid borrowing. If the company needs more funds, it reaches for external sources of funds – first debt, then corporate bonds, and finally, the issue of shares. Contrary to Modigliani and Miller's theory, the POT considers that the value of the firm depends on the capital structure, regardless of taxes. Since it deals with two types of capital, internal and external, the POT does not recognize the existence of an optimal capital structure, unlike the TOT.

The implications of these two theories have often been discussed and empirically tested in the literature. Although not always unambiguous, the effects of the internal factors affecting capital structure have been suggested in the literature. Starting with Modigliani and Miller [33], apart from the TOT and the POT, several theories about capital structure have been developed, such as market timing theory, agency theory, the theory of signalization, and the theory of free cash flow [28]. All these theories have their arguments in explaining corporate financing, but there is no single and complete answer about optimal capital structure management.

Review of previous research

Among the studies on the determinants of capital structure, we observed several different approaches. First, there was a country-specific approach – for example, Bevan and Danbolt [6] for the UK, Chen [11] for China, Ozkan [39] for Turkey, Mazur [32] for Poland, Handoo and Sharma [23] for India, and Cortez and Susanto [12] for Japan. Second,

there was an industry-specific approach – for example, Pinkova [41] and Afza and Hussain [2] for the automotive industry, Acaravci [1] for manufacturing, Rehman et al. [45] for pharmaceutical, Shambor [47] for oil and gas, and Berkman [5] for energy. Third, there was a multi-country approach – for example, Berkman [5], Delcoure [16], Psillaki and Daskalakis [42], and Moradi and Paulet (2018) for European countries, De Jong et al. [14] and Shambor [47] for a global selection, and Deesomsak et al. [15] for the Asia Pacific. Our study has a multi-country industry-specific approach.

Rajan and Zingales [44, pp. 1453-1454] proved that size, growth, profitability, and tangibility are important factors that affect firms' capital structure in the most developed (G7) countries. They found that the impact of the determinants on capital structure differs among different countries. Mokhova and Zinecker [36, p. 2533] proved that the determinants of capital structure in EU member and EU candidate countries depend on the specifics of the country. Joeveer [26, p. 294] concluded that firm-specific factors are the most influential on leverage for both listed and non-listed large firms in Eastern European countries. Bradley et al. [9, p. 858] noted that firms make sure that their leverage follows the industry average. Titman [50, p. 150] revealed that companies with unique, high-quality offers usually have lower leverage. Bevan and Danbolt [6, p. 159] state that 'analysis of capital structure is incomplete without a detailed examination of all forms of corporate debt', meaning not only leverage but also its components. This approach was applied by many authors, such as Bauer [4], Feidakis and Rovolis [17], and Handoo and Sharma [23], analysing the influence of capital structure determinants on total leverage, short-term leverage, and long-term leverage. Li and Stathis [30, p. 27] and Frank and Goyal [18, pp. 21-22] argued that the significant influence of some determinants on the capital structure of companies is not absolute and unchanging over time; rather, it depends on the business condition and macroeconomic policy.

Berkman et al. [5] performed panel data analysis of 79 European energy companies in the period 2009–2012 and found that liquidity has a negative association with leverage, which supports the POT, while equity turnover and tangibility (asset structure) have a positive association with leverage, which is consistent with the TOT. Investigating the influence of firm-specific and country-specific determinants on capital structure in Russia and the Baltic countries (Estonia, Latvia, and Lithuania) in the period 2002–2008, Tamulyte [48] reveals that tangibility, liquidity, and profitability had a significant impact on total, short-term, and long-term leverage in those four countries. Liquidity had a significant role in all Baltic countries, and profitability was significant in Lithuania and Russia, supporting the POT. Teixeira and Parreira [49, p. 114] noticed that Portuguese commercial ICT companies have higher debt when compared to ICT service providers. Using multiple regression, they found that business risk, size, and tangibility had a significant positive impact on debt and the cost of financing, while the firm's age in years and profitability had a significant negative impact on debt. Shambor [47] analysed 346 global oil and gas firms from six continents in the period 2000–2015. By using six explanatory variables (growth, tangibility, profitability, size, liquidity, and non-debt tax shield), he found that the capital structure policy of global oil and gas companies is mainly consistent with POT, due to the dominant negative influence of profitability, tangibility, and liquidity.

Li and Stathis [30, p. 29] determined that, although Australian companies mainly follow the POT, in times of higher taxes, they redirected towards the TOT. Frank and Goyal [18, p. 1] proved that US companies lean toward the TOT. Guner [22, p. 84] examined the capital structure determinants for listed non-financial Turkish firms in the period 2008–2014 and found that most of the analysed determinants are in line with POT. Mateev et al. [31, p. 28] also found more support for POT. They conducted a panel data analysis of 3,175 SMEs from seven Central and Eastern European (CEE) countries during the period 2001–2005 and found that medium-sized firms prefer internal financing over external ones, unlike small firms. Hernadi and Ormos [25] analysed capital structure in two ways: qualitative and quantitative. They applied panel regression for 498 firms from 10 CEE countries in the period 2005–2008 and conducted a qualitative survey among CFOs

of those firms about the firms' financial policies. The results of the panel regression are in agreement with the responses of the CFOs that POT is the dominant relevant theory in explaining the financial decisions of CEE firms. About three-quarters of the observed CEE firms were not at their targeted levels of financial leverage, preferring a higher use of internal funds.

Studies dealing with the capital structure of telecom operators in the previous period were rare. Using the empirical method of a case study of three leading European operators (BT Group, Deutsche Telekom, and France Telecom) in the period 1994–2003, Carapeto and Shah [10, p. 200] concluded that the optimal value of the capital structure (debt/equity) of telecom operators exists and that its value is about 60%. The authors also pointed out that the majority of state-owned companies often exceed their debt capacity, because the state practically protects them from bankruptcy. In the example of five telecom operators that operated in Indonesia in 2008–2015, Rahmatillah and Prasetyo [43] found that size, tangibility, liquidity, risk, interest rate, GDP, and ownership are factors that significantly affect the capital structure of Indonesian telecom operators, while profitability and effective tax rate had no significant effect.

Even with several theories being offered and numerous empirical studies being conducted on the topic of capital structure determinants, the topic is still actively researched and discussed in the literature.

Research methodology

Variables in the model

Various authors have used different sets of potential determinants of capital structure, depending on the possibility of finding appropriate data to calculate and define these determinants. Titman and Wessels [51] and Harris and Raviv [24] were among the first to investigate potential determinants of capital structure. In the common group of determinants, they identified profitability, size, asset structure, non-debt tax shield, growth, earnings volatility, uniqueness, and industry classification. Pandey and Singh [40, pp. 171-172] enumerated 13 determinants of capital structure most often used in research from 2002 to 2015. In this paper, we selected seven of them: size, growth opportunity, assets tangibility, profitability, non-debt tax shield, liquidity, and cost of debt.

The variables were chosen to acknowledge the diversity of the analysed telecom operators in terms of size, corporate efficiency, and the market in which they operate. All of these variables have been used in previous literature, as can be seen in Table 1.

The following paragraphs explain the nine predictor variables used in our econometric model.

Growth Opportunity (GROS) – Fast-growing companies generally do not have enough of their own funds to invest in new projects, and they have to take on debt. So, POT

Table 1: Description, measure, and reference of used variables

Variables	Abbr.	Measure	References
Dependent variables			
Leverage	LEV	Total Liabilities / Total Assets	Bauer [4]; Psillaki and Daskalakis [42]; Viviani [52]; Guner [22];
Short-term Leverage	STLEV	Short-term Liabilities / Total Assets	Pinkova [41]; Feidakis and Rovolis [17]; Handoo and Sharma [23];
Long-term Leverage	LTLEV	Long-term Liabilities / Total Assets	Pinkova [41]; Feidakis and Rovolis [17]; Handoo and Sharma [23];
Independent variables			
Growth	GROS	(Sales(t) – Sales(t-1)) / Sales(t-1)	Karadeniz et al. [27]; Alipour et al. [3];
Liquidity	LIQ	Current Assets / Current Liabilities	Bradley et al. [9]; Ozkan [39]; Mazur [32]; Berkman et al. [5];
Profitability	PROF	ROA = EBIT / Total Assets	Rajan and Zingales [44]; Bauer [4]: Mazur [32]; Karadeniz et al. [27];
Size of firm	SIZE	Natural Logarithm of Sales	Titman and Wessels [51]; Delcoure [16]; Afza and Hussain [2]; Tamulyte [48];
Tangibility	TANG	Fixed Assets / Total Assets	Booth et al. [8]; Frank and Goyal [18]; Cortez and Susanto [12]; Moradi and Paulet [37];
Assets Turnover	ASTUR	Sales / Total Assets	Feidakis, Rovolis [17]; Serghiescu and Vaidean [46]; Berkman et al. [5];
Non-Debt Tax Shield	NDTS	Depreciation & Amort. / Total Assets	Bradley et al. [9]; Ozkan [39]; Cortez and Susanto [12]; Moradi and Paulet [37];
Cost Of Debt	COD	Interest Paid / Long-term Liabilities	Afza and Hussain [2]; Teixeira and Parreira [49]; Handoo and Sharma [23];
GDP Growth	GDPG	Annual country GDP growth (%)	Booth et al. [8]; Feidakis and Rovolis [17]; Gaud et al. [19];

Source: Authors' layout based on previous studies

assumes a positive relationship between growth and leverage. In contrast, TOT expects a negative relationship because it believes that high leverage threatens the firm's growth, as well as its sustainability.

Liquidity (LIQ) – TOT advocates the positive impact of liquidity on leverage. TOT believes that good liquidity guarantees interest payments and debt use. In contrast, POT expects a negative relationship between liquidity and leverage because a cash-rich firm has real possibilities to service its investments without borrowing.

Profitability (PROF) – TOT implies a positive relation between profitability and leverage. This theory holds that more profitable companies can get loans more easily. Also, such companies want to use debt to reduce their tax liabilities (using the tax shield), thereby increasing profitability. In contrast, POT sees a negative relation between profitability and leverage, suggesting that more profitable companies have more retained earnings that they can use for new investments. It is also a benefit that internal financing is cheaper than external financing.

Firm Size (SIZE) – Larger companies regularly report on their operations, have more assets, and have a lower probability of financial distress due to a more diversified business. Such companies have relatively easy access to the financial market and can take more debt at lower prices. Therefore, according to TOT, firm size is positively associated with leverage. POT considers that larger companies have more internal funds that they will use before reaching for external ones. Therefore, POT predicts a negative relationship between firm size and leverage.

Tangibility (TANG) – We use tangible assets to measure the asset structure of telecom operators. TOT expects that asset tangibility is positively related to leverage. More tangible assets imply more collateral for creditors, which leads to decreased credit risk and risk of bankruptcy. According to POT, higher tangibility means lower leverage – a negative relationship.

Assets Turnover (ASTUR) – This is a proxy to measure the efficiency of using the assets and shows how many units of sales revenue were generated by a unit of the total assets. There is no clear empirical result on the impact of this proxy on leverage because this variable has only been analysed in a few prior studies. This research will contribute to the literature by providing insight on this effect.

Non-debt Tax Shield (NDTS) – The non-debt tax shield includes all expenses that affect tax reduction, except for interest expenses. Depreciation and amortisation (D&A) usually have the largest share in NDTS. D&A are non-cash expenses; they do not cause cash outflow and they reduce the need for loans. Therefore, NDTS reduces tax payments, indirectly increasing the firm's internal funds and reducing the need for debt – consistent with the POT. Based on TOT, higher NDTS leads to a decrease in the firm's tangible assets, which can be collateral for easier borrowing. This means that NDTS is negatively related to leverage in both the TOT and the POT.

Cost of Debt (COD) – COD is an effective interest paid on a firm's outstanding long-term debts. In the capital structure theories, there is no precise expectation about the influence of COD on leverage. The high cost of debt certainly discourages the use of leverage, although interest costs are tax-deductible.

Country GDP Annual Growth (GDPG) – A favourable economic situation and economic development have a positive impact on a company's performance – demand grows, sales grow, profit grows. Therefore, in such circumstances, a company can be financed either from increased internal funds or by taking on debt under appropriate conditions. There is no clear theoretical postulation on the impact of GDPG on leverage.

Different calculations of explanatory variables limit the potential for generalizing the findings. When comparing results from various authors, one should take into consideration the apparent diversity of variable calculation methods.

Data source

The sample is based on a hand-collected data set comprised of annual reports or financial statements published on the official corporate websites of 46 European telecom operators from 32 countries. The study covers a period of 12 years, from 2009 to 2020. The data form a strongly balanced panel data model. Our sample was selected according to the availability of complete financial data in the observed

period. We relied on the values reported in annual/financial reports (i.e., book values). The sampled telecom operators include both listed and non-listed, predominantly state-owned and privately owned, national and multinational, ex-incumbent and alternative operators, but all operators are so-called multiservice operators (MSOs).

Some data needed to calculate the required ratios (e.g. GROS) were collected from the financial reports for 2008. Given that financial data in annual reports are mainly expressed in national currencies, to calculate some variables in the model (e.g. SIZE), we had to normalize the data values and express them in euros, according to the exchange rate of the national currency on December 31 for each observed year. The exchange rate values of 20 different currencies had to be converted into euros. Data on the annual GDP growth rate of European countries were downloaded from the official website of the World Bank (https://data.worldbank.org/indicator/ NY.GDP.MKTP.KD.ZG).

The Stata 17 program was used for data processing.

Regression model

Following the recommendation of leverage decomposition [6, p. 159], we consider three regression models with the three dependent variables LEV, STLEV, and LTLEV, as defined in Table 1. These three dependent variables were also used by Bauer [4], Feidakis and Rovolis [17], Pinkova [41], Afza and Hussain [2], and Handoo and Sharma [23], among others. Panel data analysis takes into account both differences between firms and time effects. Following Ozkan [39], Gaud et al. [19], Karadeniz et al. [27], Mateev et al. [31], and Vo [53], among others, we chose a dynamic panel data analysis over a static one because it more effectively solves the problems of heteroscedasticity and autocorrelation, as well as possible data endogeneity. Getzmann and Lang [20, p.13] highlighted that 'endogeneity often exists in econometric models'.

At the same time, in our empirical model, we check how the leverage from the previous year affects the current leverage, following Ozkan [39]. Gaud et al. [19, p. 52] promoted the attitude that 'capital structure decisions are dynamic by nature'. Given that a firm's decisions on capital structure often fluctuate and that there is a possibility of endogeneity problems among the independent variables, we decided to apply the generalized method of moments (GMM). GMM regressions are robust to heteroscedasticity and autocorrelation [20, p.15]. Alongside the independent variables, the lagged value of the dependent variable appears in the model as an additional variable to examine its influence.

Our general empirical regression model is expressed in the equation form (1) as follows:

$$Yit = \beta_0 + \beta_1 Y_{i,t-1} + \Sigma_{k=2}^{10} \beta_k X_{kit} + \mu_i + \varepsilon_{it} \qquad (1)$$

where the case Y=LEV represents regression model 1, Y=STLEV represents regression model 2, and Y=LTLEV represents regression model 3; Yt-1 is the lagged dependent variable; the subscript *i* represents cross-sectional dimension (firms, telecoms) and *t* represents time-series dimension (years), whereby *i*=1 to 46, *t*=1 to 12; β0 – β10 regression coefficients, μ – unobserved individual effects, ε – error term, and X2 to X10 (k=2 to 10) are variables GROS, LIQ, PROF, SIZE, TANG, ASTUR, NDTS, COD, and GDPG, as defined in Table 1, respectively.

The Stata 17 program was used for data processing.

Results and discussion

The data are analysed by descriptive statistics, correlation analysis, and dynamic panel data regression.

Descriptive statistics

Table 2 provides the descriptive statistics – a summary of the mean, median, standard deviation, minimum, and maximum values of the selected variables.

Leverage has a mean value of 54.59% and a median of 56.64%. That represents a good balance in debt/equity financing. Telecoms, on average, are not overburdened with debt, despite the need for continuous investments. On average, among telecoms, STLEV has lower participation in total leverage than LTLEV, with LTLEV making up around 60% of LEV. The profitability, measured as ROA, has a mean value of 8.97% and a median of 8.05%, which confirms that providing telecom services is a profitable

activity. The mean value of annual sales growth is 1.6%, which is comparable to the mean of countries' GDP growth (1.1%). The average liquidity (current ratio) is 1.11, which is considered a good value for non-manufacturing companies. The average tangibility is 40%, although there have been significant investments in telecom networks and equipment in previous years. However, in today's era of digitalization of business and virtualization of network functions and services, telecoms are investing more and more in their intangible assets (e.g. enterprise business and operation-support software, user licenses, TV rights).

Correlation analysis

The correlation analysis presents the relationship between each pair of variables used in our empirical model. A Pearson's correlation matrix is reported in Table 3. The results of the correlation analysis indicate a significant moderate positive correlation (0.4–0.6) between leverage and liquidity and leverage and tangibility, as well as a significant moderate negative correlation between leverage and the size of firms. PROF, NDTS, and GDPG have a negative correlation with leverage, while GROS has a positive correlation with leverage. Among the independent variables, a significant moderate positive correlation (0.4–0.6) exists between SIZE and LIQ, SIZE and TANG, NDTS and TANG, ASTUR and PROF, and ASTUR and NDTS.

To check the presence of multicollinearity among the independent variables, we performed a variation inflation factor (VIF) test. A VIF value greater than 10 is considered an indication of a multicollinearity problem. The results of the multicollinearity VIF test are specified in the final column of Table 3. VIF values (<10) show that there is no problem with multicollinearity between the selected variables, and there is no need to omit any of them from our econometric model. However, some values of correlations (0.4–0.6) between the previously described independent variables raise doubts about the endogeneity of the data, which justifies the application of the GMM method.

Regression analysis

After the multicollinearity test, we checked the data for the presence of autocorrelation and heteroscedasticity. The results of the White test for heteroscedasticity proved

Table 2: Descriptive statistics

	LEV	STLEV	LTLEV	GROS	LIQ	PROF	SIZE	TANG	ASTUR	NDTS	COD	GDPG
Mean	0.5459	0.2184	0.3275	0.0156	1.1080	0.0897	7.7461	0.4000	0.5326	0.0992	0.0663	0.0108
Median	0.5664	0.2146	0.3203	-0.0001	0.8315	0.0805	7.8979	0.3953	0.5020	0.0986	0.0437	0.0183
Std. Dev.	0.2357	0.0826	0.2138	0.1320	0.7911	0.0763	1.6653	0.1392	0.1912	0.0298	0.1252	0.0371
Min.	0.0759	0.0504	0.0053	-0.5578	0.1358	-0.0292	4.2920	0.0990	0.0997	0.0374	0.0001	-0.1531
Max.	1.4322	0.6225	1.2066	1.3162	4.5212	0.4919	11.5229	0.8490	1.3917	0.3002	1.5797	0.1120
Obs.	552	552	552	552	552	552	552	552	552	552	552	552

Source: Authors' calculations in Stata 17

Table 3: Correlation matrix and multicollinearity VIF test

	LEV	STL	LTL	GROS	LIQ	PROF	SIZE	TANG	ASTUR	NDTS	COD	GDPG	VIF
LEV	1.000												
STL	0.428	1.000											
LTL	0.937	0.086	1.000										
GROS	0.079	0.016	0.081	1.000									**1.04**
LIQ	-0.597	-0.556	-0.443	-0.064	1.000								**1.27**
PROF	-0.134	0.110	-0.190	0.072	0.152	1.000							**1.68**
SIZE	0.549	0.256	0.506	0.032	-0.401	-0.061	1.000						**1.44**
TANG	-0.425	-0.064	-0.443	0.010	0.202	0.170	-0.428	1.000					**1.64**
ASTUR	-0.047	0.482	-0.238	0.039	-0.019	0.578	-0.046	0.364	1.000				**2.51**
NDTS	-0.008	0.198	-0.086	-0.020	0.006	0.199	-0.165	0.461	0.580	1.000			**1.87**
COD	-0.117	0.171	-0.196	-0.015	-0.035	0.003	-0.113	0.206	0.143	-0.011	1.000		**1.22**
GDPG	-0.050	-0.014	-0.050	0.147	0.033	0.010	-0.069	0.042	0.038	0.008	-0.248	1.000	**1.12**

Source: Authors' calculations in Stata 17

the presence of heteroscedasticity (chi2(54)=94.53, p=0.0005<0.05; the null hypothesis of homoscedasticity is rejected). A Wooldridge test for autocorrelation in panel data indicated an autocorrelation problem (F(1,45)=5.733, p=0.0209<0.05; the null hypothesis of no first-order autocorrelation is rejected).

After these tests, we applied the GMM proposed by Blundell and Bond [7] to control for potential endogeneity among the independent variables and to address the existing heteroscedasticity and autocorrelation problems. We performed a two-step robust system GMM estimation using the Stata command *xtdpdgmm*. The results of the dynamic GMM panel data analysis are presented in Table 4.

The quality of the applied GMM estimator is evaluated based on the overall validity of the selected instruments. That validity is determined using the Sargan–Hansen test of over-identifying restrictions and the Arellano–Bond second-order autocorrelation test (AR(2)). In our model, the AR(2) test confirms the absence of serial correlation between the instruments and the error term (p>0.05). The Sargan–Hansen test shows that the null hypothesis cannot be rejected (H0=over-identifying restriction is valid, p>0.05). The results of these two tests confirm that the instruments are valid, which means that our model is specified correctly.

The results in Table 4 show that the significant determinants of total leverage are lagged leverage, annual growth of sales, profitability, liquidity, assets turnover, and non-debt tax shield. The significant determinants of short-term leverage are annual growth of sales, liquidity, assets turnover, non-debt tax shield and cost of debt. The significant determinants of long-term leverage are lagged long-term leverage, annual growth of sales, profitability, liquidity, and cost of debt.

The current total leverage and long-term leverage of European telecoms strongly depend on the past (lagged leverage and lagged long-term leverage), as Ozkan [39, p. 187] also claims. Long-term indebtedness is a long-term characteristic of telecoms, so the LTLEV lag is very strong (coefficient=0.95). In contrast, the current short-term leverage does not significantly depend on the past. This is understandable, as short-term leverage depends on the level of current liabilities related to operational business.

Profitability has a significant negative relationship with LEV at a level of 1% significance and with LTLEV at a level of 10% significance. This means that telecom operators keep part of their profit and use it for investments before reaching for debt, which supports the assumptions of POT. However, profit increases capital, reducing the need for external sources of financing. These findings are consistent with Rajan and Zingales [44], Bauer [4],

Table 4: The results of the GMM regression analysis

Depend. var.	LEV			STLEV			LTLEV		
	GMM robust system			GMM robust system			GMM robust system		
Independ. var.	Coefficient	z	P>|z|	Coefficient	z	P>|z|	Coefficient	z	P>|z|
L1. LEV	0.95134***	12.39	**0.000**						
L1. STLEV				0.20027	1.63	0.103			
L1. LTLEV							0.94936***	7.29	**0.000**
GROS	0.08158**	2.34	**0.019**	-0.03261*	-1.70	**0.090**	0.10769***	3.07	**0.002**
LIQ	-0.02459***	-3.32	**0.001**	-0.05055***	-5.59	**0.000**	0.01131*	1.67	**0.095**
PROF	-0.25720***	-4.16	**0.000**	-0.12750	-1.51	0.130	-0.17286*	-1.74	**0.081**
SIZE	0.02257	1.15	0.249	0.00947	0.67	0.504	0.01395	0.82	0.410
TANG	-0.02004	-0.22	0.829	-0.07510	-1.27	0.206	-0.09800	-1.51	0.130
ASTUR	0.13618***	2.98	**0.003**	0.10169***	2.64	**0.008**	0.07749	1.35	0.178
NDTS	-0.81735**	-2.19	**0.028**	-0.35863**	-2.09	**0.036**	0.13612	0.86	0.392
COD	-0.10792	-1.60	0.110	0.12656*	1.66	**0.097**	-0.13944***	-3.55	**0.000**
GDPG	0.06646	0.65	0.515	0.06527	0.95	0.344	0.02985	0.27	0.786
_cons	-0.06638	-0.36	0.712	0.17131	1.38	0.168	-0.08626	-0.62	0.536
Sargan–Hansen (p-value)	0.1346			0.2503			0.0903		
AR(2) (p-value)	0.2510			0.9684			0.7284		
Obs. #	506			506			506		

Source: Authors' calculations in Stata 17. L1 is one year lagged of the dependent variable. Significance at: *p<0.10, **p<0.05, ***p<0.01

Mazur [32], Karadeniz et al. [27], Afza and Hussain [2], Shambor [47], and Moradi and Paulet [37], among others.

Liquidity has a significant negative relationship with LEV and STLEV at a level of 1% significance, but it has a positive significant effect on LTLEV at a level of 10% significance. Liquid telecoms do not need loans for working capital. Additionally, liquid telecoms use the generated funds to service their obligations, especially short-term ones, which affect total debt decrease. This is consistent with the POT's predictions. However, increasing liquidity can increase the firm's long-term borrowing capacity because excess cash can be used to pay interest on the debt. Ozkan [39], Mazur [32], Serghiescu and Vaidean [46], and Berkman et al. [5] came to the same findings for LEV.

The impact of GROS on LEV and LTLEV is positive and significant at a level of 5% and 1% significance, respectively. However, GROS has a significant negative impact on STLEV, at a level of 10% significance, meaning that sales growth provides current funds to settle daily business liabilities to some extent. We can conclude that telecoms do not have enough internal funds to finance their growth and must use additional external funds. Companies experiencing periods of high sales growth are encouraged to take on additional long-term borrowings to help them support and facilitate the growth. These findings correspond to the views of POT, and they agree with the findings of Črnigoj and Mramor [13], but they contradict the findings of Delcoure [16] and Alipour et al. [3].

As a measure of business efficiency, ASTUR has a positive effect on all three forms of leverage, but this effect is only significant on LEV and STLEV at the 1% significance level. More efficient telecom operators are looking for additional sources of financing, and it is easier reach for debt – more often, for short-term debt to bridge current obligations or meet current needs. Alipour et al. [3] and Berkman et al. [5] came to the same conclusion. In contrast, Viviani [52] and Feidakis and Rovolis [17] found a negative relationship between ASTUR and leverage.

The impact of NDTS on LEV and STLEV is negative and significant at a level of 5% significance. For a fixed level of profitability, which is accounted for by variable PROF, companies with higher levels of NDTS have stronger cash flow than their counterparts with low NDTS. This is due to the fact that depreciation is a non-cash expense. Therefore, they have less need to borrow cash. Furthermore, the significant influence of NDTS on the telecoms' capital structure can be explained by the shortened period of use for telecommunications equipment in telecoms' networks and the need to renew that equipment more often due to technological changes. Ozkan [39] and Cortez and Susanto [12] also found that NDTS has a negative association with LEV, but Delcoure [16], Shambor [47], and Moradi and Paulet [37] found that this relationship is positive.

The influence of COD on LTLEV is negative and significant at a level of 1% significance, and it has a non-significant negative impact on LEV. During periods of lower interest rates, companies are tempted to use leverage more intensely. However, COD has a positive significant impact on STLEV at a level of 10% significance. Increasing interest costs reduce the appetite for long-term borrowing. It is possible that difficult long-term borrowing opens up the need for short-term borrowing to regulate the firm's obligations. Similar to this study, analysing Indian firms in the period 2001–2010, Handoo and Sharma [23] found a negative significant impact of COD on LTLEV at a level of 1% significance, a negative but insignificant impact of COD on LEV, and a positive but insignificant impact of COD on STLEV. Teixeira and Parreira [49] and Mohanraj [35] reached similar findings.

The impact of the firm size and the country's GDP growth on all three types of leverage is positive and non-significant, while tangibility affects all three types of leverage negatively and non-significantly. Favourable economic circumstances (GDP growth) certainly have a positive impact on telecom operators' earnings. Larger companies have easier access to loans, which they often use, as shown in numerous studies. In our case, tangibility does not have a significant impact on the capital structure, possibly due to the specificity of telecommunications equipment and infrastructure (non-attractive collateral) but also to its decreasing share in the telecoms' total assets (average TANG is 0.40). Our results regarding the insignificant effect of TANG on leverage contradict most prior studies [27], [42], [46], [1], [8], [16], [18], [12], [37].

To decide which theory of capital structure best reflects the financial policy of the telecom operator, we created Table 5.

While both theories are supported by our findings, POT is more supported. Therefore, we conclude that POT explains more aspects of the observed behaviour of telecom operators in managing their capital structure than TOT does, making POT somewhat more relevant for the financial managers working in the telecom industry. This finding is consistent with Tamulyte [48], Mateev et al. [31], Berkman et al. [5], and Shambor [47], among others.

Conclusion

In this study, we investigated the impact of internal and external determinants of the capital structure of 46 European telecom operators in the period 2009-2020. The results of the conducted dynamic panel data analysis provide insight into how firm-specific and country-specific determinants affect the capital structure of telecoms and reveal which theory best describes the observed capital structure of European telecom operators. By providing answers to these questions, our research has fulfilled its goals.

According to the results of this research, the relevant determinants of the capital structure of European telecom operators in the period 2009-2020 were the following variables: annual sales growth, profitability, liquidity, assets turnover, non-debt tax shield, and cost of debt. Tangibility, firm size, and annual GDP growth did not significantly affect the capital structure of European telecom operators in the observed period. We found that total leverage and long-term leverage have a memory effect and significantly depend on their previous year values.

Annual sales growth, profitability, liquidity, assets turnover, and non-debt tax shield are significantly associated with total leverage. Profitability, liquidity, and non-debt tax shield have a negative association with total leverage, while annual sales growth and assets turnover have a positive association. To provide a more complete overview of the influence of various factors on the capital structure, we also considered their impact on the leverage components – short-term and long-term leverage. Assets turnover and cost of debt have a significant positive impact on short-term leverage, while liquidity, annual sales growth, and non-debt tax shield have a negative impact on short-term leverage. An increase in annual sales growth and liquidity leads to an increase in long-term leverage (positive effect), but an increase in profitability and especially the cost of debt causes a decrease in long-term leverage (negative effect).

The mentioned impacts mostly correspond to the assumptions of the pecking order theory of capital structure. In the past 10 years, telecom companies have operated stably and profitably; as such, they preferred to pay dividends to shareholders rather than interest on loans. They mainly financed their growth and development with internal funds characterised by high liquidity, stable sales growth, and sustainable profitability (retained earnings).

The main theoretical implication of this study is that both pecking order theory and trade-off theory are capable of explaining the observed effects of the selected factors on the capital structure of telecom operators. The fact that relatively more effects can be explained by pecking order theory does not mean that this theory should be chosen as the one that should prevail. On the

Table 5: The relationship between determinants and leverages – predictions of TOT/POT vs. results of study

Variables		GROS	LIQ	PROF	SIZE	TANG	ASTUR	NDTS	COD	GDPG	L1. Y
Expected relationship	TOT	-	+	+	+	+	+ / -	-	-	-	+ / -
	POT	+	-	-	-	-	+ / -	-	+ / -	+	+ / -
Results	LEV	+ **	- ***	- ***	+	-	+ ***	- **	-	+	+ ***
	STLEV	- *	- ***	-	+	-	+ ***	- **	+ *	+	+
	LTLEV	+ ***	+ *	- *	+	-	+	+	- ***	+	+ ***
Dominant CS theory	LEV	POT	POT	POT	tot	pot	?	?	tot	pot	?
	STLEV	TOT	POT	pot	tot	pot	?	?	POT	pot	?
	LTLEV	POT	TOT	POT	tot	pot	?	?	TOT	pot	?

Source: Authors' analysis (***- = significance at level 1%, **- = significance at level 5%, *- = significance at level 10%, + = positive impact, - = negative impact, ? = non-defined impact, TOT/POT = confirmed significant impact, tot/pot = confirmed non-significant impact, L1.Y is one year lagged of the dependent variable).

contrary, we prefer to interpret the findings in a way that supports the use of both theories and encourages their integration in a unified framework that would use the principles derived from both theories in a non-mutually exclusive manner.

This study has some limitations. First, our sample is limited to 46 firms, so the findings cannot be generalized to all the telecom operators. Second, the data are based on accounting reports, so the accuracy of our results depends on the accuracy of these reports. Third, our leverage measure represents the broadest measure of financial leverage. Total liabilities also include some non-financing liabilities, such as accounts payable, untaxed reserves, and trade credits, which, in certain cases, make the values of this ratio falsely inflated.

We can offer several proposals for future research: expand the sample of telecom operators, apply other appropriate empirical methods (e.g. hierarchical panel), take into account additional predictors (e.g. risk, earnings volatility) or different proxy of used predictors (e.g. GROWTH, LIQ, PROF), include additional relevant macroeconomic factors (e.g. interest rates), or analyse operators by groups with some common characteristics (e.g. developing and developed markets).

This study enriches the body of research on capital structure by providing relevant evidence about the capital structure of European telecom providers. Compared to other studies, apart from the number of analysed variables and the international approach, this study is also specific because it examines the influence of both internal and external factors on the capital structure. The results can help the management of telecom operators with setting their capital structure policy. The focus should be on determinants having a significant impact. The findings can also be used to determine whether the capital structure of any individual telecom operator is relatively (or even overly) aggressive or conservative, given the values of all the other relevant factors. This type of conclusion is difficult to draw in a predominantly objective manner outside of a statistical framework such as the one presented in this study.

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INFLUENCE OF EURIBOR ON INTEREST RATES ON NEW LOANS GRANTED TO CORPORATES AND HOUSEHOLDS: THE CASE OF SERBIA

Uticaj Euribora na kamatne stope na nove bankarske kredite odobrene privredi i stanovništvu – slučaj Srbije

Abstract

The paper deals with the impact of the Euribor and risk premium on interest rates on foreign currency loans and FX-indexed loans that are approved to the corporate sector and the household sector in Serbia. Total new loans granted to corporates, total new loans granted to households, new investment loans granted to corporates and new housing loans granted to households are observed. The observed period is from September 2010 to August 2020. The main goal is to determine whether there is a long-run relation between Euribor and risk premium and the given interest rates, and what is the strength of the given relation. Empirical estimates show that there is a statistically significant impact of Euribor, as well as country risk premium, on lending rates on new households as well as corporate investment FX and FX-indexed loans, with high pass-through coefficients. For the total new corporate FX and FX-indexed loans we also included nonperforming loans as explaining variable which is shown to be statistically significant and whose fall also influenced the fall of lending rates on these loans.

Keywords: *Euribor, risk premium, NPL, interest rates, corporate loans, retail loans*

Sažetak

Rad se bavi uticajem Euribora i premije rizika na kretanje kamatnih stopa na devizne kredite i kredite indeksirane u evrima koji su odobreni sektoru privrede i sektoru stanovništva u Srbiji. Posmatraju se ukupni krediti odobreni privredi, ukupni krediti odobreni stanovništvu, investicioni krediti odobreni privredi i stambeni krediti odobreni stanovništvu. Posmatra se period od septembra 2010. do avgusta 2020. Osnovni cilj je da se utvrdi da li postoji dugoročna veza između Euribora i premije rizika i datih kamatnih stopa i koja je jačina date veze. Empirijska ocena je pokazala da je uticaj Euribora, kao i premije rizika zemlje, na kamatne stope na nove devizne i devizno-indeksirane kredite odobrene stanovništvu, kao i investicione kredite privredi, statistički značajan, sa visokim koeficijentom prenosa. Kada je reč o ukupnim novim deviznim i devizno-indeksiranim kreditima privredi, u analizu su kao objašnjavajuća varijabla uključeni i problematični krediti, za koje je pokazano da su statistički značajni i da je njihov pad doprineo padu kamatnih stopa na ove kredite.

Ključne reči: *Euribor, premija rizika, NPL, kamatne stope, krediti privredi, krediti stanovništvu*

Introduction

Bank loans are the most important external source of financing for companies in Serbia. The financing of the SME sector with bank loans is specifically important. Commercial banks are the backbone of the financial system in Serbia. The banking sector in Serbia represents more than 90% of the assets of the financial sector. This sector is highly liquid and profitable. Foreign banks are dominant, while the participation of pension funds and leasing companies is quite small. According to the data of National Bank of Serbia, twenty-six commercial banks currently operate in Serbia. According to the data of the National Bank of Serbia for the period 1.1.2019-31.3.2020, the five commercial banks in Serbia with the highest net business assets are: Banca Intesa, UniCredit Bank, Komercijalna Banka, OTP Banka and Raiffeisen Banka.

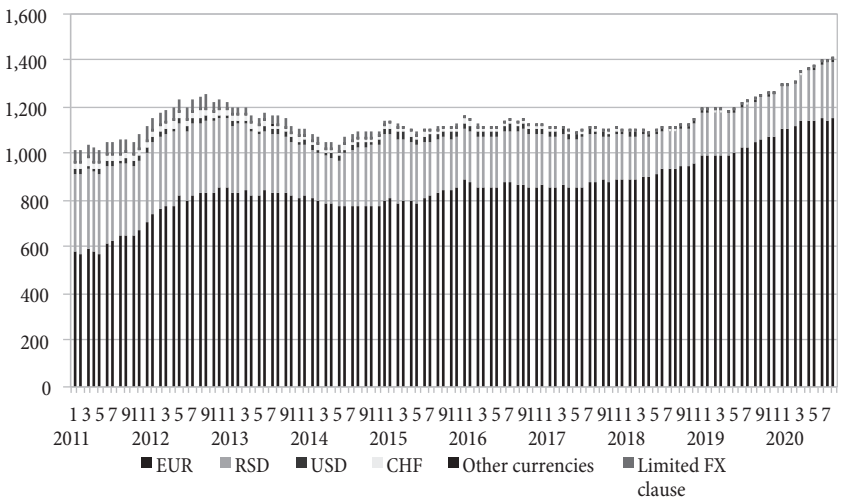
The corporate sector in Serbia - micro, small, medium and large enterprises are financed predominantly by foreign currency loans and dinar loans indexed in euros (see Figure 1). Investment loans are used by companies to finance the purchase of equipment, machineries, plants, the construction or purchase of business or production space. As interest rates in these contracts are linked to Euribor interest rates, mostly of 3- and 6-month maturity, it is to be expected that fall of Euribor rates is transmitted to lending rates, though this does not have to be the case, from various reasons ranging from level of competition among banks, asymmetric information, macroeconomic environment etc. That motivated us to empirically estimate the size and significance of pass-through of Euribor to lending rates on new corporate loans.

We will also investigate influence of Euribor on interest rates on new household loans in Serbia, where the level of euroisation, though declining, is still significant (Figure 2). As well as for corporate loans, we will, naturally, take into consideration only households FX loans and FX-indexed loans.

The Euribor rates are based on the average interest rates at which a huge number of European banks borrow funds from each other. The Euribor rates are considered to be the most significant reference rates in the European money market. The interest rates do provide the basis for the price and interest rates of all kinds of financial products. There are different maturities of Euribor, ranging from one week to one year. In our paper we will use Euribor rates for the period from September 2010 until August 2020, by using maturity of three months and six months.

Given the high euroization of the domestic credit market (more than 60% of domestic loans are indexed in foreign currency), interest rates on the European money market (Euribor) directly affect interest rates on euro-indexed loans to businesses and households. Besides direct influence of Euribor on variable interest rates on FX and FX-indexed loans, it also affects fixed interest rates, as it

Figure 1: Bank claims on corporate sector by contracted hedge and currency structure, outstanding amount (in billion dinars, end-of-period)



Source: National Bank of Serbia

alters costs of sources of financing (when Euribor falls it lowers costs of sources of financing).

EMBI (Emerging market bond index) is the risk premium indicator. EMBI which is based on dollar-denominated debt and calculated by the American financial institution J.P. Morgan, is no longer to be calculated and published for Serbia from August 2020. Since 2019, new benchmark data became available on the EMBI risk premium for Serbia based on euro-denominated debt. In this paper we will use US-dollar EMBI risk premium data calculated as the weighted spread between yield rates on eurobonds of emerging economies and yield rates on US bonds of comparable maturity.

Euroisation in Serbia has its main cause in a previous history of monetary instability of a country. Extreme inflations occurring during the last decade of XX century has undermined trust in the local currency - dinar and discouraged dinar savings. At the same time, large supply of foreign capital inflows has provided easy access to foreign currency lending at low interest rates, which caused loans in a foreign currency to be more desirable than dinar loans. Due to a high level and significance of euroisation in Serbia, in our paper we will focus on foreign currency loans and FX-indexed loans of different types.

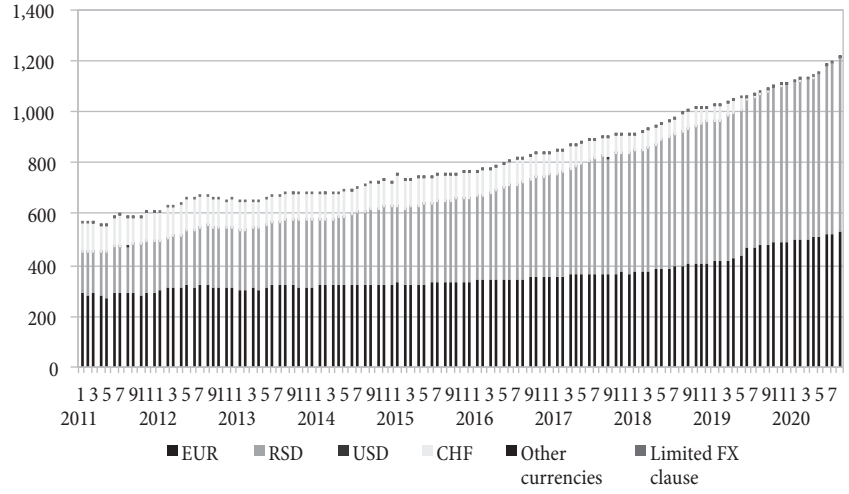
The subject of this paper is the impact of the movement of Euribor and EMBI on the movement of interest rates on total bank loans granted to the corporates and households, as well as investment and housing loans, whereby foreign currency loans and dinar loans indexed in euros are observed. The significance of the paper is in estimating the connection between Euribor and EMBI and interest rates on bank loans to the corporate sector and households in Serbia and the strength of this relationship. Thus, we will conclude whether the fall in Euribor and the country's risk premium makes loans cheaper for companies and households in Serbia. In this paper, we will apply econometric analysis using the two-step procedure of Engle and Granger. We will use monthly data and examine the movement of the interest rates, Euribor and EMBI during the period September, 2010 – August, 2020.

In the rest of the paper we will examine the previous research of different authors of Euribor influence on interest rates. After that, we will present the methodology we will use in our paper considering Engle and Granger two-step procedure. In the next part of the paper we will provide the full description of the used data. We will provide presentation of our empirical results and make a final conclusion. At the end of paper, we will list literature we have used for this paper.

Review of the previous relevant research

The impact of Euribor on interest rates and the volume of loans to corporates and households has been the subject of research by numerous authors, who have primarily focused on the Eurozone. Different researchers observed different

Figure 2: Bank claims on households by contracted hedge and currency structure, outstanding amount (in billion dinars, end-of-period)



Source: National Bank of Serbia

types of loans, some focused on business loans, some on household loans, etc. Likewise, authors have observed different periods, some focused on the long term, while others observed short-term developments. The majority of researchers have observed movements of the interest rates during the crisis period that began in 2008.

Many authors have been investigating the relation between the stock of nonperforming loans and interest rates on bank's loans. Some authors were focused on euro zone, while others were focused on specific countries. Likewise, some researchers focused on the impact NPLs have on credit supply of the banks, while other investigated the impact on interest rates on new loans.

According to research by Gallo [12], the impact of Euribor movements on interest rate movements is much more pronounced in the corporate sector than in the household sector. The given research also showed the existence of a positive correlation between Euribor and interest rates in the euro area during the period 2003-2010, whereby the relation was found to be weak.

Bredin, Fitzpatrick & O Reilly [6] investigate retail interest rate pass-through in Irish economy in period 1980-2001. They found that the pass-through from the money market rate to lending rates is incomplete, and that the speed of adjustment varies considerable between different types of lending rates.

Jobst & Kwapil [15] analyzed interest rate movements in Austria. According to their research, interest rates on loans with a maturity of less than a year fully follow the trend of the three-month Euribor. Likewise, the research of these authors discovered that in the case of interest rates on loans with a maturity of more than one year, interest rates follow the movement of the three-month Euribor and interest rates on government bonds.

Kazaziova [16] investigated the movement of interest rates in The Czech Republic in the period 2004-2010. According to the given research, interest rates on loans granted to households follow changes in Pribor (Prague interbank offered interest rate) more than Euribor.

Kregždė & Murauskas [17] studied the impact of Euribor on interest rate movements in Lithuania. According to their research, the relation is strong if a long term is observed. Their research showed that if Euribor changes by 100 basis points, the interest rate on mortgage loans in Lithuania will change by 72 basis points. However, in this research, no relation was detected in the short term.

According to research by Graeve et al. [14], the relation exists in the long run but it is not 1:1, but weaker. As per their research, the relation is absent in the short run. Moreover, the authors noticed that in the case of loans granted to business entities, the competition of banks is stronger compared to loans granted to households.

Golitsis et al. [13] were investigating how shocks in Euribor affect domestic interest rates, real effective exchange rates, foreign exchange reserves and industrial production. They were analyzing data for several countries: Bulgaria, Croatia, Greece, North Macedonia, Romania and Slovenia. Their results show that a negative Euribor shock has a positive effect on industrial production while there is limited evidence regarding the effects of Euribor on foreign reserves, interest rates, and the real effective exchange rate.

Cifarelli and Paladino's research [9] examined the relationship between Euribor and a long-run interest rates, on loans to non-financial corporations. They were examining eight countries from euro zone. The authors have concluded that for some countries the spread between domestic and German long-term bond interest rate has an important role in changes of the bank's cost of funding.

Mihaylov [19] examined the process of loan interest rate formation in Bulgaria using Euribor as a reference rate. The author has used both standard and asymmetric VECM. The author has concluded that the pass-through of loan interest rates in Bulgaria has decreased during the crisis and that there are differences across the individual segments of the credit market.

Landini et al. [18] analyzed fixed and adjustable rate mortgages dynamics and the relations between FRMs and ARMs markets. Research of these authors showed the effects of the European Central Bank control on the Euribor transmit to the movement of interest rates term structure as well as to interest rates of contracts involved in the mortgage markets in Italy.

Bernoth & Hagen [4] were investigating different aspects of the predictability of money market rates in the European Monetary Union. The aspects these authors

were investigating were: efficiency of the three-month Euribor interest rate futures market, effect of European Central Bank policy announcements on the volatility of Euribor futures rates and effect of European Central Bank policy announcements on the prediction error contained in Euribor futures rates. Their main results showed that the new Euro money markets were able to predict short-term rates successfully.

Bredl [7] was investigating the relation between stock of nonperforming loans in the Eurozone and lending rates on new loans. The results of his research showed that there is no clear relation between NPLs and lending rates. However, the author concludes that after dividing the gross NPL stock into net NPLs and loan loss reserves, a high stock of NPLs will be associated with higher lending rates, if it is not sufficiently covered by loan loss reserves.

Accornero et al. [1] were investigating the relation between non-performing loans and credit supply of the banks in Italy. The results of these authors showed that, although exogenous shocks to NPLs can cause a decline in credit supply, the correlation between NPLs and credit supply is mostly driven by demand-side effects. The authors concluded that due to demand-side effects, NPL ratios have no significant influence on banks' lending strategies.

Bahruddin & Mansur [3] were analyzing the impact NPLs have on banks' interest rates in Malaysia. The authors have used NARDL approach to test the non-linear asymmetric relationships between lending interest rate and NPLs. The main result of this research was that lending interest rate and NPLs has an asymmetric relationship in the short-run and symmetric relationship in the long run.

Albertazzi et al. [2] were investigating an impact of NPLs on lending rates. The results of these authors suggest that this relation is shown in the form of a higher mark-up on lending rates and is significantly independent from the monetary policy stance.

In National Bank of Serbia's November 2020 Inflation Report [21], the effectiveness of transmission of the NBS one-week repo rate to interest rates in the interbank money market and their transmission to retail dinar rates has been analyzed. This study relies on equilibrium error correction model and estimates both the long-run and short-run relationship of the repo rate on interest rates in the interbank money market – BELIBOR rates with the maturity from one week to six months. It concludes that the pass-through of the main instrument to interest rates in the interbank money market is complete in all cases. Then the pass-through of BELIBOR to dinar lending rates (on total household loans, cash loans, total corporate loans and working capital corporate loans) is analyzed and results suggested that there is also a complete pass-through of BELIBOR on lending rates. Besides BELIBOR, in the equations representing transmission of BELIBOR to lending rates, measure of country risk premium (EMBI) is included and is shown to be statistically significant, and thus contributed to the fall in lending rates. Primarily guided by this analysis, we wanted to assess whether the impact of the Euribor interest rates on EUR and EUR-indexed lending rates in Serbia is also significant and whether the pass-through is complete or not. As in the above-mentioned analysis, we also include country risk premium (EMBI) in our research. Additionally, we test for the nonperforming loans influence on different types of FX and FX-indexed rates.

Methodology

As many economic variables tend to be non-stationary, before conducting the analysis, we tested for the existence of unit roots. As all observed variables had a unit root, based on Augmented Dickey-Fuller test statistic, hence are non-stationary i.e. I(1) variables, further we tested for cointegration. Cointegration means that, even though variables are non-stationary, there exists a linear combination of such variables that is stationary. An alternative approach of dealing with I(1) variables means analyzing differences of those series (which are I(0)), but it would describe only short-run, but not long-run relationship which we are mainly interested in, and which is why we opted for cointegration approach.

It is important to distinguish between spurious and cointegrating relationships, as some unrelated time series may appear to be related when conventional testing procedures are used. Hence we applied various cointegration tests (Trace, Maximum Eigenvalue) and based on them concluded that there is one cointegration

relationship between interest rates on total FX loans and loans indexed to FX, Euribor and risk premium in the case of total loans to households (for Euribor maturity of both 3 and 6 months), housing loans (for Euribor maturity of 6 months), and corporate investment loans (for 3- and 6-month maturities). In the case of total corporate loans (for 3- and 6-month maturities) there is more than one cointegration relationship as well as in the case of housing loans in the case of Euribor maturity of 3 months. As Johansen-Granger Representation Theorem suggests, when a set of variables are cointegrated, then they can be represented by equilibrium error correction model (ECM). That means if there is a long run relationship between I(1) variables, there is a force that pulls back error term to zero. Engle and Granger [11] formulated a following two-step procedure: first we estimate long-run (equilibrium) relationship between non-stationary variables, which in our case is:

$$i_t^c = \beta_0 + \beta_1\, euribor_t^m + \beta_2 rp_t + v_t \qquad (1)$$

Where i_t^c represents interest rates on new FX loans for the cases where there exist one cointegration relationship – total households, housing loans, and investment corporate loans; m is the maturity of Euribor rates (3 months and 6 months) and rp_t is the risk premium, in our case represented by Emerging Market Risk Premium (EMBI) for Serbia. The OLS residuals (v_t) from (1) are the measure of deviation from long-run equilibrium ($Y_t = \beta_0 + \beta X_t$). Testing for cointegration is actually testing whether these residuals are stationary, which in practice means using ADF tests with the MacKinnon critical values adjusted for the number of variables. If series are cointegrated, residuals have to be stationary and *vice versa*. If there is cointegration, the OLS estimates are cointegration estimates and are said to be super-consistent. The second step consists of estimating short-run relationship:

$$\Delta i_t^c = \gamma_0 + \alpha v_{t-1} + \gamma_1 \Delta i_{t-1}^c + \gamma_2 \Delta euribor_t^m + \gamma_3 \Delta rp_t + e_t \qquad (2)$$

where α measures the speed of adjustment to long-run relationship. While long-run relationship is based on the level of the variables, the short-run relationship is based on the changes (first differences) of variables. Here we measure how big impact on the change in lending rates have change in lending interest rates from previous period, change in Euribor rates, change in risk premium and deviation from the long-run equilibrium from the previous period. The adjustment coefficient α must be negative. This equation explains how observed variables behave in the short run, in a way that is consistent with a long-run cointegration relationship.

As nonperforming loans (NPLs) to a great extent influence banks' readiness to borrow, we also included them in the analysis and, as we found one cointegration relationship in the case of corporate loans and investment loans in the case when 3-month Euribor rate is used, together with risk premium, we also reported these results in our analysis. The long run relationship in this case takes the following form:

$$i_t^c = \beta_0 + \beta_1\, euribor_t^m + \beta_2 rp_t + \beta_3 npl_t + v_t \qquad (3)$$

Where npl_t represents the share of nonperforming loans in observed category of loans – in our case in total corporate loans and in loans to companies (for the investment loans).

Short-term relationship is represented by:

$$\Delta i_t^c = \gamma_0 + \alpha v_{t-1} + \gamma_1 \Delta i_{t-1}^c + \\ + \gamma_2 \Delta euribor_t^m + \gamma_3 \Delta rp_t + \gamma_4 \Delta npl_t + e_t \qquad (4)$$

Where, as before, α measures the speed of adjustment to long-run relationship and in addition to change in lending interest rates from previous period, change in Euribor rates, change in risk premium and deviation from the long-run equilibrium from the previous period, we also measure how the change in the share of NPLs influences change in lending rates.

Data description

Our sample encompasses period between September 2010, since comparable data on per annum average lending interest rates are available, and August 2020, when EMBI data for Serbia ceased to exist (just to become available again at the very end of 2020, with the issuance of new dollar Eurobond which once again enabled its calculation). For lending rates on new loans we use National Bank of Serbia data, specifically FX interest rates on total new corporate loans, investment loans, total household loans and housing loans. Around

80% of new corporate loans are FX or FX-indexed, and though their share in new loans to households is declining, it still accounts for somewhat above 40% (Figures 1 and 2). We conduct separately the analysis of influence of Euribor and risk premium on interest rates on housing household loans, as almost all of new housing loans are FX-indexed, and interest rates on new investment corporate loans as above 90% of these loans are FX or FX-indexed. As measure of risk premium we used Emerging Market Risk Premium (EMBI) for Serbia, which is no longer published as of the last day of August 2020, as time to maturity of the only dollar Serbian eurobond at that moment was less than 13 months, and this is when, according to J.P. Morgan's criteria, the bond is excluded from the index calculation. For Euribor we use European Money Markets Institute (EMMI) data, for maturities of 3 and 6 months, as those are the most common maturities to which banks tie FX-lending rates in loan agreements. Besides its prudential aspect, as a tool which is used to regulate banks' liquidity, reserve requirement ratio is also used as a supportive instrument of monetary policy of National Bank of Serbia, i.e. a tool to enhance lending activity and thus influence economic activity and inflation. Standard economic theory suggests that lower reserve requirement leads to higher loan supply and results in higher economic activity and inflation. Not found only in theory, but, as noted by Palic & Tasic [23], this approach was also implemented by many central banks during the 80s and 90s of XX century in order to influence lending rates. Hence, we corrected Euribor rates for effective FX reserve requirement rate. This is achieved through dividing Euribor rates by (1-effective FX reserve requirement rate).

In Figures 3-6 we represented comovements of Euribor, EMBI and interest rates on selected new EUR and EUR-indexed loans – in Figure 3 total households loans, Figure 4 only housing loans to households, Figure 5 total loans to corporates, and Figure 6 only investment loans to corporates. The reduction of Euribor should be reflected in the lower cost of new borrowing in euros, as it contributes to lower funding costs for these loans. What is interesting is that the fall in interest rates on loans in euros was more pronounced than the fall in Euribor which is

Figure 3: EURIBOR, EMBI and interest rates on EUR and EUR-indexed loans to households, new business, three-month averages (%)

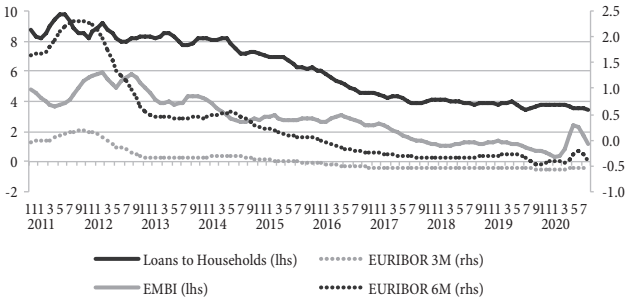


Figure 4: EURIBOR, EMBI and interest rates on EUR and EUR-indexed housing loans, new business, three-month averages (%)

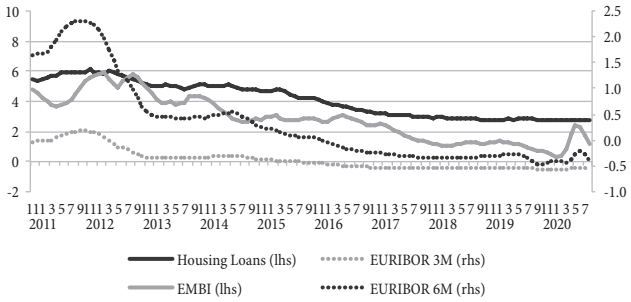


Figure 5: EURIBOR, EMBI and interest rates on EUR and EUR-indexed loans to corporates, new business, three-month averages (%)

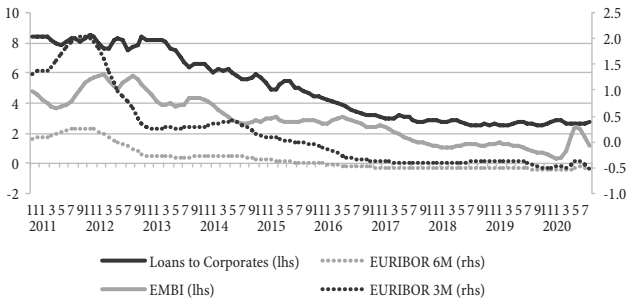
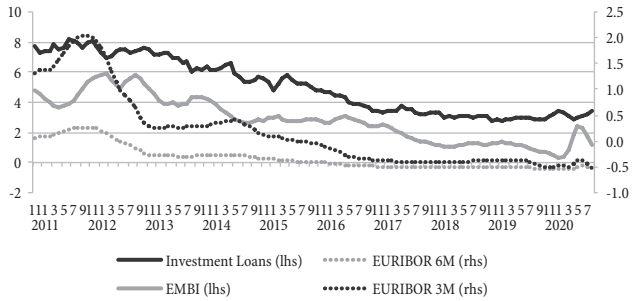


Figure 6: EURIBOR, EMBI and interest rates on EUR and EUR-indexed investment loans, new business, three-month averages (%)



Source: National Bank of Serbia, European Money Markets Institute, JPMorgan.

why we introduced EMBI, as a measure of risk premium that presumably enhanced the fall in new lending interest rates. All of the observed variables experienced a notable fall in the observed period, with Euribor rates going into negative territory. EMBI risk premium has also recorded a significant fall, with mild rise near the end of period, due to the corona virus pandemic outbreak at the beginning of 2020. Figures show the similar pattern in movements of those variables and we further empirically estimate the existence and significance of relationship among them.

Empirical results

As mentioned above, first we tested for existence of unit root in observed variables, and concluded that they are I(1) variables. Test results are given in the Table 1.

Table 1: Augmented Dickey-Fuller unit root test results

	Test statistic	p-value
Total Loans to Corporates	-1.19	0.68
Investment Loans	-1.14	0.70
Total Loans to Households	-0.51	0.88
Housing Loans	-0.46	0.89
Euribor 3M[1]	-1.77	0.39
Euribor 6M[1]	-1.62	0.47
EMBI	-1.26	0.65
NPL Total Loans to Corporates	1.22	0.99
NPL Loans to Companies	1.23	0.99

[1] adjusted for effective FX reserve requirement rate.

Then we test for optimal number of lags, using different lag length criteria, where we opted for two lags, according to Schwarz and Hannan-Quinn criteria, and thus using one lag when testing for cointegration (see Table 2). After testing for cointegration (Trace, Maximum Eigenvalue tests) we concluded that in certain cases there is one cointegration relationship between variables we observe - interest rates on various types of FX loans and loans indexed to FX, Euribor and risk premium, as well as NPL. In those cases, we were able to further apply the two-step Engle and Granger procedure to estimate long and short-run relationship.

Table 2: Johansen procedure - number of cointegration equations

	3 months Euribor		6 months Euribor	
"Lending Rates on New Loans"	Max Eigen-value Test	Trace Test	Max Eigen-value Test	Trace Test
Total Loans to Corporates*	1	1	2	2
Investment Loans	1	2	1	2
Investment Loans*	1	1	2	2
Total Loans to Households	1	1	1	1
Housing Loans	2	2	1	1

*Besides Euribor and EMBI, NPL also included as explanatory variable.

In comparison to the research of Gallo [12], we were investigating data for Serbia only and for period 2010-2020. We did not find that the relation between Euribor and interest rates on corporate loans is much stronger than relation between Euribor and interest rates on household loans. In comparison with the research of Jobst & Kwapil [15], we are analyzing both three-month and six-month Euribor movements. Similar to the results of Graeve et al. [14], in our research we found the long-term relationship to be strong, while short term relationship is not significant. In comparison with the method that Mihaylov [19] used in his research which is standard and asymmetric VECM, in our research used two-step procedure by Engle and Granger.

Results shown in Table 3 indicate that in the long run there is a complete pass-through of Euribor rates on euro and euro-indexed bank lending rates on total new corporate loans, as well as loans to households, for both 3- and 6-month maturities (coefficient for Euribor 3 months and 6 months ranging between 1.01-1.30). Looking only at investment loans to corporates there is almost complete pass through of Euribor 6 months and full pass through of Euribor 3-month rates, as well complete pass through of 3-month Euribor rates when NPL is included. Somewhat weaker relationship in the long run exists in the case of housing loans for Euribor of 6-month maturity (0.66). Actually, in all of the observed cases, it seems that there is a somewhat higher pass-through of 3-month than 6-month Euribor rates. What is conspicuous is that coefficients for Euribor in case of both total loans to corporates and loans to households (both for 3- and 6-month Euribor maturities), as well as 3-month Euribor in case of investment loans are greater than 1, indicating an excessive sensitivity of those lending rates to change in Euribor, which could be explained by fierce competition among banks in the observed period which, in attempt to retain old and gain clients lowered their interest rates even more than the fall in Euribor would suggest.

Table 3: Estimation results for interest rates on various types of new EUR and EUR-indexed loans

	Total Loans to Corporates		Investment Loans			Total Loans to Households		Housing Loans
Maturity of Euribor	3m	6m	3m	3m	6m	3m	6m	6m
Long-term relationship								
Euribor[1]	1.30***	1.22***	1.11***	1.07***	0.98***	1.13***	1.01***	0.66***
EMBI	0.68***	0.63***	0.46***	0.68***	0.66***	0.77***	0.76***	0.41***
Constant	2.16***	2.07***	2.68***	2.94***	2.86***	3.74***	3.63***	2.76***
NPL	0.04***	0.04***	0.05***					
R2	0.88	0.88	0.87	0.84	0.84	0.83	0.83	0.89
Short-term relationship								
Lag of Δ of interest rate on loans	-0.30***	-0.30***	-0.31***	-0.34***	-0.34***	-0.11	-0.11	-0.34***
Δ Euribor[1]	0.41	0.03	0.48	0.85	0.37	0.4	0.72	0.35*
Speed of adjustment	-0.14***	-0.14***	-0.34***	-0.29***	-0.27***	-0.09**	-0.09**	-0.07**
Δ EMBI	-0.24**	-0.22**	-0.13	-0.17	-0.15	0.08	0.07	-0.05
Δ NPL	0.11**	0.12**	0.22***					
R^2	0.23	0.23	0.36	0.31	0.31	0.07	0.08	0.19

[1] adjusted for effective FX reserve requirement rate.
*p-value < 0.1; **p-value < 0.05; ***p-value < 0.01.

Though in the short run there seems not to be a significant relationship in most cases among observed variables (except for lags of interest rates which is in most cases significant), it is important that α, the speed of adjustment to long-run relationship, is in each and every case significant and negative. Though, it is more significant in the case of loans to corporates, both total and investment loans (at 1%), than in the case of total loans to households and housing loans (at 5%). Also, the speed of adjustment is highest in the case of investment loans then total loans to corporates, followed by total loans to households and housing loans. In models where we included NPL, it seems it is also significant in the short-run equation (at 5%), with highest coefficient in the case of investment loans, followed by total corporate loans for Euribor maturity of 6 months, and smallest in the case of total corporate loans for Euribor maturity of 3 months.

Conclusion

In the paper we were examining the impact that Euribor has on interest rates on FX loans and loans indexed to FX. We were investigating four types of loans: total new loans granted to the corporates, total new loans granted to the households, total new housing loans and total new investment loans. In addition, we were observing the impact of risk premium (EMBI) on the given interest rates, as well as influence of nonperforming loans' level. We were observing the case of Republic of Serbia and the period from September 2010 until August 2020. Using the econometric approach, specifically Engle and Granger procedure, we made final conclusions.

In our research we found that there is a strong long-run relationship between Euribor and the interest rates on total new corporate loans, total new household loans and new investment loans. The long-run relationship between total new housing loans and Euribor is also significant, but somewhat weaker. Regarding relationship between risk premium and given interest rates, we found a significant influence in all cases, with stronger connection with interest rates on new lending rates on total corporate loans and weaker connection with interest rates on total household loans and total investment loans. In models where NPLs is included, it showed significant, with fall in NPLs helping reduce the lending interest rates. Regarding short-term relationships, we found most of them not to be significant, with the exception of NPLs which are significant in all models where they were included. Finally, we found that the speed of adjustment to long-run relationship is significant and negative for all observed models.

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PROFESSIONAL TRAINEESHIP PROGRAMME AS A TOOL FACILITATING PARTICIPATION OF UNEMPLOYED YOUTH IN THE LABOUR MARKET: CASE STUDY OF THE REPUBLIC OF SERBIA

Program stručne prakse kao podrška nezaposlenim mladima u učešću na tržištu rada – studija slučaja Republike Srbije

Abstract

Active labour market policies (ALMPs) aim to increase employment mainly targeting vulnerable groups as beneficiaries – long-term unemployed, youth, women, people with disabilities, Roma, etc. The prevalence of ALMPs and their intensity vary from country to country as determined by available financial resources, targeted beneficiaries' characteristics as well as the labour market characteristics. The objective of this paper is to examine the 12-month Professional Traineeship Programme (PTP) implemented by the National Employment Service (NES) of the Republic of Serbia. The programme was conducted from 2017 to 2018 assigning 9,561 participants to workplace training based on their educational background with a view to easing the transition from education to work. Our analysis illustrates the characteristics and labour market outcomes of the programme's participants. Every third participant got employed in the company after completing the programme, and after one year every second participant was employed (in the same company or elsewhere). We find that those who participated in the programme in the public sector were somewhat less likely to gain employment a year after its completion. Moreover, women were more likely to be employed one year after finishing the traineeship as well as those who were better educated and those who lived in more economically developed regions. Gender, education level and one's regional background are therefore found to be important correlates of success in securing employment when young people enter the labour market following education.

Keywords: *professional traineeship programme, Serbia, unemployment, youth*

Sažetak

Aktivne politike tržišta rada (APTR) imaju za cilj povećanje zaposlenosti i uglavnom su fokusirane na ranjive kategorije na tržištu rada, kao što su dugoročno nezaposleni, mladi, žene, osobe sa invaliditetom, Romi i dr. Primena i intenzitet mera varira od zemlje do zemlje, ali i od visine izdvojenih finansijskih sredstava, kao i od karakteristika korisnika i karakteristika tržišta rada. Cilj ovog rada je da se ispita uspeh dvanaestomesečnog programa stručne prakse koji je implementiran 2017. i 2018. godine od strane Nacionalne službe za zapošljavanje Republike Srbije. Ukupno 9.561 polaznik je učestvovao u programu i to isključivo u oblastima njihovog obrazovanja. Takođe, program je imao za cilj da olakša učesnicima tranzicioni period od škole do posla. U radu su prezentovani nalazi o karakteristikama i ishodima na tržištu rada učesnika programa stručne prakse. Svaki treći ispitanik se zaposlio u firmi u kojoj je radio praksu, a nakon godinu dana svaki drugi ispitanik je bio zaposlen (u istoj ili drugoj firmi). Utvrđeno je da su oni koji su učestvovali u programu u javnom sektoru imali nešto manje šanse da se zaposle godinu dana nakon završetka programa u odnosu na učesnike iz privatnog sektora. Takođe, rezultati pokazuju da je veća verovatnoća da će žene imati zaposlenje godinu dana nakon završetka programa, kao i da su učesnici sa višim nivoom obrazovanja i oni koji žive u ekonomski razvijenijim regionima imali bolje šanse za zaposlenje. Od grupe faktora koje smo analizirali u radu, rezultati pokazuju da pol, obrazovanje i region najviše koreliraju sa uspehom pri ulasku mladih na tržište rada.

Ključne reči: *program stručne prakse, Srbija, nezaposlenost, mladi*

Introduction

Active labour market policies and programmes (ALMPs) are a set of policies used by governments with a goal to enhance the labour market opportunities of job seekers and improving the matching process between job seekers and employers. While ALMPs aim to support all job seekers who need help, vulnerable job seekers such as long-term unemployed, low-educated, youth, women, Roma and persons with disabilities, etc., constitute important target groups of these policies. The success of an ALMP and its impact on the beneficiaries depend on how well the measures have been defined and then implemented. Governments have limited resources to invest in ALMP measures, and as a consequence, their implementation should be monitored regularly and ineffective measures should be eliminated or redesigned [12]. This is especially the case for Serbia where funds are limited and only those individuals most in need can be supported with more intensive ALMPs.

This paper examines a vocational training programme, the Professional Traineeship Programme (on-the-job training programme) implemented by the Serbian National Employment Service in 2017 and 2018. The main aim of the programme was to provide on-the-job training to unemployed persons and support them in their path from education to work. This paper presents the findings on characteristics and labour market outcomes of the programme's participants. In line with the current research on employment, our paper uses administrative data from the National Employment Service (NES) of the Republic of Serbia. Evaluating labour market policy programmes and measures using administrative data has become increasingly a focus of research. Such evaluations are used to provide guidance to decision makers on improving employment policies [4], [13]. Both private and public sector employers implemented the programme, however, 30% of the participants at most could be placed in the public sector. In order to be eligible for the 2017 NES programme, a participant had to be up to 30 years of age; for the 2018 programme, all unemployed persons regardless of age were eligible to participate. A group of authors summarising 37 studies evaluating active employment policy measures in the EU concluded that such measures have a significant positive impact on youth when formal training, job market training or alternative training are utilised to integrate unemployed youth into the labour market [1].

In this paper we analyse the largest ALMP targeting youth in Serbia: the Professional Traineeship Programme. We rely on both administrative data on the socio-economic background and the labour market history of participants as well as survey data with a subsample of the programme's participants. While administrative data give a clear overview on the formal employment trajectories of participants, the survey data serve to provide descriptive information on the programme participants' experience. Programme participants were on average 26 years old, higher educated and were more frequently females than males. Prior to entering the programme, participants were, on average, registered unemployed for a year. After finishing the programme, every third participant stayed with the company where they did the traineeship. 180 days after finishing the programme, 38.7% of participants were employed and this share rose to 47.6% after 365 days, i.e. one year. The most relevant correlates for the success in the programme were female gender, previous work experience and geographical region. The employed participants most frequently had a fixed-term contract. The results from the satisfaction survey with participants reveal that they believe that the programme helped them to acquire knowledge and skills; they reported that they were well received in the companies and supported throughout the traineeship. Almost all participants would recommend the programme. Most participants who sit the professional exam were successful, i.e. they passed the exam. Finally, there are some differences between participants in the public and the private sector. A larger share of public sector participants entered the traineeship because they needed work experience in order to sit the professional license exam. Public sector trainees were more educated, but had a lower employment rate. These findings do not speak against the programme in the public sector, they rather underline the restrictive regulation of hiring new employees in the public sector. Overall, the results of this study show that the programme is successful both in the public and in the private sector and that it is very

important for both sectors. Some professions in the public sector require a professional licence which in turn can only be gained with work experience, and the Professional Traineeship Programme helps graduates to fill this gap. On the other hand, schools and universities do not prepare sufficiently their graduates for the working life, and in the private sector the programme is used as a transition from school to independent work. The programme should be further promoted among companies in the private sector as it is a cost-effective mechanism for screening potential employees and helping young people transition to their full working capacity.

The paper proceeds as follows. Section 2 gives an overview of the literature, sections 3 and 4 describe the programme and provide descriptive statistics. Section 5 elaborates the empirical methodology and presents the results. Finally, section 6 concludes and discusses the findings.

Literature review

This paper focuses on a specific type of ALMP, a vocational training programme offered by the National Employment Service. There exist a large number of ALMPs and they can be grouped into 4 large categories: (1) job search assistance, (2) job market trainings, (3) private sector employment incentives and (4) public sector employment incentives [8]. Job search assistance programmes have the largest target base, i.e. all individuals registered with the public unemployment service benefit from this type of programmes. Their goal is to help job seekers increase their job search effort so that their job search is more efficient and the quality of the subsequent job match is improved. There are different subtypes of job search assistance programmes: (a) job search training, (b) counselling, (c) monitoring and (d) job clubs. A job search assistance programme can be composed of one or a combination of the four subtypes. With regard to effectiveness, job search assistance programmes have large short-term impacts, but in the long term these impacts do not persist. Job market trainings include any type of training aiming to increase the human capital, and they can be classified into the following 5 subtypes: (a) classroom vocational/technical training, (b) work practice (on-the-job training), c) basic skills training, d) life skills training and e) job insertion. Job market skills trainings have smaller short-term impacts, but in the medium to long term the impacts are positive. Turning now to the private sector employment incentives, these programmes and measures include subsidies for employment or self-employment. The main purpose of the private sector employment schemes is to improve the matching process and raise the labour demand. Similar to training programmes, these schemes have only minor impacts in the short term, but their positive impacts are evident in the long term. Finally, public sector employment schemes are direct temporary employment schemes in the private sector. Public works are the most prominent type of public sector employment scheme, however, any other activities that produce public goods or services would fall into this group. These schemes, in most cases, target the most disadvantaged individuals and in some cases they even have the role of a safety net. In contrast to the other three types of ALMPs, public sector employment incentives do not have a positive impact neither in the short nor in the long run [2].

When looking at the effectiveness of an ALMP, it is important to consider the target group as the impacts of ALMPs are often heterogeneous. Kluve et al. [8] studied 113 interventions targeting youth in different countries, and their main finding is that entrepreneurship promotion and skills training have a positive impact on employment and earnings of youth. In contrast, the impact of employment services and subsidised employment is generally small and insignificant. The authors emphasise that impacts of these programmes are larger in low- and middle-income countries compared to high-income countries. The available evidence further suggests that programmes targeting disadvantaged youth are particularly effective. Focusing exclusively on active labour market policies in Europe, Caliendo and Schmidl [1] highlight that the evidence is only partly promising. Only job search assistance has overwhelmingly positive results, while training and wage subsidies have mixed effects and the impact estimates of public work programmes are in line with the literature, i.e., they even have a negative impact.

Kluve et al. [9] studied the same group of interventions as in Kluve et al. [10], emphasising that design and delivery are more important than the intervention type. They further find that bundling services is more effective than implementing single measures. Profiling of beneficiaries and individualized follow-up systems have reportedly shown positive impacts. Finally, the authors stress that long-term impacts are often larger in magnitude than short-term impacts and advocate for long-term evaluations of programmes.

There are numerous policy evaluations of different labour market trainings in the Western Balkans. However, one programme in Croatia is similar to the programme that we study, and we summarise some of its relevant findings. Croatian Employment Service [6] conducted an analysis of an on-the-job training (traineeship) targeting skilled youth; this programme was implemented from 2014 to 2015. The findings on the programme are mainly based on results from the survey conducted with participants and employers. Similar to Serbia, participants attended this programme to acquire experience required for getting a professional licence (e.g., teacher licence, lawyer licence, etc.). Two-thirds of participants had no previous work experience prior to joining the programme, while for those who did possess experience, the work experience was not related to their field of study. The participants stated that the main reason for their participation in the programme was to improve their working skills and get the practical experience in order to fulfil the requirements for the professional licence. On the other hand, employers reported that participants did not have practical skills and they saw the programme as a good transition into the professional world.

There are a number of different studies of ALMPs in Serbia; however, one specific study was conducted to evaluate the Professional Traineeship Programme. According to the study by Marjanović et al. [11], which uses a quasi-experimental setting, the Professional Traineeship Programme did not have a positive impact neither on employment nor on wages. Using similar quasi-experimental settings, other ALMPs implemented by the National Employment Service such as training upon request of an employer, job market training, acquisition of practical knowledge were found to have some positive impacts [11], [7].

Description of the programme

This paper studies the 12-month Professional Traineeship Programme (PTP) implemented by the National Employment Service in Serbia. In particular, we analyse the participants of this programme in 2017 and 2018. The aim of the programme was to ease the transition from education to work and train participants for their respective profession, i.e. the profession that they have studied for. It targeted private sector employers including 30% of public sector employers at most (in particular restricted to the fields of health, education and social protection). In Kosovo and Metohija and less developed municipalities there were no restrictions with regard to the public sector and more participants could be placed there. The age limit for participants in 2017 was 30, while in 2018 there was no explicit age limit, but most participants were still aged up to 30 years. Participants receive a remuneration ranging from 12,000 RSD to 14,000 RSD (100 EUR to 117 EUR). Many participants use this programme as an opportunity to acquire necessary working experience which is a precondition for getting a professional licence (such as teacher license, lawyer licence, doctor licence, etc.).

Descriptive statistics

For the purpose of this study, we use administrative data from the National Employment Service (NES) of the Republic of Serbia. This dataset contains data on socio-demographic characteristics of participants and their labour market history, i.e. their employment and unemployment spells. We supplement the administrative data with a survey that we administered to a subsample of participants.

The total number of programme participants in 2017 and 2018 was 9,561.[1] We do not report the differences between years in a separate table as they are not explored in this this study, but we do summarise them briefly here.[2]

1 In 2017 there were 4,072 participants, while in 2018 there were 5,489.

2 Complete table available upon request.

There are no differences in terms of gender between the two years, however, the average age of participants in 2018 was half a year older than in 2017, and the 2018 participants were more educated, in particular, they had a higher share of tertiary education (level VII professional qualification). There are significant differences with regard to field of education. In 2018, there was a higher share of participants from the field of economics, law and administration and a smaller share in a number of other fields (e.g. agricultural, food production and processing; mechanical engineering and metal processing; electrical engineering; trade, hotel and tourism management; social sciences; health, pharmacy and social protection). There are no statistically significant differences in terms of participation of vulnerable groups or with regard to regional distribution.

The socio-demographic characteristics both overall and by sector are reported in Table 1.

Table 1: Descriptive statistics

	Total	Private	Public	p-value
	N=9,561	N=6,073	N=3,488	
Female	66.4%	61.9%	74.2%	<0.001
Age (at entry)	26.0 (4.6)	25.8 (4.6)	26.4 (4.7)	<0.001
Education				<0.001
Professional qualification III	4.5%	7.1%	0.1%	
Professional qualification IV	26.1%	27.9%	22.9%	
Professional qualification V	0.0%	0.0%	0.0%	
Professional qualification VI-1	1.3%	1.2%	1.5%	
Professional qualification VI-2	11.0%	9.1%	14.4%	
Professional qualification VII-1	57.0%	54.7%	60.9%	
Professional qualification VII-2	0.1%	0.1%	0.1%	
Educational background (area)				<0.001
Agricultural, food production and processing	4.3%	6.4%	0.6%	
Forestry and timber processing	0.3%	0.4%	0.1%	
Geology, mining and metallurgy	0.1%	0.1%	0.0%	
Mechanical engineering and metal processing	2.5%	3.7%	0.4%	
Electrical engineering	2.6%	3.8%	0.4%	
Chemistry, non-metals and graphic arts	1.2%	1.6%	0.5%	
Textiles and leather industry	0.3%	0.4%	0.0%	
Geodesy and civil engineering	2.9%	4.4%	0.3%	
Transport/traffic	1.1%	1.4%	0.5%	
Trade, hotel and tourism management	4.4%	6.7%	0.3%	
Economics, law and administration	42.4%	56.1%	18.4%	
Education	9.6%	0.6%	25.3%	
Social sciences	6.3%	2.0%	14.0%	
Mathematics	3.7%	2.9%	5.0%	
Culture, arts and public relations	0.6%	0.5%	0.6%	
Health, pharmacy and social protection	14.7%	4.3%	32.9%	
Other	3.0%	4.5%	0.5%	
Vulnerable groups				
Persons with disabilities	0.6%	0.6%	0.7%	0.72
Recipients of social financial assistance	1.3%	1.1%	1.8%	0.003
Roma	0.4%	0.5%	0.3%	0.28
Region				<0.001
Belgrade	12.1%	12.6%	11.1%	
Vojvodina	18.1%	19.3%	16.0%	
Šumadija and Western Serbia	33.6%	36.7%	28.0%	
Southern and Eastern Serbia	29.1%	30.0%	27.6%	
Kosovo and Metohija	7.2%	1.4%	17.2%	

Note: For continuous variables the table shows the mean and the standard deviation in brackets. p<0.1 statistically significant at 10%, p<0.05 statistically significant at 5%, p<0.01 statistically significant at 1%. For binary and categorical variables we use the Pearson's chi-square test, and for continuous variables Student's t-test.
Source: Authors' calculations based on administrative NES data for 2017 and 2018 on participants of the Professional Traineeship Programme.

The programme originally envisioned that 30% of all participants at most enrol in their traineeship in the public sector. However, based on the data, the number was slightly higher than originally planned. About 36% of trainees attended their traineeship in the public sector. Participants of the programme were predominantly women (66.4%). The participation of women was also found to be higher in the public sector (74.2%) than in the private sector (61.9%).

According to the results of descriptive statistics, the median age at entry in the programme was 25 in the private sector and 26 in the public sector. Out the 4,067 participants from 2017, 197 (4.8%) were over the age of 30; in 2018, out of the 5,494 participants, 977 (19.6%) were over the age 30. The age limit had been expanded in 2017 to include participants over 30 years of age.

Regarding the level of education, more than half of the participants in both sectors (54.7% in private and 60.9% in public) completed a VII-1 level degree (i.e. master academic studies or vocational studies or integrated academic studies). The second largest category (total: 26.1% - private 27.9% and public 22.9%) holds a IV level degree (i.e. a four-year secondary education). Overall, participants attending the traineeship in the public sector have, on average, a higher level of education than participants from the private sector.

In this programme, 3 areas of education were predominant among the participants: 1) economics, law and administration; 2) education; and 3) health, pharmacy and social protection. However, there are statistically significant differences among programme participants in the private and public sectors. Participants in the private sector have more often as their educational background the field of economics, law and administration (56.1%), while all other sectors are represented by less than 10%. Those in the public sector have an educational background in the following three areas: 1) education; 2) health, pharmacy and social protection; and 3) economics, law and administration.

A total of 130 beneficiaries of social financial assistance (1.3%), 62 persons with disabilities and 39 persons of Roma ethnicity were included in PTP. The private sector included a total of 128 persons belonging to at least one of these three vulnerable groups, while the public sector included 85 persons. Beneficiaries of social financial assistance are more often included in PTP with public sector employers.

Observed by regions, the PTP most often included persons from Šumadija and Western Serbia (33.6%) and Southern and Eastern Serbia (29.1%), while fewer participants were from the region of Vojvodina (18.1%), Belgrade (12.1%) and Kosovo and Metohija (7.2%). With the exception of Kosovo and Metohija, where the participants mostly did their traineeship in the public sector, in the other 4 regions, the participants of the programme were mostly with a private employer.

In Table 2, we show the labour market experience before and after the traineeship programme. Most participants were unemployed for roughly a year before entering the programme. In the year prior to entering the programme, they were registered unemployed for 198 days, while they were employed only a minor number of days (10 days). Among all participants, 27.8% stayed with the company where they did their traineeship programme with the average time until the first employment being 100 days. In the first year after the programme, trainees were employed on average for 99 days, while they were unemployed for 162 days. With regard to employment after 180 or 365 days, we find that 38.4% had employment after 180 days while this percentage increases to 47.6% after 365 days. Most frequently, participants had fixed-term contracts (64.6% among those employed after 180 days, and 62.1% among those employed after 365 days). Prior to entering the programme, trainees from private sector firms were in a somewhat better position than trainees from public sector firms. They were unemployed for a shorter period of time. However, when comparing the success of private and public sector trainees, the results suggest that private sector employees were more likely to stay in the company where they did their traineeship and they were more likely to be employed 180 days and 365 days after the traineeship. Not surprisingly, private sector employees had somewhat more favourable employment contracts than public sector employees. These differences between the two sectors, especially with respect to employment, are mainly driven by limitation imposed on the public sector to hire freely new employees.

Empirical strategy and results

We now turn to the econometric analysis to estimate the probability of a participant being employed one year (i.e. 365 days) following the end of the programme. The calculation is based on the following general model:

$$employed365_i = \alpha_0 + \alpha_1 public\_sector_i + \gamma X_i + \delta Y_i + \varepsilon_i$$

The outcome of the model is an indicator as to whether the person is employed 365 days after finishing the programme. This simple econometric model aims to capture which characteristics of the participant correlate with the probability of being employed one year following the programme completion.

The coefficient α_1 captures the correlation between traineeship in the public sector and employment. The coefficient α_1 is not interpretable as causal; rather, it is a correlation (or association) as there could be possible unobservables not captured by the model. In this model we control background characteristics (such as socio-demographic characteristics and labour market experience) and thus, when comparing public and private sectors we control for socio-demographic characteristics of participants (gender, age, qualification level, being a member of a vulnerable group and region) as part of the vector X_1 and for labour market experience (number of weeks employed in the year before entering the programme, number of weeks unemployed in the year before entering the programme and number of weeks unemployed) within the vector Y_1.

The quantitative analysis aims to estimate which determinants are associated with success in terms of job finding. The econometric analysis aims to determine which individual factors correlate with the employability of the participant of the traineeship programme.

Table 3 shows the marginal effects estimated in a probit model with the outcome of being employed 1 year after finishing the programme. Model 1 (column (1)) includes an indicator for the public sector and the

Table 2: Labour market experience before and after the traineeship programme (TP)

	Total	Private	Public	p-value
	H=8,275	H =5,191	H =3,084	
Before TP				
Duration of unemployment before TP in days	351 (604)	319 (543)	403 (691)	<0.001
Number of days employed in the 365 days before TP	10 (45)	9 (43)	11 (49)	0.094
Number of days unemployed in the 365 days before TP	198 (133)	195 (130)	203 (138)	0.007
After TP				
=1 employed after the measure	27.8%	30.4%	23.3%	<0.001
Number of days before first employment (within 365 days)	100 (103)	88 (103)	122 (101)	<0.001
Number of days employed in the 365 days after TP	99 (134)	117 (144)	68 (108)	<0,001
Number of days unemployed in the 365 days after TP	162 (146)	146 (145)	187 (143)	<0.001
180 days after completing TP				
=1 employed	38.4%	42.1%	32.0%	<0.001
Duration of employment	109 (65)	121 (62)	82 (64)	<0.001
Contract type				<0.001
Fixed-term contract	64.6%	62.0%	70.5%	
Permanent contract	25.7%	29.6%	16.9%	
Services contract	6.0%	4.9%	8.5%	
Other	3.7%	3.5%	4.1%	
365 days after completing TP				
=1 employed	47.6%	50.7%	42.2%	<0.001
Duration of employment	196 (125)	217 (125)	154 (113)	<0.001
Type of employment				<0.001
Fixed-term contract	62.1%	58.1%	70.2%	
Permanent contract	28.6%	33.0%	19.8%	
Services contract	4.6%	3.8%	6.4%	
Other	4.6%	5.2%	3.5%	

Note: *Multiple answers possible. For continuous variables the table shows the mean and the standard deviation in brackets. p<0.1 statistically significant at 10%, p<0.05 statistically significant at 5%, p<0.01 statistically significant at 1%. For binary and categorical variables we use the Pearson's chi-square test, and for continuous variables Student's t-test.

Source: Authors' calculations based on administrative NES and CROSO data for 2017 and 2018 on participants of the Professional Traineeship Programme.

year of participation. Model 2 (column (2)) includes the participants' socio-demographic characteristics such as gender, age and educational background. Model 3 shown in column (3) includes variables on the labour market status in the year prior to entering the programme. In model (4), in column 4, we add geographical controls to capture differences in local labour markets.

The results of model (1) suggest that those who carried out their training in the public sector were 7.6 percentage points (p.p.) less likely to be employed 365 days following the completion of their traineeship compared to those who did so in the private sector (42.9% in public sector to 50.5% in private sector). Adding other controls induces the coefficient to fall to 3.0 p.p. implying that some of these controls can explain the difference in employment between the public and private sector.

Region is a decisive factor in the ability to become employed following completion of traineeship. For instance, those who carried out their traineeship in Kosovo and Metohija found it difficult to gain employment. Compared to participants from Belgrade, those who carried out their training in Kosovo and Metohija were 24.4 p.p. less likely to become employed. Considering that Belgrade is the economic centre of Serbia, it is surprising that participants from the regions of Vojvodina, Šumadija and Western Serbia as well as Southern and Eastern Serbia had a higher probability to be employed 365 days following completion of their traineeship. Compared to men, women had 2.9 p.p. better chances to become employed following their traineeship. On average, age was an important determinant, whereby each additional year successively reduced the probability of becoming employed by 0.3 p.p. Moreover, possessing prior workplace experience in the year preceding the traineeship increased the probability of employment by a successive 0.3 p.p. per week, while a week of unemployment reduced the chances successively by 0.1 p.p. per week.

Overall, the results in the empirical part suggest that trainees in the private sector were more likely to find employment, women were more likely to find employment

Table 3: Main results – outcome: being employed 365 days after completing the programme

	(1)	(2)	(3)	(4)
Public sector	-0.076***	-0.083***	-0.086***	-0.030**
	(0.011)	(0.012)	(0.012)	(0.012)
Year of participation	-0.050***	-0.049***	-0.049***	-0.047***
	(0.011)	(0.011)	(0.011)	(0.011)
Female		0.041***	0.041***	0.029**
		(0.012)	(0.012)	(0.012)
Age		-0.004***	-0.002	-0.003**
		(0.001)	(0.001)	(0.001)
University or college		0.025*	0.017	0.010
		(0.013)	(0.013)	(0.013)
Length of unemployment before traineeship (in weeks)			-0.000***	-0.000
			(0.000)	(0.000)
Number of weeks employed in the year prior to TP			0.004***	0.003***
			(0.001)	(0.001)
Number of weeks unemployed in the year prior to TP			-0.001**	-0.001*
			(0.000)	(0.000)
Vojvodina				0.164***
				(0.021)
Šumadija and Western Serbia				0.125***
				(0.019)
Southern and Eastern Serbia				0.068***
				(0.019)
Kosovo and Metohija				-0.244***
				(0.030)
Pseudo R2	0.0059	0.0077	0.0139	0.0398
Number of observations	8.108	8.108	7.982	7.982

Note: Reference categories: education - secondary school or less; region - Belgrade. Marginal effects are reported.
* statistically significant at 10%; ** statistically significant at 5%; * statistically significant at 1%.
Source: Authors' calculations based on administrative NES and CROSO data for 2017 and 2018 on participants of the Professional Traineeship Programme.

and more educated participants had a somewhat better chance for being employed after 365 days. However, the strongest correlate of success is the region, compared to Belgrade, participants from three other regions (Vojvodina, Šumadija and Western Serbia, Southern and Eastern Serbia) were more successful while participants from Kosovo had less success.

Survey results

In order to shed some light on the participants' experience with PTP, we conducted a survey with a subsample of 1,014 participants (683 from private sector and 331 from public sector companies). Answering the question on the channel through which they found the traineeship, most respondents said that they had found it with the support of NES (31.1%), other frequent responses were that they had applied directly at the employer (31.6%), they had found the traineeship through personal contacts (19.0%) and that they had worked at the company before entering the traineeship (15.4%). Prior to entering the measure, most respondents answered that they did not receive any support from NES (52.3%). However, those who said that they received support from NES, reported that they received job search counselling (32.6%), support to enter PTP (24.3%), information on vacancies (19.2%) and counselling on education and trainings (16.9%). The main reason for participants to join the programme was to gain work experience (71.9%), other reasons include: traineeship required to sit the professional state exam (35.2%), financial compensation (32.7%), need to learn something new (23.3%) and possibility to get employed in the company. A large majority of participants reported that they were satisfied with the support from NES when entering the measure (86.4%) and during the measure (85.2%) and with the programme overall (93.0%). Participants gave very positive answers about the programme, they reported that the tasks assigned helped them acquire knowledge and skills (94.2%), they felt free to ask questions (94.5%), the mentor helped them improve their knowledge and skills (95.4%), they had a good relationship with the mentor (94.9%) and they improved their knowledge and skills during the programme (94.1%). Finally, almost all participants would recommend the programme (94.7%). Among all participants, one-third (34.4%) passed the professional state exam, while among those who did not pass it, many reported that they were still preparing for it (29.2%). Other reasons for not sitting the professional state exam include answers such as that they did not know anything about a professional exam (26.1%) and that they did not need it in their current workplace (20.8%). Among participants who attended the professional exam, almost all participants succeeded (97.4%), and participants generally agreed that the knowledge and skills they acquired during the programme were helpful for the professional exam.

Some minor difference in responses between the private and public sector can be observed. Compared to the private companies, trainees in the public sector found their traineeship more frequently through direct employment and less frequently through personal contacts. Trainees in the public sector reported more frequently that they entered the traineeship scheme in order to get the necessary working experience for the professional exam. Additionally, trainees employed in the private sector worked more hours.

Overall, the survey results suggest that NES was to some degree active in recruiting the trainees, every third trainee found the traineeship through NES. Most participants entered the programme in order to get work experience. According to subjective indicators, participants were highly satisfied with the programme (see Table 4).

Conclusion and discussion

In this paper, we study the largest programme of the National Employment Service of the Republic of Serbia targeting youth – Professional Traineeship Programme (PTP). The programme is attended somewhat more frequently by females than by males with the average age of participants being 26 years. Most participants of the programme have either a college or university education. The share of persons belonging to vulnerable groups is minor. The descriptive statistics suggest that the average participant was unemployed for one year before entering the programme. Following its completion, every third participant stayed with the company where he/she did

the traineeship. 180 days after finishing the programme, 38.4% of participants were employed, while 365 days after the programme this number rose to 47.6%. The majority of participants had a fixed-term contract after 180 and 365 days, but some participants did secure permanent contracts (28.6%). A satisfaction survey conducted with participants after the programme revealed a large level of satisfaction with it. Overall, our findings speak in favour of the programme as it offers a very good opportunity for young people to get the first professional training in a real world environment and is a stepping stone towards regular employment. Similarly, the programme offers an

Table 4: Responses of trainees about their experience with the programme

	Total	Private	Public	p-value.
	N=1,014	N=683	N=331	
How did you find the traineeship				<0.001
Worked at the company before traineeship	14.0%	13.3%	15.4%	
Personal contacts	25.7%	29.0%	19.0%	
Applied for the job advertisement	4.7%	5.4%	3.3%	
Direct application at the employer	23.0%	19.9%	29.3%	
Through the counsellor of the National Employment Service (NES)	31.5%	31.6%	31.1%	
Other	1.1%	0.7%	1.8%	
Support received from NES before entering the measure*:				
No support	52.3%	49.6%	57.8%	0.015
Job search counselling	30.7%	32.6%	26.8%	0.063
Information on vacancies	19.2%	20.2%	17.2%	0.26
Counselling on education and trainings	16.9%	17.9%	14.8%	0.21
Placement in education and trainings	7.8%	8.0%	7.4%	0.74
Support to enter the Professional Traineeship Programme	24.3%	26.4%	20.0%	0.028
Reason(s) to participate in the Programme*:				
Traineeship required for licence	35.2%	26.5%	53.0%	<0.001
Possibility to get employed in the company	10.6%	12.2%	7.3%	0.016
Good employment prospective	9.4%	9.4%	9.4%	0.98
Wanted to learn something new	23.3%	24.2%	21.5%	0.35
Wanted to gain work experience	71.9%	72.0%	71.8%	0.96
Financial compensation	32.7%	35.0%	28.2%	0.032
Satisfied with support from NES when entering the measures+	86.4%	86.5%	86.3%	0.91
Satisfied with support from NES during the measures+	85.2%	86.7%	82.2%	0.078
Satisfied with the programme+	93.0%	92.2%	94.6%	0.17
Number of hours worked in a week	38.0 (5.3)	39.1 (4.2)	35.8 (6.5)	<0.001
Tasks assigned during the programme contributed to the acquisition of knowledge and skills +	94.2%	93.5%	95.5%	0.22
Asked questions without feeling uncomfortable+	95.4%	94.0%	98.5%	0.001
Mentor helped to improve knowledge and skills+	93.0%	91.7%	95.7%	0.019
Good relationship with mentor+	94.9%	94.1%	96.6%	0.086
Improved knowledge and skills during the programme+	94.1%	93.5%	95.2%	0.31
Would recommend the programme+	94.7%	94.7%	94.5%	0.91
Finished	88.6%	88.0%	90.0%	0.33
Passed the professional exam	34.4%	25.8%	52.0%	<0.001
Reason for not passing the professional exam				<0.001
I have not attended sufficient number of trainings	6.7%	6.6%	7.1%	
I am still preparing for the exam	29.2%	23.7%	47.1%	
Not required at my current work	20.8%	21.9%	17.4%	
Did not know that there is a professional exam	26.1%	32.2%	6.5%	
Personal reasons	14.3%	12.5%	20.0%	
Other	2.9%	3.2%	1.9%	
Passed professional exam (conditional upon attending)	97.4%	95.3%	99.4%	0.018
Knowledge and skills acquired during the programme helpful for professional exam+	94.1%	95.2%	93.0%	0.41

*Multiple answers possible. + Scale is 1 to 6, answers 4 to 6 are classified as yes. For continuous variables the table shows the mean and the standard deviation in brackets. p<0.1 statistically significant at 10%, p<0.05 statistically significant at 5%, p<0.01 statistically significant at 1%. For binary and categorical variables we use the Pearson's chi-square test, and for continuous variables Student's t-test.
Source: Survey with participants of the Professional Traineeship Programme in 2017 and 2018.

opportunity for companies to train labour market entrants at a relatively low cost. Due to data limitation we were not able to conduct an impact evaluation, however, this type of evaluation would further help understand the impact of the programme and it would help improve it.

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HUMIDITY AND AIR TEMPERATURE PREDICT POST COUNT ON TWITTER IN 10 COUNTRIES: WEATHER CHANGES & LIWC PSYCHOLOGICAL CATEGORIES

Vlažnost i temperatura vazduha predviđaju broj objava na Tviteru u 10 zemalja – vremenske promene i LIWC psihološke kategorije

Abstract

There are many indications that weather conditions influence human life and well-being. Some of these indicators, such as the influence of weather on human health, have been explored in detail. On the other hand, the influence of daily fluctuations of different meteorological variables on the human psychological state still remains unknown. We apply combined methods from statistics, psychology, machine learning, and complex networks theory to explore the influence of weather parameters on different psychological categories of Twitter users in ten different countries. Our results show that the temperature, pressure, and humidity are highly correlated with Twitter users' activity, sense, and affect. Our comparative analysis for different countries shows that the strongest correlation was found for the USA, Italy, and Portugal, indicating differences between countries. However, our results show that the level of activity of Twitter users, described as Post Count, is strongly connected to changes in temperature and humidity in all countries. We use complex networks theory to explore these connections and differences between countries further. Our findings suggest that weather parameters can be used to predict Twitter users' activity and psychological manifestations, which can be beneficial to marketing and advertising.

Keywords: *Twitter, social media, weather, advertising, big data*

Sažetak

Postoje mnoge indikacije da vremenske prilike utiču na živote i dobrobit ljudi. Neki od ovih pokazatelja, kao što je uticaj vremena na zdravlje ljudi, detaljno su istraženi. S druge strane, uticaj dnevnih fluktuacija različitih meteoroloških varijabli na psihičko stanje čoveka i dalje ostaje nepoznat. U ovom radu primenjujemo kombinovane metode iz statistike, psihologije, mašinskog učenja i složene teorije mreža da bismo istražili uticaj vremenskih parametara na različite psihološke kategorije korisnika Tvitera u deset različitih zemalja. Rezultati pokazuju da su temperatura, pritisak i vlažnost u korelaciji sa aktivnošću, čulnim izražajima i afektom kod korisnika Tvitera. Komparativna analiza među zemljama pokazuje da su najjače korelacije pronađene za SAD, Italiju i Portugal, što ukazuje na razlike između zemalja. Međutim, rezultati pokazuju da je broj tvitova korisnika društvene mreže Tviter povezan sa promenama temperature i vlažnosti u svim zemljama. Koristimo kompleksnu teoriju mreža da dalje istražimo ove veze i razlike između zemalja. Nalazi sugerišu da se vremenski parametri mogu koristiti za predviđanje aktivnosti i psiholoških manifestacija korisnika Tvitera, što može biti korisno za marketing i oglašavanje.

Ključne reči: *Tviter, društvene mreže, vremenski parametri, oglašavanje, veliki podaci*

Introduction

Most of us feel sleepy while it's raining. Others react to sudden weather changes. People sometimes report feeling depressed, low in energy or uplifting, depending on the weather. The richest individuals move to places with a lot of sunshine. These statements could be considered anecdotal evidence, pointing towards potential weather-mood relationships. The question bears wider importance, because human mood may be related to cognitive flexibility, social connectedness, perceived social support, optimism, adaptive coping responses, quality of life and happiness [59], [44], [58], [14].

Early studies

Both psychological and physiological studies have been conducted by early researchers of mood-weather relationship. Main characteristic of these attempts is small groups of research participants. Goldstein [24] correlated semantic mood ratings of 3 female and 4 male students with temperature, humidity, and pressure to conclude that reactivity depends from sex and belief in external control of reinforcement. Persinger [49] calculated correlations between 4 self-reported mood reports per day of 10 subjects and 10 meteorological variables during a 90 days period. Multiple regression analyses indicated that the weather could account for 35% of the mood. However, the conclusion was that lower moods were associated with fewer sunshine and higher humidity. Cunningham [15] conducted two field studies to conclude that generosity of the tip left in restaurant was related to sunshine, lunar phase, sex and age. Sanders & Brizzolara [55] had been conducting a poll every weekday morning to 30 college students for 5 weeks, while at the same time obtaining weather data from the National Weather Service. They found that vigor, social affection and elation correlate significantly with high humidity. Additionally, sunshine and temperature were related to the waitress's self-reported mood. In their research paper "A multidimensional approach to the relationship between mood and weather", Howarth & Hoffman [28] examine concentration, cooperation, anxiety, potency, aggression, depression, sleepiness, skepticism, control, and optimism in a study that included 24 male subjects over 11 consecutive days. They concluded humidity, temperature and hours of sunshine had the utmost effect on mood. Rising temperatures lowered anxiety and skepticism scores. Humidity was a significant predictor in regression and canonical correlation analysis. Research of Parrott & Sabini [48] established the relationship between mood and high levels of sunlight in 2 field quasi-experiments. Rind, B. [52] conducted two studies on sunshine and tipping. The first one was based on a food delivery to 266 hotel rooms, during which the delivery boy had been reporting actual sunshine conditions to guests, either sunny, partly sunny, cloudy or rainy. The conclusion was that the tip increased linearly from the worst to the best conditions. Kripke [35] had been conducting light therapy for nonseasonal depression, while measuring benefits of 12-35% within 1 week. He concluded that light produced faster antidepressant benefits than conventional treatment. Stain-Malmgren et al. [57] examined 11 patients with seasonal affective disorder (SAD) before and after light therapy that was applied in duration in 10 days, two hours per day. They found that 7 patients had a 50% reduction in CPRS scores, which was used to measure SAD. In their paper "Effect of Beliefs About Future Weather Conditions on Restaurant Tipping", Rind, B. & Strohmetz, D. [53] found that favorable weather is connected with increased tipping and that beliefs that weather is favorable can provoke higher tips.

Some authors attempted exploring the impact of weather on mood from a physiological perspective. Mood, behavior and affective disorders were examined by Lambert et al. [36] in relation to weather and seasonal changes. Authors took blood samples of study participants to measure concentration of serotonin. They found turnover of serotonin by the brain was lowest in winter, while its production was directly related to the duration of sunlight. Serotonin is related to feelings of happiness and fulfillment. Leppämäki at al. [38] divided 80 study participants into two groups, one exercising outdoors in bright light, while the other did that in normal indoor conditions. Authors concluded that the exercise was significantly effective at alleviating atypical depressive symptoms when combined with exposure to sunshine.

After earliest studies we register some more recent ones, with larger numbers of research participants. Watson [63] traced the daily mood reports of 498 students and found no important correlations between self reported mood and weather variables such as sunshine, barometric pressure, temperature and precipitation. In two studies of 605 participants, Keller et al. [31] discovered that hotter weather was associated with better mood, increased memory for the period of the spring, as time outside increased. Another study followed 497 adolescents during 30-day period matching responses with weather data [32]. Authors grouped participants into summer lovers, unaffected, summer hater and rain haters. They concluded that weather reactivity may run in the family. Finally, an online diary study of 1233 participants was conducted by Denissen et al. [17] to discover effects of temperature, wind power, and sunlight on negative affect.

There has been a special focus of researchers towards establishing a connection between current mood induced by the weather and life satisfaction. For example, women were more reactive than men to the weather, found Connolly [13]. Additionally, he establishes that life satisfaction decreases if it rains on the day of the interview. As research was done in a sunny climate during the summer it showed that low temperatures increase happiness and reduce tiredness and stress, while high temperatures reduce happiness. Li et al. [39] explored the influence of weather factors on 4 mood dimensions: Hostility-Anger, Depression-Dejection, Fatigue-Inertia and Sleepiness-Freshness. They concluded people tend to be happier as temperature becomes cooler, while they become a little bit negative after a small temperature increase. Researchers found strong relationships between negative mood and precipitation, while establishing influence of temperature on anger, snow depth and depression and high temperature leads and tiredness. In a robust study, self-reported life satisfaction was examined by Feddersen et al. [22] to conclude that day-to-day weather variation impacted self-reported life satisfaction. Another inquiry looked at 1 million US citizens over 5-year period to conclude that weather conditions were unrelated to life satisfaction judgments [40].

As presented above, early studies have harvested opposite conclusions by researchers, which made the debate about the psychology of weather confusing and long-lasting, with lots of open questions. In most cases, traditional research methods have been surveys, self reports, quasi experiments and field studies. The main drawbacks of this kind of approach have been subjectivity of responses, limited datasets and the fact that these were usually one-time surveys, without continuity. However, some of the newer inquiries consider social media data.

Analyzing social media

The appearance of new kinds of data sources such as social media made it possible to make large and long-lasting quantitative inquiries in this direction. On one side, we have social media with posts published each day by their users. Social media users tend to express their emotions, attitudes and values through social media platforms, such as Facebook, Twitter, Instagram, TikTok and others, which is valuable for researchers. Social media therefore surpass traditional polls, because of the quantity of data from many users and chronological aspect, as well. Another useful source of data in this realm is weather API, with live weather parameters, which are at easy disposal to researchers. Important characteristic of both social media and weather data is their non-expensiveness. Researchers are able to access these data for free.

These possibilities have been used by Li et al. [39]. They acquired Twitter posts data, contrary to traditional means, that have been used before in similar "weather – mood" research inquiries. By analyzing 10% of all posts, in duration of two years, from 17 US cities to establish correlations between multiple dimensional structure of human mood with meteorological effects Li at al. did a comprehensive study. They confirmed some longstanding hypotheses, such as people tend to be angrier at high temperatures, snow increases depression and suicide rates or Seasonal Affective Disorder. Using artificial intelligence on the Twitter data, correlated with the weather, at the time and geo-location of the tweets, Hannak et al. [25] found that when the humidity

increases, the predicted sentiment decreases for all values of temperature. Coviello et al. [14] measured emotional contagion provoked by rainfall on Facebook data of millions users across the US to establish that rainfall influences the emotional content of status messages published by persons experiencing rainfall, but also friends of those persons in areas without the rain, at that moment. Dzogang et al. [20] analyzed logs of Wikipedia pages and Twitter in the UK over a period of four years using LIWC to conclude that subjects search for Seasonal Affective Disorder at the time when indicator in Twitter content is increasing. Additionally, authors compared Twitter mood indicators with weather data, finding that negative affect can be partially explained in terms of the climatic temperature and photoperiod. Sadness can be partially explained by the photoperiod, while anxiety is partially explained by the level of precipitation. Baylis et al. [5] encompassed both Twitter and Facebook data from the 75 most populated metropolitan areas in the US to compare them with temperature, precipitation, humidity, and cloud cover. Their analysis used LIWC dictionaries to measure expressions of sentiment finding that positive expressions increase up to maximum temperatures of 20°C and decline past 30°C, precipitation worsens expressed sentiment and finally levels of relative humidity exceeding 80% decrease positive expressions. Additionally, Baylis, P. [4] analyzed more than a billion Twitter posts from seven English speaking countries with natural language processing. He found significant declines in expressed sentiment related to both hot and cold temperatures. Similar results were acquired in four countries, while results in the other two differed. Purpose of Baylis's analysis is to estimate how climate change affects the economy.

Some of the recent research inquiries also take into account weather changes and social media sentiment. Molina et al. [43] found that people's mood on social media platforms such as Twitter is influenced by weather conditions. Another research demonstrates the effectiveness of including external contextual features such as weather, location, and time in sentiment analysis on social media, and that they can improve performance by 3% compared to transformer-based language models [29]. This study by Dzyuban et al. [21] examined the relationships between weather and social media sentiment on Twitter, demonstrating the viability of Twitter data as an indicator of periods of higher heat experienced by the public and greater negative sentiment towards the weather. Finally, the study by Stevens et al. [60] investigated the relationship between temperature and both offline assault and online anger on Twitter, finding that while assaults increased with hot weather, angry tweets decreased, suggesting that online anger is an inverse predictor of assault.

To sum it up, previous research inquiries considered few parameters such as positive and negative expressions. Locations that have been examined in the past included one, or in one case four, English speaking countries. Some authors explored multiple locations within one country. Also, previous investigations have found conflicting results in regard to the relationship between weather and mood.

Based on the literature review above we seek to explore the following questions:

RQ1: First of all, are other psychological parameters correlated to weather changes, except positive emotions, negative emotions, anger, sadness and fear?

RQ2: Secondly, are there some weather parameters correlated in the same way with psychological categories detected in Twitter posts in different countries?

By understanding the link between weather and Twitter users' activity, marketers and advertisers can use this information to better target their campaigns. For example, they could launch campaigns during times when Twitter users are most active and receptive to messages, or when their sentiment is most favorable. Knowing the weather conditions and their correlations with human psychology, marketers can apply this knowledge to create targeted advertising campaigns or targeted discounts for customers in different countries, considering the local weather conditions. Through the link between weather and Twitter users' activity, marketers and advertisers can create more effective campaigns and consequently generate higher returns on investment.

Materials and methods

Source of data

We chose Twitter as the most suitable source of data for this kind of analysis. After getting posts from Twitter users, the next step was to analyze them by LIWC software. This helped us get the desired stats then imported to SPSS software, for basic correlation analysis. Finally, we wanted to examine findings further by applying the generalized cross-correlation measure and tools from complex networks theory.

Twitter is social media that empowers its users to publish short textual posts since its inception in 2006. The Twitter content is usually public, but mainly seen by followers of a profile that publishes these short texts, usually called tweets. Tweets are limited to 280 characters. Twitter users don't post their demographic data, except the location they post from and nickname they use. Since its inception in 2006, Twitter has become one of the most popular social media online. As of the year 2021, Twitter had 206 million daily active users worldwide and 500 million tweets per day.

This platform offers access to massive amounts of data through two kinds of API protocols, which are used for research and other purposes. These are Streaming and Rest APIs. First one is chosen for our analysis, as it provides live data, rather than the second one, which provides data in batches. Streaming API is capable of getting public posts of twitter users from chosen locations for free, thus being more suitable for research purposes. There are two downfalls however. First of all, the free version of API provides up to 1 percent of data [50]. As we decided to ask Twitter for a live stream of posts from at least 10.000 of users per each location, this enabled us to have more than sufficient number of posts per location for analysis. Also, when compared to Rest API, getting data from Streaming API is a slow process, as Twitter provides live data this way. This meant we had been collecting data from 11th May of 2019 until 5th January of 2020. This is 7 months and 25 days in total. Additionally, the choice to use the Streaming API from Twitter came as this social network offered clear contracts to users of its API, which lists scientific research as legitimate purpose of use. Other social media have much more limited API protocols, as they usually have lots of private profiles. This is not the case with Twitter.

Another important reason to choose Twitter as source of data was their highly precise offering of geolocated tweets. This means that users of Twitter API could set geo coordinates of desired points and get all tweets published in diameter around it, which is also set by API users. Specifications we sent to Twitter included locations in centers of major cities, in countries that were chosen for analysis, and diameters of just 20 km around these points. These cities were London in the UK, Paris in France, Moscow in Russia, Lisbon in Portugal, San Francisco in the US, Belgrade in Serbia, Berlin in Germany, Amsterdam in the Netherlands, Rome in Italy and Madrid in Spain. The reason why we chose noted countries was because we were limited to LIWC dictionaries that we had. We took the most prominent locations representing the languages that we were limited to.

To get more precise results, profiles that tweeted more than 20 posts per day were kicked out from the analysis, as these usually were not private profiles. Additionally, we excluded re-tweets to only consider straightforward content generated by users.

We have recognized various factors that could affect mood swings within major populations, such as negative news, the ones related to crime, pandemics, disasters and death of celebrities. Because of that, the so-called algorithmic pre-analysis was used to detect any major public event that could change the mood parameters of the public. In case when this kind of event is detected, the posts wouldn't be considered.

Further, exactly the same geo locations were sent to a free weather API [46], to get daily weather parameters that included barometric pressure, humidity. wind speed, cloudiness, rain volume, snow volume and air temperature. We match meteorological variables in a location to the tweets from the same places and dates.

We have gathered 29.347.201 tweets from 135.258 Twitter profiles in 10 locations during 240 days, after application of all above mentioned filtering techniques. Similar number of tweets were collected each day.

Digital footprints

Digital footprints are potentially useful for research of mass behavior, group sentiment and psychological patterns. The following studies attempted to establish a firm connection between psychological indicators found in online data and people expressing them. In that regard, Settanni and Marengo [56] validate online sources for studies in the domain of social psychology. They found people suffering from depression, anxiety and stress used to express negative emotions through emotion-related-textual indicators more frequently. On the other hand, use of positive emoticons correlated negatively with stress level. Twitter research has been shown as sensitive at detecting psychological patterns [18] and real-life events in various fields including health [62], economics and stock market [51], political events [45], [37]. Extracting public sentiment has been a challenge for researchers starting from blogs [42], Twitter [47], Facebook and other social media. By extracting 46 billion words and 4.6 billion expressions published during 33 months by 63 million Twitter users, Dodds et al. [19] established a text-based hedonometer. Additionally, Kramer [33] validated metrics of Gross National Happiness, previously launched by Facebook. He showed that positive and negative words from status updates on Facebook correlated with self reported satisfaction with life. Emotions can be spread to others through emotional contagion, making people experience the same emotions, without being aware of that [34].

Primary analysis

Primary analysis of data included application of natural language processing (NLP). This is a technique used to translate unstructured text into the quantitative data [41]. We wanted to focus on sentiment analysis, so choosing one of more than 60 publicly available algorithms for that purpose was the next step. Because we wanted to examine the relationship of weather with as many parameters that could be registered in text beyond just positive and negative sentiment, we chose to use the Linguistic Inquiry Word Count (LIWC).

LIWC dictionaries were first introduced in 1992. They have been in development ever since, with many scientific inquiries confirming their capability to accurately identify emotions in texts [3], [30], [61], [10], [26]. The dictionaries were available in dozens of languages, but we had access to 9 of them: English, Spanish, German, Italian, French, Russian, Portuguese, Dutch, and Serbian. They measure the following linguistic categories: standard linguistic dimensions, psychological categories, personal concerns, and spoken categories. We decided to use psychological categories, personal concerns, while omitting standard linguistic dimensions and spoken categories as this would be relevant for examination of our research questions. Within psychological processes we covered: social, affective, cognitive, perceptual biological processes and relativity. Additionally, beyond LIWC psychological categories, we took number of posts published per day as another parameter in the analysis. We called this Post Count.

Procedure to use LIWC dictionaries included examination of all the words from raw corpus of downloaded tweets to check how many of them belong to any of the noted categories. Stats were grouped by day and location. Of course, different LIWC dictionaries were used to analyze text depending on the language that was used in a particular country. At the end of the day we had separate tables for each location, showing stats for LIWC categories and Post Count per day.

Secondary analysis

The next step was to use SPSS software to perform the data analysis [9]. Pearson correlations were calculated to inspect significance and strength of relationships. If r is lower than 0.2 we considered this as a weak correlation. Additionally, when r was between 0.2 and 0.5, this would be judged as moderate correlation [54]. Following this, multiple regressions were calculated only for strongest correlations to draw solid conclusions.

We decided to further examine data by implementing methods from complex networks theory by applying the community structure analysis to our datasets.

We have a N time series for each country dataset showing the number of tweets, average daily weather

parameters, and the value of different LWIC categories in tweets for each day. To calculate the similarity between time series, we use the generalized cross-correlation GCC [2]. The GCC measure compares the determinant of the correlation matrix calculated for time lags until a time lag k of the bivariate vector with the correlation determinants of the two univariate vectors. By calculating GCC measures for each pair of time series in the dataset, we obtain the similarity matrix for a given dataset.

We determine the similarity matrix for each country and for time lags k={8,9,…,15}. The similarity matrix is then mapped onto a weighted undirected complex network [7]. The nodes in a weighted undirected network represent measured variables. A link between two nodes shows the similarity between two variables. The link weight equals the value of the similarity coefficient between two variables. Since the similarity matrix can be viewed as a fully connected weighted graph that would map onto the fully connected network, we need to remove several links. We use a threshold method for this [64] to filter out the similarity matrix. All elements in the similarity matrix smaller than a threshold are disregarded in this method, while those higher than the threshold are mapped onto network links. We obtain a network for each country and each time lag k.

To explore how different time lags influence the network structure, we compare the structure of networks obtained for different values of k within one country dataset. We focus on links since the number of nodes in networks for each country is fixed. We use the Jaccard correlation coefficient to compare the sets of links between networks obtained for different k. We also analyze how the link density is changing with lag k. Link density is a ratio between the number of existing links L and the number of possible links in the network 0.5*N(N-1). This analysis reveals the robustness of network structure regarding the lag k and its most suitable value.

After determining the most suitable choice of lag based on the analysis described in the previous paragraph, we analyze the structure of obtained networks. We are primarily interested in the possible formation of groups of different variables and their content. For this, we use the community detection approach [23]. To detect communities in weighted undirected networks, we use the Louvain algorithm. The Louvain algorithm finds communities in the network by maximizing the modularity function [6]. Modularity is a function that measures the density of links inside communities compared to links between communities. The maximum possible modularity value for a given network corresponds to the best possible grouping of the nodes in that network. We apply the Louvain method to each network and analyze the content of the groups found using this algorithm to find similarities between networks representing different countries.

Advantage of this methodology is escaping subjectivity of survey respondents. Aggregated analysis can surpass data errors because of the significant volume of population encompassed in this kind of analysis. Differences in age, gender and personality traits are thus leveled out, because of the high number of research participants, as concluded by Hopkins & King [27] and O'Connor et al. [45]. Also, other studies came to similar conclusions, confirming validity of Twitter data for the purpose of social sciences, especially in terms of flexibility, robustness and sensitivity [18], [19].

Limiting factors of this kind of LIWC analysis on Twitter may be about the context of posts. For example, to individually determine which post expresses a positive mood can be a daunting task. If we have a dictionary with positive and negative words, which are further recognized in the text, this will produce a certain number of mistakes because it wouldn't take context into account. Although this kind of analysis could give us an overview of underlying emotional states in chosen locations despite described limits, it may be important to note that this analysis is focused on all LIWC categories and Post Count, which is much more than just sentiment.

Results

Correlations

Numbers of correlations between weather parameters and measured categories, sorted by locations were 68 for US,

58 for Portugal, 54 for Italy, 50 for UK, 44 for Serbia, 38 for France, 37 for Spain, 31 for Germany, 27 for Netherlands and 24 for Russia. Numbers of correlations, sorted by weather parameters, listed as: temperature (123), pressure (80), humidity (70), wind speed (43), wind direction (41), cloudiness (37), rain volume (27) and snow volume (10). Correlations sorted by measured categories were Post Count (49), senses (26), affect (24), see (22), space (22), spiritual (21), achievement (20), hear (20), money (20), motion (20), social (20), humans (18), negative emotions (18), positive emotions (18), feel (16), leisure (15), work (14), sex (14), taste (11), friends (10), health (10), relative (9), family (8) and home (6). As for strength of correlations between weather parameters and measured categories 9 were found to be strong, 170 were found to be moderate and 252 were to be weak. Total number of significant correlations found was 431.

The most consistent and strongest correlations were found between air temperature and humidity, on one side, and Post Count on the other side, in all countries. Among these 20 correlations, some of them were strong (9), others were moderate (11) and none of them were weak. Direction of noted correlations was negative for temperature and positive for humidity in most countries: France, US, Serbia, Germany, Netherlands, Italy and Spain. On the other hand, the direction of correlations was positive for temperature and negative for humidity for the following countries: UK, Russia and Portugal.

Correlations between air temperature and Post Count were: .824** for UK, -.362**for France, .650**for Russia, .431** for Portugal, -.233**for US, -.402**for Serbia, -.622**for Germany, -.651**for Netherlands, -.656** for Italy, and -.531**for Spain. Additionally, correlations between humidity and Post Count were: -.549**for UK, .239**for France, -.494** for Russia, -.450**for Portugal, .270**for US, .562**for Serbia, .448**for Germany, .339**for Netherlands, .387**for Italy, and .506**for Spain.

Taken as a set, the predictors air temperature and humidity account for the following percentages of the variance in Post Count: 69.6% for UK, 13.1% for France, 39.7% for Germany, 51.7% for Russia, 24.7 for Portugal, 47.2% for Netherlands, 44.7 for Italy, 8.6% for US, 31.2% for Spain and 33.7% for Serbia.

Complex networks theory

Furthermore, the relations between the time series of meteorological variables and LIWC categories obtained from the Tweets for one country are studied using tools and methods from complex networks theory. For each country, a network was created. In these networks, nodes represented time series, for instance, number of tweets per day, average values of meteorological variables per day, and values of LIWC categories per day. Time series of the number of tweets, average daily temperature, and LWIC category "feel" could be seen in Figure 1. The network links represent similarities between time series. To calculate the similarity between two different time series, we used the generalized cross-correlation function introduced by Alonso & Peña [1]. The generalized cross-correlation measure (GCC) compared the correlation matrix's determinant, until some lag k, the bivariate vector, with those of the two univariate time series.

The generalized cross-correlation coefficients for each country for several values of the time lag k were calculated. Figure 2 shows distribution of GCC, calculated for k=8 and k=15, corresponding to one-week and two-week time lags, respectively for UK and Spain. All GCC coefficients were non-negative. The bulk of the coefficients, with more than 50% of them, were smaller than 0.1.

We have calculated GCC for each country for time lags k={8,..,15}. Based on calculated GCC, we created a network for each country and each k, by only considering correlations GCC>0.1. This way, we created a network, where the link's weight equals the GCC value between two time series. First, we wanted to inspect the difference between two networks obtained for the same country and different values of k. First, we checked the similarity of networks when it comes to the retained links. For this, we used the Jaccard index to compare the set of links in networks obtained for different time lags. The overlap between networks' links decreased as we increased the time lag difference (Figure 3), where the overall overlap is smaller for USA networks. On average, networks obtained for Portugal had higher overlap, while other countries fell somewhere in between these two extremes. The link

density had been growing with time lag k, which was expected (Figure 4).

Community structure analysis

Finally, community structure analysis *is performed* (*Fortunato, 2010*) for networks obtained for the time lag k=8. We consider networks to be weighted and undirected. Link weights were equal to the generalized correlation coefficient between two nodes representing time series. The largest connected component had four communities for the most countries, except Spain with five, and the USA and France with three communities. However, the structure of communities differed. Figure 5 showed the networks and their community structure for the first group consisting of Serbia, Netherlands, and Germany. In these countries, the Post Count variable belonged to the weather variable community, and it was only connected to variables belonging to this community, indicating a strong dependence of Post Count on the weather variables. The second group, depicted in Figure 6, contained the group of countries in which Post Count was connected to weather and LIWC variables. In Spain and Russia, the Post Count variable belonged to the weather community, while in the case of the UK, it belonged to one of the communities containing LIWC variables. Group 3 shown in Figure 7, depicted the countries where the Post Count variable belonged to one of the LIWC communities, while not being connected to temperature.

Figure 1: Time series of different variables

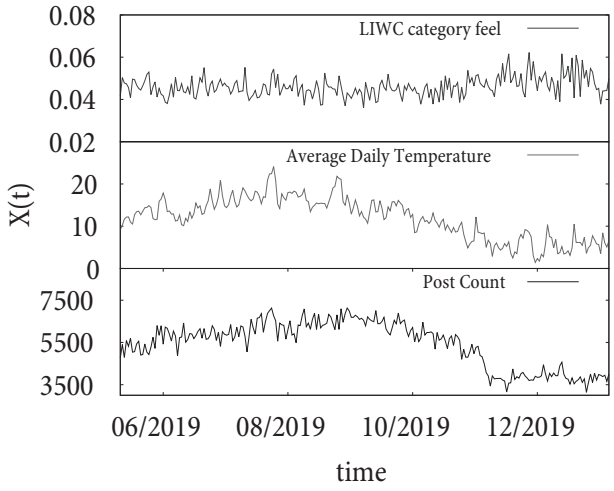


Figure 2: Probability density distribution of the value of GCC for UK and Spain and time lags k=8 and k=15

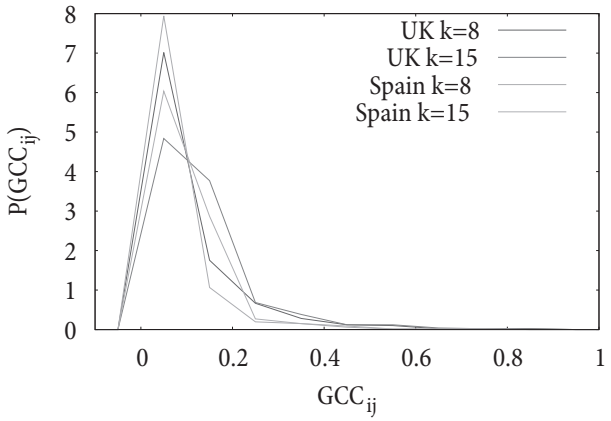


Figure 3: The dependence of Jaccard index calculated for the sets of links between two different networks on the difference of their time lags k

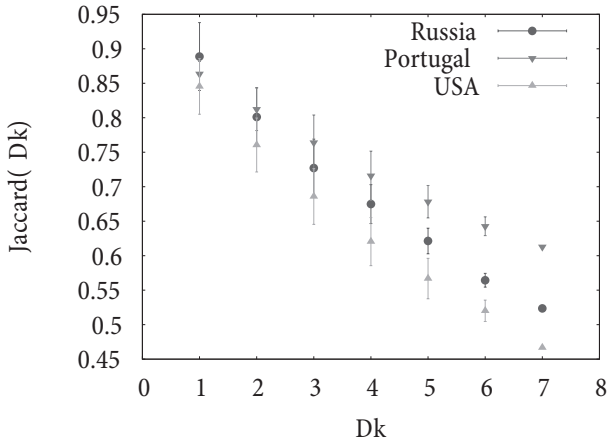


Figure 4: The link density dependence on time lag k average over all countries

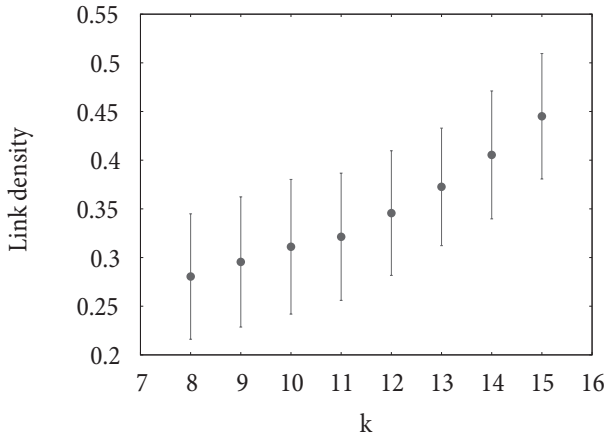


Figure 5: An example of network and community structure of countries belonging to Group 1

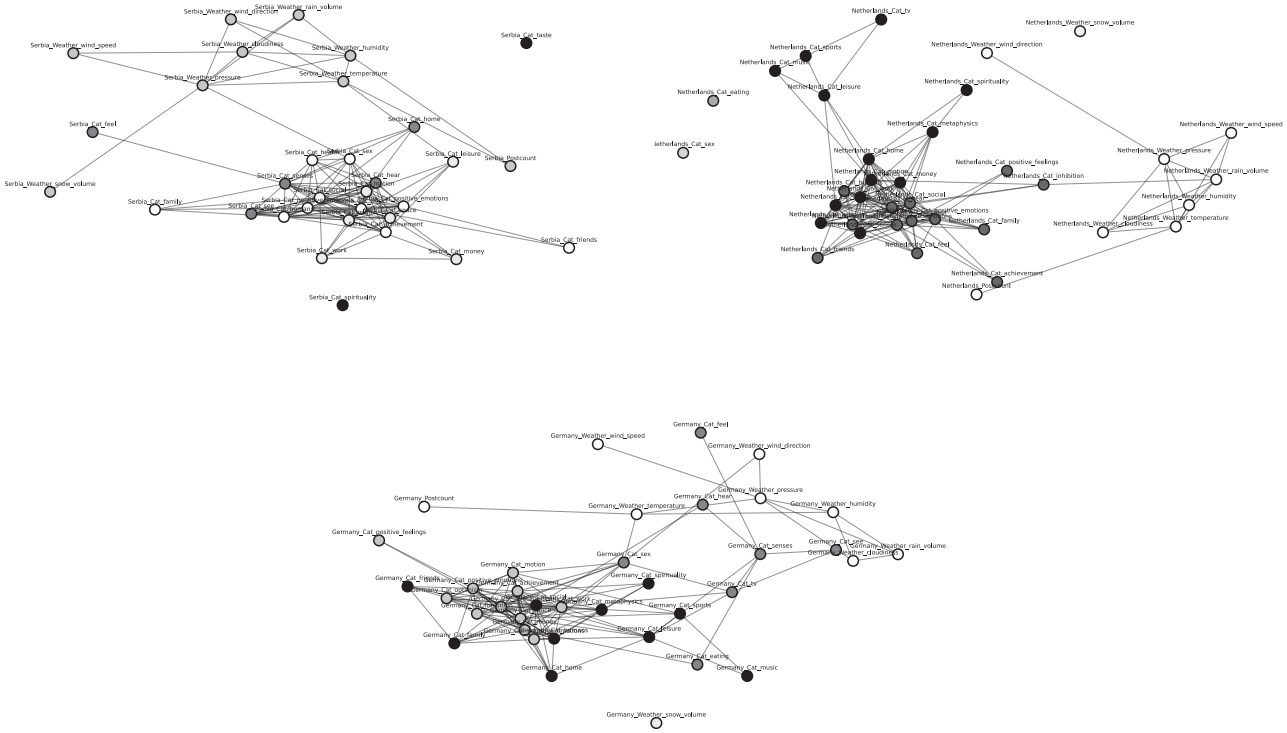


Figure 6: An example of network and community structure of countries belonging to Group 2

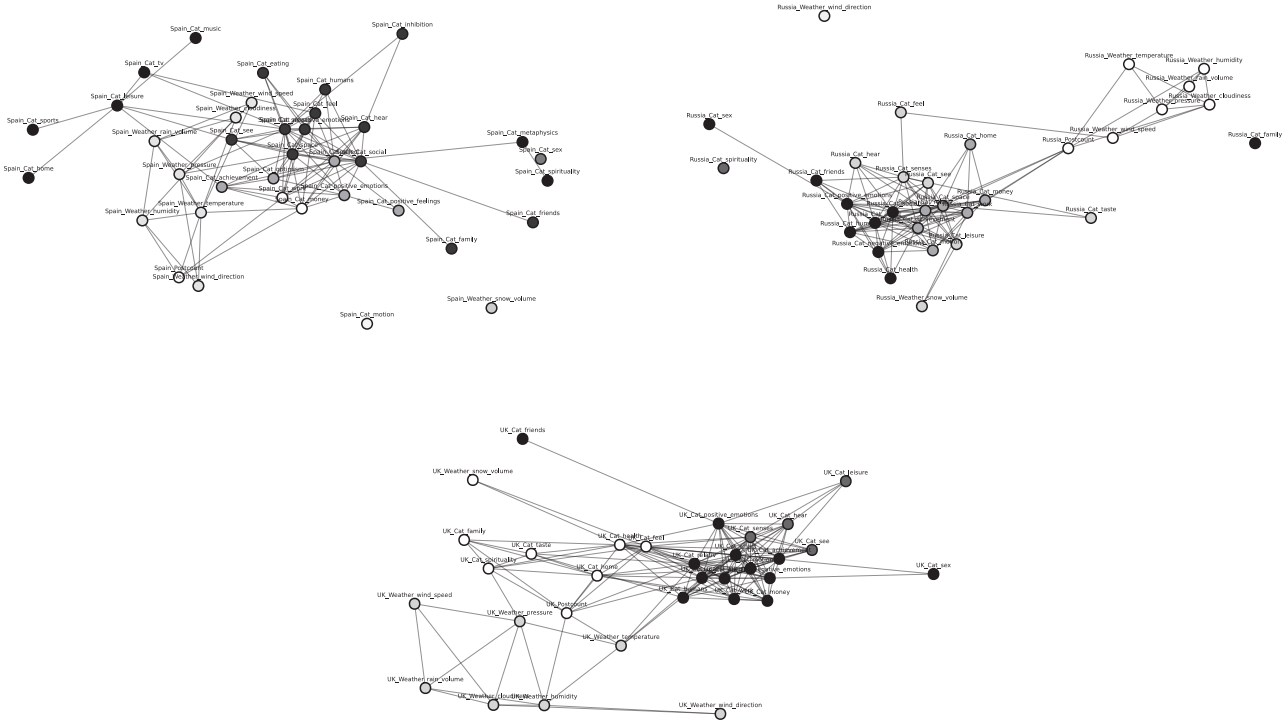
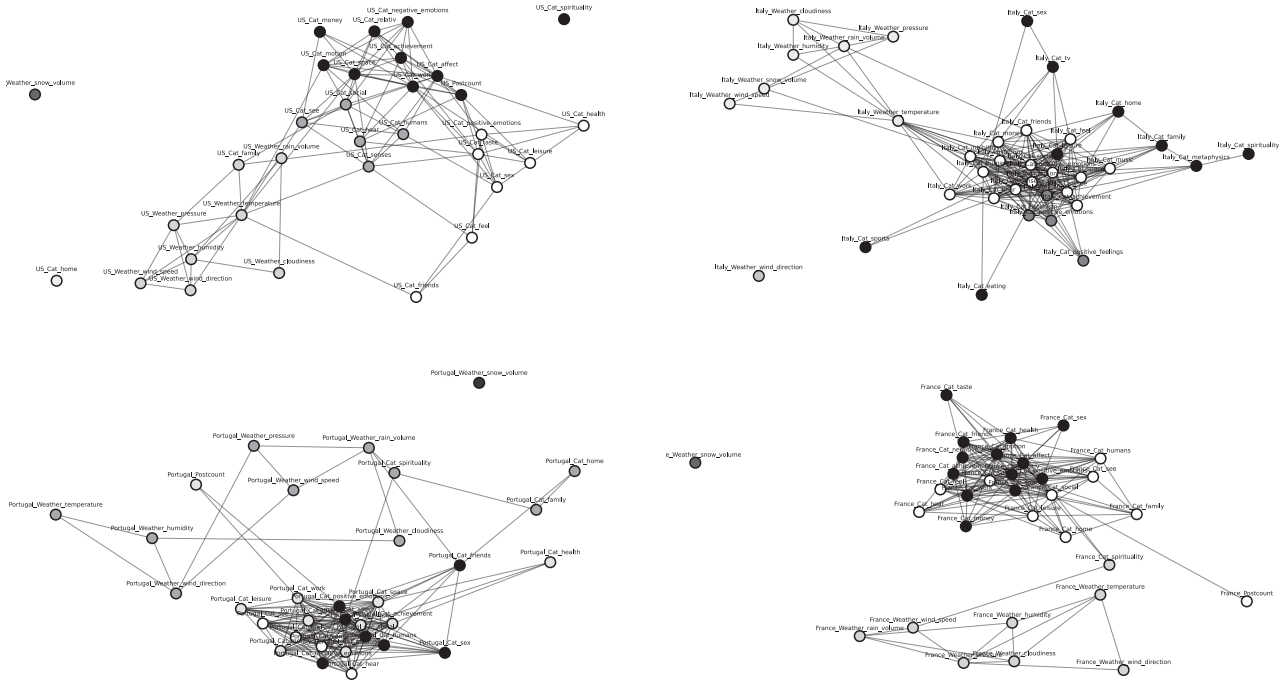


Figure 7: An example of network and community structure of countries belonging to Group 3



Discussion

In short, this inquiry answers all research questions. Weather parameters are not only correlated with positive and negative affect, which is found by most of the previous studies, but with other psychological categories as well. Also, humidity and air temperature are correlated the same way with Post Count of Twitter users in all examined countries.

Analysis of findings

This exploratory study indicates that weather may have a greater impact on people in some countries than in others, and that the most impactful weather parameters to humans may be temperature, pressure and humidity. Furthermore, the study found a strong relationship between Post Count, temperature and humidity. Further research is needed to examine the possible explanations for the different impacts of weather on people in different locations, and to investigate the implications of this finding for our understanding of the influence of weather on emotions and creative work.

First of all, simple correlation analysis indicates that weather may have a greater impact in some countries, such as the US, Portugal and Italy, than in other locations. The idea that there may be different impacts of weather on people, depending on the location, is a new one. There might be many possible explanations, such as that measured locations have hotter climates than the rest of those involved in the research. However, this is just an indication that needs further examination.

The Second finding indicates that the most impactful weather parameters to humans might be temperature, pressure and humidity. This finding has been confirmed by multiple studies [25], [49], [55], [28], [31], [17], [13], [39], [25], [4]. Third finding shows that weather impacts the most to some of the measured categories, such as Post Count, Senses and Affect. Given the fact that no previous weather-mood study involved LIWC categories and Post Count, this finding is a rather new one. The noted categories are related to level of activity (Post Count), expressivity (senses) and emotions (affect). Therefore, the finding may indicate how important weather is in stimulating our overall activity and life in general.

As only 9 correlations were found to be strong ($r > 0.5$), it may be significant to examine what these might be. By looking at the strongest correlations, we have focused on Post Count, to discover a very strong relationship of Post Count to temperature and humidity, in all examined countries. As much as 9 strong correlations were found,

and 11 moderate (r 0.2 > 0.5). However, it was found for most locations that as Post Count increases, temperature decreases and humidity increases. In fewer countries correlations are opposite, while Post Count increases, at the same time temperature increases and humidity decreases. We would not go into further speculation as to why the direction of correlations is different for France, US, Serbia, Germany, Netherlands, Italy and Spain on one side and UK, Russia and Portugal on the other side. Nevertheless, according to noted results, we suspect a very firm connection between Post Count, temperature and humidity.

Because of this, we undertook further advanced methods to check this finding, such as multiple regression, tools and methods from complex networks theory. These methods were used to analyze relations between the time series. As it can be seen in Figure 1, impact of temperature to Post Count had been clearly registered. The same can be concluded when the community structure analysis is performed, for networks obtained for the time lag k=8, especially in Figure 5-6, which illustrated Post Count, as a category heavily influenced by weather parameters in 6 countries. Post Count in the remaining 4 countries illustrated in Figure 7 didn't belong to weather parameters. Although there were some deviations from the rule, lots of evidence showed a firm connection between weather parameters and Post Count in all countries.

This is the first weather-mood study that considered more than one non-English speaking country. In fact, given the fact that the study examined 10 countries, results of this inquiry may be a good starting point for similar ones.

This finding might be important because Post Count can be connected to the overall quantity of emotions that are being expressed. If we publish more posts chances are great we would express both positive and negative emotions through them. Having more positive emotions is connected to happiness, despite the fact that negative emotions will follow up, as well [12]. That means, if this analogy is correct, that weather might dictate when we would feel more or less happy overall. This might relate to creative context as well, because if the time when we publish more posts is affected by weather, that means the same time could be more susceptible for creative work. Finally, it would be useful to examine if we're ready to receive messages better, advertisements for example, at the times when we publish more posts.

In conclusion, this study has identified the weather parameters that have the greatest influence on mood and Post Count, as well as the countries where the influence seems to be the greatest. It has shown that, in some countries, temperature, pressure and humidity have a strong influence on Post Count and that, in some countries, Post Count has a strong correlation with temperature and humidity, while in others the correlation is reversed. Finally, it has shown that Post Count may be a good indicator of overall emotion and, potentially, of creative potential, which can be used in marketing. Further research is needed to understand the implications of these findings and to see how they might be applied in practical contexts.

Implications for advertising

The relationship between weather and Twitter users' activity is an interesting concept for marketers and advertisers to consider. Understanding the correlation between weather and the activity of users on Twitter can give companies a competitive edge. By analyzing the user activity and weather conditions in different countries, marketers and advertisers can better target their campaigns to achieve higher returns on investment.

One of the most effective ways to use this information is to launch campaigns during times when Twitter users are most active and receptive to messages. By understanding the influence of weather on user activity and sentiment, companies can create targeted advertising campaigns or targeted discounts that are tailored to the local weather conditions. This will allow them to reach a larger audience and drive more conversions.

Another benefit of using the link between weather and Twitter users' activity is that it can help companies better predict customer behavior. For example, if a company knows that the weather is going to be good in a certain region, they can anticipate that people in that region will be more likely to purchase their products or services. This can help them to plan their campaigns more effectively and maximize their return on investment.

The link between weather and Twitter users' activity can also be used to create more targeted and personalized marketing messages. Companies can use the weather data to create ads that are tailored to the local conditions, making them more relevant and engaging for users. This will help to drive more conversions and generate higher returns on investment.

In conclusion, understanding the link between weather and Twitter users' activity can be a powerful tool for marketers and advertisers. By analyzing the weather conditions and their correlations with human psychology, companies can create more effective campaigns and consequently generate higher returns on investment. This information can be used to launch campaigns at the right times, create more targeted messages, and better predict customer behavior.

In conclusion, here are three practical examples of using the findings of this study. First, a company can use this information to target their campaigns regionally by launching campaigns when Twitter users are most active. In other words, companies should adjust their advertising spending on weekly basis according to changes in weather conditions. Second, companies can create ads tailored to local weather conditions, making them more relevant and engaging for users. Third, companies can use the weather data to create discounts that are tailored to the local weather conditions, helping them reach a larger audience and drive more conversions. By using the findings of this study, companies can use the weather data to better predict customer behavior and plan their campaigns more effectively.

Limitations

However, some limitations must be noted. Although the study included a large amount of data, gathered from more than 100.000 profiles in 10 countries, during the period of 6 months, and included LIWC, complex network theory and community structure analyses, we may not claim that it captured correct sentiment. The findings were reflections of social media posts, and though this kind of methodology might be considered accurate to some degree, it would be optimal to include daily self reported emotional states. Social media posts may discover underlying emotions but they may provide rather noisy results. That is why we recommend finding a way to improve methodology for social media analyses by proposing a combined method for further inquiries.

Another limitation is that the research wasn't conducted over a one-year period in order to reflect all weather conditions due to the occurrence of COVID-19 pandemic.

In this paper, the focus was solely on the effects of weather conditions on Twitter posts. While it is true that there are other factors that can affect Twitter posts, this paper was meant to be limited to the effects of weather conditions on Twitter posts. The social factors that can affect Twitter posts include the type of content that is posted, the type of audience that is engaging with the post, the time of day the post is made, the platform the post is made on, and the language the post is made in. All of these factors can have a significant impact on the reception and engagement with a post, and can ultimately have an effect on the overall success of the post. It is important to recognize the limitations of this paper when it comes to the social factors that can affect Twitter posts. This paper does not consider the effects of any of these social factors, as the focus of the paper is solely on the effects of weather conditions on Twitter posts. Thus, any conclusions about the effects of weather conditions on Twitter posts must be made with this limitation in mind.

Also, weather measurements used in this study from free weather API may be imperfect, as they reflect data from weather stations that might be distant from research participants. We cannot know if registered weather conditions were the same, as ones experienced by all Twitter users from the analysis.

Additional limitations may arise from the representativeness of Twitter. For example, older and younger people may choose different social media, in their daily routines. In some countries Twitter is used more for expressing political attitudes and less for showing lifestyle and interacting with friends. Although we don't have introspection into the demographics of research participants, their large number may cancel some of our concerns related to capturing representative results for a major population.

We must bear in mind that climate conditions differ from country to country, in which this research study is conducted. Therefore, we don't control research by taking locations with the same climate into consideration. Of course, we had to choose locations that were included into the research because of some limitations discussed in the methodology section.

Future research

Given the fact there are many limitations, we must highlight the significance of this challenging issue, and our major findings in that context. If we know more about the impact of weather conditions on our lives, this knowledge could help our lifestyle decisions and routines both on individual and group level. For example, individuals could choose to do their creative work when weather conditions are stimulating for this kind of activity. On the other hand, brands could choose to invest more into advertising on days when their messages could be received better. These are just two ideas related to potential implications of our findings, if we presume that people are more receptive to advertising messages when they post more, which could be predicted by the weather forecast. However, the next important research that might be inspired by findings of this study might be comparison of Post Count on social media and self reported happiness. Determining the importance of Post Count and its comparison to other parameters could open up new spaces for exploration in social sciences.

Ultimately, there are no gold standards in exploration of mood – weather relationship. Thus, employing new means of analysis related to big data could give us some firm findings and important cues, such as the one captured in this inquiry. Despite all presented research challenges and inability to control numerous conditions in social media analysis, further research is strongly recommended. For example. it may be useful to train a machine learning algorithm based on a larger volume of data to see if psychological categories expressed in posts can be predicted. We certainly hope this study could give some ideas for direction of future inquiries.

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DEVELOPMENT OF THE BELT AND ROAD INITIATIVE IN SERBIA[1]

Razvoj inicijative „Pojas i put" u Srbiji

Abstract

The paper presents a general overview of the projects, observed according to the sectors of the Serbian economy, which were implemented in Serbia through the Belt and Road Initiative or are in the phase of implementation, planning or signed memoranda between China and Serbia. This initiative to strengthen trade, infrastructure and investment links between China and the countries of Asia, Africa and Europe, through a network of land and waterways, has affected the landscape of global trade, investment and financing, thereby expanding China's influence in the world. As a European country which is not a member of the European Union, Serbia found itself in a specific situation and was able to independently manage its relations with China and conclude contracts directly. In addition to the European Union as the main economic partner, Serbia is also turning to China, so this cooperation has a growing trend in the form of Chinese investments in Serbia, which are being investigated here, in contrast to the almost non-existent implementation of Serbian projects in China. Chinese companies in Serbia are actively building infrastructure, investing in the energy sector as well as the privatization and renewal of production of the former metallurgical giants of Serbia, and more. So, despite the large trade deficit with China, this initiative brings tangible economic and social benefits at the local level, creating new opportunities for employment and income generation in the community. That is why it can be said that the Belt and Road Initiative contributed to the development of cooperation between Serbia and China.

Keywords: *The Belt and Road Initiative - BRI, China, Serbia, EU, economy, industry, trade, infrastructure, energy, transport*

Sažetak

U radu je predstavljen opšti pregled projekata, sagledanih prema sektorima srpske privrede, koji su realizovani u Srbiji kroz inicijativu „Pojas i put" ili su u fazi realizacije, planiranja ili potpisanih memoranduma između Kine i Srbije. Ova inicijativa jačanja trgovinskih, infrastrukturnih i investicionih veza između Kine i zemalja Azije, Afrike i Evrope mrežom kopnenih i vodenih puteva uticala je na pejzaž globalne trgovine, investicija i finansiranja, čime Kina širi svoj uticaj u svetu. Srbija se, kao evropska zemlja koja nije članica Evropske unije, našla u specifičnoj situaciji i u mogućnosti da samostalno uređuje svoje odnose sa Kinom i direktno sklapa ugovore. Pored Evropske unije kao glavnog ekonomskog partnera, Srbija se okreće i Kini, pa ova saradnja ima rastući trend u vidu kineskih investicija u Srbiji, koje se ovde i istražuju, nasuprot gotovo nepostojećoj realizaciji srpskih projekata u Kini. Kineske kompanije u Srbiji aktivno grade infrastrukturu, ulažu u energetski sektor, kao i privatizaciju i obnavljanje proizvodnje bivših metalurških giganata Srbije, i drugo. Dakle, i pored velikog trgovinskog deficita sa Kinom, ova inicijativa donosi opipljive ekonomske i socijalne koristi na lokalnom nivou, stvarajući nove mogućnosti zapošljavanja i ostvarivanja prihoda u zajednici. Zato se može reći da je inicijativa „Pojas i put" doprinela razvoju saradnje Srbije sa Kinom.

Ključne reči: *inicijativa „Pojas i put", Kina, Srbija, EU, ekonomija, industrija, trgovina, infrastruktura, energija, transport*

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Introduction

Within the framework of the Belt and Road Initiative (BRI), Serbia was given the opportunity to independently regulate its relations with China and directly conclude contracts. The authors' intention is to investigate the essence of the concluded agreements and a growing trend of this bilateral cooperation, which began to expand with the creation of the BRI. We are searching through the impact of this initiative in Serbia.

It should be noted here that not all data on this Serbian-Chinese cooperation is publicly available so, for example, it is not known for all contracts what the terms of the loan are, and therefore the analysis of the effects is difficult. Previous experience with completed and started projects tells us that the works are mainly carried out by Chinese companies with Chinese workforce. Based on the bilateral agreements with China, public tenders are not called for such projects, but the conditions for the implementation of the projects are agreed upon bilaterally.

Until now, the question of repaying loans was rarely raised, and those who asked it were EU officials, but the circumstances have changed significantly due to the pandemic and the conflict in Ukraine and, in accordance with the general crisis, it is to be expected that similar questions will be heard more and more in Serbia itself.

At the beginning of the paper, we will briefly refer to the basic characteristics and the framework of the BRI which spans the area of Eurasia and eastern Africa. This network is connecting Asia, Europe and East Africa, and infrastructure connectivity projects are the first ones planned to be implemented. The plan is to facilitate the development and China's international trade through transport connections. After providing the basic and most important data about the Chinese initiative, the paper is directed to Serbia and the scope of this initiative in this country. An overview of the importance of Serbia in the Chinese vision, the way of concluding contracts through direct negotiations and bilateral cooperation, as well as a potential danger of excessive borrowing from one partner, is given here. Then the paper enters into the structure of the projects, which we divided for this purpose according to the sectors of the economy in which the most contracts were signed or implemented. Transport infrastructure in Serbia was obsolete and it is quite logical that the first project started here. Given the strategic importance of energy, this area of the Serbian economy has become interesting in strengthening economic cooperation between the two countries. With the successful completion of initial projects and investments in the construction of the road and railway network and investment in the power plant, it is time to get the former industrial giants of Serbia back on track by concluding bilateral contracts in the field of heavy industry. Then there was a chance to expand this cooperation through manufacturing companies and other BRI activities for Serbia, which is the next part that is covered in this paper. This analysis ends with the most important conclusions for the development of cooperation between Serbia and China through the BRI.

The Belt and Road Initiative

The BRI, a Sino-centric initiative, based on the idea of regaining the influence, power and significance the ancient Silk Road once had, is a relatively new economic phenomenon in its complexity and scope, trying to be a global game-changer. The Chinese government issued the "Vision and Actions on Jointly Building the Silk Road Economic Belt and 21st Century Maritime Silk Road" on 28 March 2015 [21]. This has outlined the framework and key areas of cooperation within the BRI. The overland Silk Road Economic Belt and the Maritime Silk Road cover Eurasia and eastern Africa, land and sea. Furthermore, the BRI has currently also reached a region in South America. The main goal is to strengthen trade, infrastructure and investment links between China and 65 countries (first estimate). China has shown itself prepared to put money into projects on a large-scale basis and the BRI started to affect the global trade, investment and finance landscape in significant ways [25]. The full quantification of this still ongoing growing project is challenging. Some general conclusions and striking points are as follows:

- The BRI includes 1/3 of world trade and GDP [34]
- The BRI includes over 60% of the world's population [34]
- China has signed 173 cooperative documents with 126 countries and 29 international organizations [33]

- China has signed currency swap agreements with 20 countries along the Belt and Road and formed RMB clearing arrangements with seven countries [37]
- Total trade between China and other Belt and Road countries in the period 2014-2016 exceeded USD 3 trillion [30]
- China's investment in "Belt and Road" countries has surpassed USD 50 billion [30]
- BRI investment projects are estimated to add over USD 1 trillion of outward funding for foreign infrastructure over the 10-year period from 2017 [1].

At first glance, we can see the massiveness of this Chinese project. It is mapping and networking, first of all, Asia with Europe, then Asia with East Africa. The omission of the American continent, above all the USA, from this initiative, is noticeable and intentional.

This initiative, proposed by China in 2013, represents a huge change in China's foreign policy [6]. With this initiative, China is connecting globally even more. However, it is not just connecting – it is spreading Chinese influence and the Chinese way of doing business to countries not just outside of China, but to countries far away and barely at reach and seemingly less significant. This project includes both rich and poor countries. These impressive numbers and projections include not only developed but developing countries as well. Infrastructure connectivity projects are the leading one, including the China-Laos Railway, the China-Thailand Railway and the Port of Piraeus. On the other side, in recent years, the world and Europe have suffered several crises. The 2008 financial crisis, Brexit, migration crisis and COVID-19 crisis are some of them. This has contributed to the emergence of the feeling that the West and its system are vulnerable and not so united, so China, feeling that the right moment has come, directed its strategy towards conquering new markets. China is rising and building plans to expand its economic power globally. With its economic power but also with its cultural, political, and military power and especially with the BRI, China is trying to catch up with the West led by the USA and the EU.

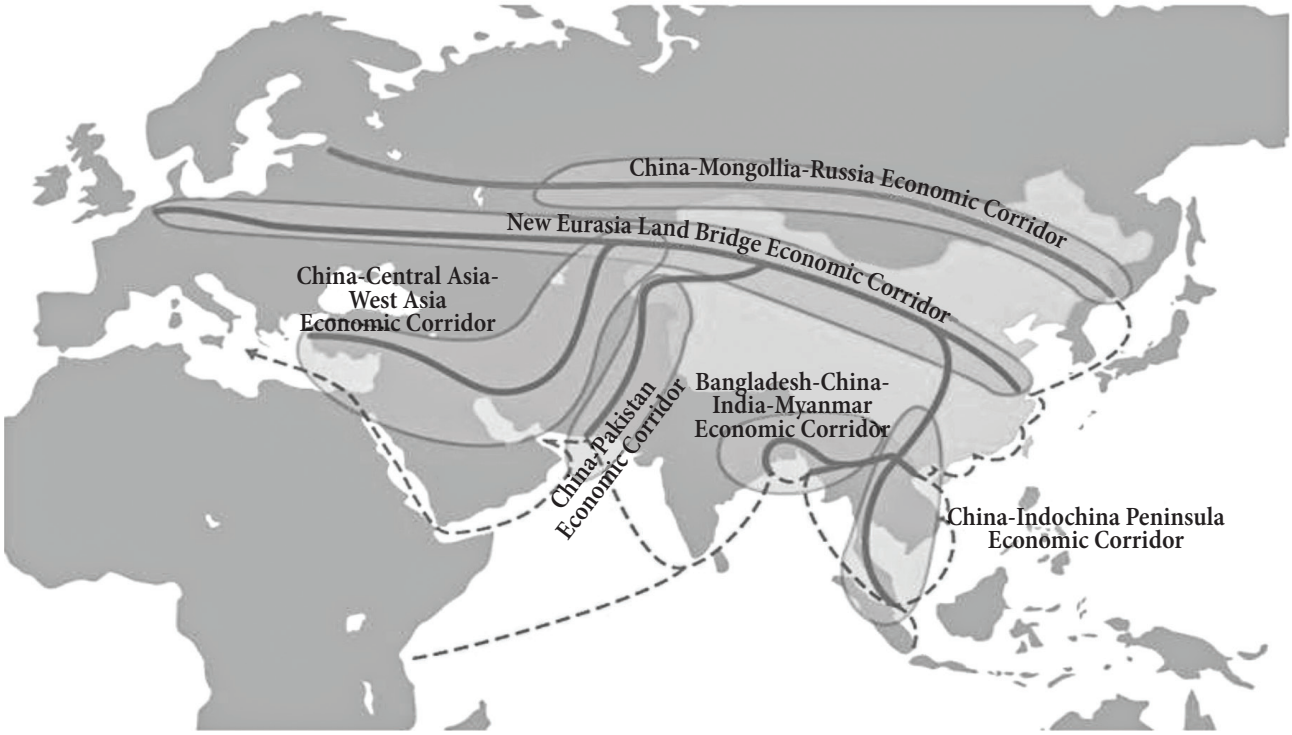
From the start of this initiative it seems that BRI is playing a critical role in providing financing for much-needed infrastructure for poor and developing countries across the globe. The most visible parts of the BRI are infrastructure projects - railways, roads, bridges, airports, etc. From experience, it is known that better transport connections facilitate development and trade. The initiative itself is made up of several economic corridors. The BRI establishes six international economic corridors (see Figure 1):

- The New Eurasia Land Bridge Economic Corridor
- The China-Mongolia-Russia Economic Corridor
- The China-Central Asia-West Asia Economic Corridor
- The China-Indochina Peninsula Economic Corridor
- The China-Pakistan Economic Corridor
- The Bangladesh-China-India-Myanmar Economic Corridor.

These six economic corridors confirm the intention of stronger integration within Asia as well as stronger integration of the Asian continent with the European continent, with a noticeable absence of the American continent. "The successful implementation of the BRI over the medium-to-longer term will be influenced, in part, by the way in which the initiative is perceived by the wider global development community. Perception represents an important factor in terms of maximizing domestic support for the BRI projects in the partner states of the respective corridors. A distinguishing characteristic of the BRI is the emphasis placed upon linking the global investment, trade and corporate instruments of economic growth in the creation of tangible economic and social benefits at the local level, to create new employment opportunities and community income generation and capacity-building" [27]. In the modern world, the benefit of free trade to improve the quality of life and not to widen inequality has been somewhat out of sight. China's total exports trade with the countries along the BRI increased from USD 263.67 billion in 2007 to USD 571.92 billion in 2016 [35].

Slowing growth in the years previous to the BRI has put pressure on China to open new markets for its consumer goods and excess industrial capacity. Chinese money was looking for investment. Along with starting this major project, doubts arose in the form of concerns about debt trap, debt distress, geopolitical or even military ambitions. All these BRI years China is pointing out that it is the only peaceful economic project. The approach of

Figure 1: The six economic corridors of BRI



Source: HKTDC Research, http://china-trade-research.hktdc.com/business-news/article/One-Belt-One-Road/The-Belt-andRoad-Initiative/obor/en/1/1X000000/1X0A36B7.html

China in the BRI detaches economic and political interests by focusing on practical, achievable projects [35].

In recent years, billions of USD of investment are coming from the People's Republic of China and going all across the BRI [36]. A China-led initiative is aiming to improve connectivity and cooperation on a transcontinental scale with the network of railways, energy pipelines, highways, and streamlined border crossings. In the future years, China will continue to strengthen the connections and communications with all involved in the BRI. In terms of the connections, it applies to solid constructions of roads, railways and airports, and in terms of communications this applies to policies, rules, standards and the way of doing business and spreading its influence. Through this Initiative, China is expanding its economic influence to a growing number of countries in the world.

The Belt and Road Initiative in Serbia

China's export potential to the BRI countries grew about 8% faster than to non-BRI countries, which confirms that one of the goals of the Initiative is being achieved – to expand China's exports to BRI countries. This is also the case in Serbia where, in 2019, Serbia had nearly eight times higher import than export to China. Serbia had a total of USD 2.8 billion in foreign trade with China. Goods were exported to China for USD 329 million and imported for USD 2.5 billion. There is a stronger impact of the Initiative on China's exports of capital-intensive products than labor-intensive and resource-intensive products in BRI countries. Trade Potential index for Serbia in 2011 was 0.3292, and in 2015 was 0.3536, with the change of 7.43% [35]. This shows growing potential of our country for trade, suggesting we could boost volume in both export and import.

Serbia is of particular importance to China because it is located at the crossroads of Southeastern Europe, on important land and river routes that enable it to have good east-west and north-south communications and is in the immediate neighborhood of the European Union for which China is especially interested [5]. Serbia is a hub of Chinese activity, accounting for more than half of announced funding in the Western Balkans since 2012 [4]. Since the establishment of the comprehensive strategic partnership between Serbia and China in 2016, bilateral cooperation in various fields has been steadily advancing.

Non-compliance with the principle of equal treatment, transparency, non-discrimination and competition, has the effect of preventing EU companies from participating in large-scale infrastructure projects implemented in Serbia. China in Serbia, has the benefit of not having to abide by EU legal rules. Most of the Chinese companies operating on the Serbian market are state-owned or have close ties with the Chinese state. In this way, Chinese companies compete unfairly with companies from the EU on the Serbian market. Besides, Johannes Hahn, European Commissioner for European Neighborhood Policy and Enlargement Negotiations, in 2019 expressed concern that Serbia and other Balkan countries were borrowing heavily from China and if a country is not able to pay its loans, there is some pressure for transfer into Chinese ownership. He pointed out that the EU is maybe slower and demands more than the others, but at the end is by far the fairest partner. Although the EU holds the title of the largest investor in Serbia, growing Chinese investment has not gone unnoticed and unresponsive, because its influence is growing not only in the culture and media but in the economic area [14].

BRI in the transport infrastructure

With cooperation frameworks being signed, the BRI is also gaining momentum in Serbia. Serbia saw the BRI as an opportunity to improve its old railway infrastructure and build new highways. Transport infrastructure projects that are at different stages of implementation in Serbia are harmonized with the BRI as well as the guidelines and programs of cooperation 16+1, but also with the European Unified Development Programs of the Basic and Regional Transport Network.

Serbia, with its road and rail network, belongs to the Silk Road Economic Belt and the 21st Century Maritime Silk Road on several grounds: through the road and rail sections of the Pan-European Corridor 10 and the maritime road, which leads from the port of Piraeus to the countries of Southeast, Central and Western Europe. Then, through the Corridor 10 rail sections in the territory of Serbia, which represent an important part of the southern Asian-European railway union that should connect the Asian railways with the European Unified Railway. Also, Serbia belongs to the BRI with a significant part of the Danube River waterway, and therefore Serbia has been nominated to be the site of the multimodal link of the European railway and network of European waterways.

Only several years from the BRI in Serbia, Chinese companies are actively building infrastructure. The Mihajlo Pupin Bridge in Belgrade, a road bridge over the Danube River, which connects Municipalities Zemun and Borča, was built by the Chinese state company China Road and Bridge Corporation (CRBC) with local subcontractors and using Chinese materials for 50 percent of the construction. The total value of the bridge together with all connecting roads amounted to 260 million USD. The China Exim Bank financed 85% and the rest was financed by the Republic of Serbia and the city of Belgrade. The works on the Mihajlo Pupin Bridge began in the fall of 2011, and it was ceremonially opened in December 2014 during the China-CEEC summit 16+1 in Belgrade. That was the first China large-scale infrastructural project completed in Southeast Europe. The CRBC is also involved in building the Surcin-Obrenovac section of highway, which would lead to a future China-Serbia industrial park in Borča.

The modernization of the Belgrade-Budapest railway was agreed as one of the capital projects under the BRI (Figure 2). The project of the Belgrade-Budapest High-Speed Railway construction was conceived in 2013 on the China-CEEC Summit. In the Serbian territory modernization and construction of the railway section from Belgrade to the border with Hungary in the north (Belgrade – Novi Sad – Serbia-Hungary border) has a total length of 188 kilometers. The value of the works in Serbia is about USD 2 billion [28].

Among the current projects with China which are being implemented, reconstruction and modernization of the Belgrade-Budapest railroad through Serbia is a very important one. China has committed to provide the bulk of USD 3 billion needed to upgrade this highspeed railway line. The works on the project for the overhaul of the Belgrade-Budapest railway line in Serbia started in November 2017, with the modernization of the Stara Pazova-Belgrade section. This project has suffered delays

Figure 2: The Belgrade-Budapest high-speed railway

Source: The high-speed train between Belgrade and Budapest should transport Chinese goods arriving at the Greek port of Piraeus, https://kafkadesk.org/2020/05/15/belgrade-budapest-high-speed-train-highway-to-rail/

and difficulties that illustrate the potential friction between BRI practices and EU policy frameworks for its internal market and competition policy. Also, debt-financed projects, such as this one, have often proved more problematic in the EU environment [28].

In Serbia the railway line Belgrade-Budapest project includes three sections:

- Section Beograd Centar-Stara Pazova (34.5 km)
- Section Stara Pazova-Novi Sad (40.4 km)
- Section Novi Sad-Subotica-state border (107.4km).

The construction is underway at the Belgrade Centre Station-Stara Pazova section, funded by a CEXIM loan of USD 297.6 million. In July 2018 started the construction by Chinese and Russian companies on the 75 km segment from Belgrade to Novi Sad. At the same time, for the railway construction of Novi Sad-Subotica-state border section, Serbia signed a commercial contract worth USD 1.1 billion [18]. The plan was to start the works at this section at the end of March 2020, and to finish by the end of 2022. Because of the global pandemic of coronavirus disease COVID-19 plans have somewhat changed, but on 22 May 2021 the percentage of physical realization of the railway section Belgrade Centre Station–Stara Pazova was 54.47%. For the section Novi Sad–Subotica–state border, the planned completion date is April 2024. The reconstruction and modernization of the Rasputnica railway line G– Rakovica–Resnik (7.5 km) was finished with the Chinese partners. The project was financed from the EBRD loan, with the value of a EUR 23.8 million and executed with the Chinese contractor CCECC [18]. This was the first project in Serbia of this Chinese company.

The Chinese companies were also engaged in the construction of the highway Miloš Veliki on Corridor 11 and the works on the Surčin-Obrenovac section and section Obrenovac-Ub, which was financed with a Chinese loan (85%) and funds from the budget of the Republic of Serbia (15%), total value of USD 541 million [3]. Among the planned projects is the sections on Corridor 11 Novi Beograd-Surčin, Surčin-Obrenovac and Preljina-Požega. Then, a 107 km long Požega-Boljare section on Corridor 11 which will connect Belgrade with Montenegro. The whole project should set up a unified railway-transport and customs system that would connect the Greece port of Piraeus, through Macedonia via Serbia and Hungary and the rest of Europe, transporting the goods from China to Central Europe and vice versa.

A preferential loan arrangement with the representatives of China and the Exim Bank was arranged under a favorable interest rate of three percent, despite the new rules and limitations recently introduced by the Chinese government. The Exim Bank approved a loan for the construction of the section of the highway from Preljina to Požega. A loan was also approved for the construction of a road (bypass) around Belgrade, from Ostružnica to Bubanj stream, on the so-called Sector C and the construction of a bridge near Vinča. The Chinese company Sinehidro will be engaged on the construction alongside the Azerbaijan Company Azvirt. At this high-level meeting in Bejing on September 2018 was also discussed about fast roads Novi Sad-Ruma and Ruma-Šabac and renovation of Belgrade-Niš railroads on Rail Corridor 10 in the amount of EUR 602 million [32].

As part of an agreement signed by Serbia's infrastructure ministry, Serbia and the Power Construction Corporation of China (PowerChina) it is planned to cooperate on the construction of a new metro network in Belgrade. Serbian ministers also signed agreements with PowerChina that are aimed at implementing a road construction project around Belgrade, as well as the reconstruction and modernization of railroads close to Serbia border with North Macedonia. These projects are ongoing and the details of all loans are not known.

A reduction in transportation costs has a statistically significant and positive impact on international trade [12]. The construction of the Zemun-Borča bridge, as well as the highway and the construction of the Belgrade-Budapest railway line, clearly demonstrate the intention to build a unique transport system in order to goods from China could be transported from the port of Piraeus to Central Europe and vice versa. The China-Europe freight trains, connecting China with 50 cities in 15 European countries, a total of 815 freight trains ran between China and Europe in 2015, but made more than 14,000 trips by the end of March 2019, and even the pandemic year of 2020 saw 12,406 trains between China and Europe, with another surge during the first six months of 2021 [2]. By concluding the planned projects as well as by modernizing and building its road and rail network, Serbia could significantly increase revenues from the transport of goods through its rail and road network. Safer and faster transportation of both goods and people should improve Serbia's position as a transit country.

BRI in the energy sector

Even before Serbia joined the New Silk Road project, it revised the Agreement on Economic and Technical Cooperation concluded with China in 2009 to stimulate the construction of a new unit of Kostolac Thermal Power Plant worth over USD 700 million, but also the construction of a section of the Corridor 11 motorway from Obrenovac to Ljig, all involving Chinese companies. The Chinese investment in the Serbian energy sector started with the investment related to the revitalization of Kostolac-B Coal Power Plant. Kostolac power station comprises the 310-megawatt (MW) Kostolac A plant and the 700 MW Kostolac B plant. In 2010, the Public Enterprise Elektroprivreda Serbia (EPS) and China Machinery Engineering Corporation (CMEC) signed a preliminary contract for the redevelopment of Kostolac Power Plant, called unit B3. Under the terms of the preliminary contract, CMEC will contribute 85% of the cost of the refurbishment of the plant and the installation of sulphur controls [17]. The new 350 MW unit B3 is the largest investment in the domestic energy sector and the first large power plant that is being built in Serbia after nearly three decades. The revitalization of unit 2 of the Kostolac Thermal Power Plant as well as the new unit 3 was completed, the revitalization of the Drmno surface mine was completed, the construction of a power plant for the production of electricity from waste was agreed, and the renewable energy project was started [24]. In addition, contracts were concluded on the construction of a heating and transmission line between Obrenovac and New Belgrade, then for the treatment and disposal of waste water from the central parts of Belgrade, etc. [23].

BRI in the heavy industry

In addition to cooperation in the construction of road and rail infrastructure in Serbia, which is mainly implemented through Chinese loans, new types of economic cooperation of these two countries have started from 2016 with two important privatizations of the former metallurgical giants of Serbia – the steel mil Smederevo and the mining company Bor. We should bear in mind that out of about 80 different minerals that are mined and traded worldwide, steel and coal are the most important in international trade. The privatization of these two large companies, with a large number of employees, whose funding and coverage of losses have burdened the budget of the Republic of Serbia, is considered a new and significant step forward in deepening and expanding cooperation through the BRI initiative. In these two cases, a strategic partnership may have become the most evident one. Acquisition of Smederevo is the most important project of economic cooperation between the two countries. In 2016, while President Xi Jinping visited Belgrade, the Serbian side insisted that China could bring more jobs, improve living standards, and lift the country's economic growth. We could witness the seriousness of China's approach to cooperation with Serbia when they invested in the RTB Bor copper mines and smelter and the Smederevo steel mill.

In 2003 Serbia's biggest steel producer Smederevo Steel was sold to U.S. Steel, but then in 2012, they sold the mill back to the Republic of Serbia. After a few years, the Serbian steel mill company Smederevo was sold to the Chinese company Hesteel in 2016. The company was

sold (98%) for EUR 46 million. The steel mill changed the name to the Hesteel Serbia, and in 2017 again changed the name to the HBIS GROUP Serbia Iron and Steel. At that time the Hesteel's acquisition of the Smederevo steel mill was the most important project of cooperation between the two countries. This Chinese investment boosted steel production and the company's international competitiveness, and it benefited local employment and the standard of living [15]. A significant increase in exports of this company from the moment of sale to the Chinese partner was also recorded, and in 2019 the HBIS become the largest Serbian exporter. Iron and steel in Serbia were the fastest-growing among the top 10 export categories, up 57.3% in value from 2016 to 2017 [13]. In the period January-May 2019, the HBIS group Serbia has become the largest Serbian exporter, with the amount of 313.2 million EUR [17]. This is in line with the new model of industrial growth in Serbia for the period 2011-2020 which is an export-oriented and includes dynamic growth of investments, the high rate of merchandise exports, and growth in industrial employment [31]. So, the development of export-oriented enterprises like this is one of the priorities for Serbian economy. Serbia, as a special value of this sale, appreciates the fact that after the sale to the Chinese partner, the company has retained 5,050 workers, which adds a social dimension to the entire enterprise. This has brought China a lot of political and media sympathy in Serbia. The company plans to invest 300 million EUR in order to improve energy use and cut costs and improve technology, reaching a maximum production of 2.1 million tons.

The main market for the export of steel from Serbia is the European Union market. The restrictions on the US market, caused by Section 232 tariffs on steel, are causing a diversion of trade flows into the EU, which is seriously threatening EU steelmakers. As a response, the EU Commission from 31 January 2019 imposed definitive safeguard measures on imports of steel products [10]. The measures concern 26 steel product categories and consist of tariff-rate quotas above which a duty of 25% will apply. Since February, quotas have been introduced for Serbia. The HBIS Serbia was also affected by the limitation of imports of cold-rolled products, white sheet metal and in particular hot rolled products. The Commission imposed provisional safeguard measures on imports of steel in July 2018, with an increase in quota by 5% for steel imports in the EU, which was welcomed in the HBIS Serbia. Serbia has claimed that the average import volumes of the 2015 to 2017, used by the Commission to establish the TRQ levels, is not representative of its historical trade with the Union, since its steel plant had been on standstill during that period and that the plant's new owners managed to bring its traditional production and sales back to normal levels only recently [9]. We are expecting further development of these quotas on EU imports of steel products from Serbia.

Zijin Mining Group, one of China's largest gold miners and one of the country's top copper producers, became a major shareholder of Serbia's only copper complex RTB Bor in August 2018. After 12 years spent on four unsuccessful attempts for the privatization of RTB Bor (in 2006, 2007, 2008 and 2009), finally from the fifth attempt, the Chinese company was introduced directly into negotiations with the Government of Serbia for a strategic partnership. On 18 December 2018, Zijin Mining Group completed the investment in RTB Bor Group by signing the closing documents with the Government of the Republic of Serbia, and formally took over the company under the new name Serbia Zijin Bor Copper. The Government of Serbia was obliged to find a strategic partner or a buyer in a memorandum with the International Monetary Fund and in this way has been able to deliver on that obligation. Zijin officially became a partner on 1 January 2019. Zijin Mining took over 63% of the equity interests of the company for USD 350 million, and the Serbian government became a minority owner with 37% ownership. Total Chinese investment in the Bor mines and smelters, for upgrading, expansion or new constructions, will be implemented over a period of 6 years in the amount of USD 1.46 billion.

The copper mining and smelting complex in Bor was key in the development of Serbia's industrial sector in Yugoslavia. The company Bor was founded in 1903, and it is the only active copper production facility in Serbia, which includes mines and smelters. It includes 4 mines with low copper content (gold) in porphyry beds

and smelters. The mines are located on the Eurasian metallogenic belt, the reservoirs are rich in natural resources and provide great opportunities for exploration and exploitation of ore. It used to be the largest Serbian state-owned copper company with over a century of mining history, and more than 5,000 employees. Especially now this company is vital to the economic development of eastern Serbia. The Serbian government entered into strategic cooperation with Zijin also with the goal that employees retain their jobs. Effluents from Bor have always been a major environmental problem, and potential ecological and human health risk, not only for Serbia but for the western Balkans and the Danube Basin [26] [11]. The mentioned problems and potential dangers must be closely monitored, especially with regard to the management of the company from abroad.

Zijin Bor Copper production and operation indicators gradually improved within the first three months of 2019. Under Zijin Mining, Zijin Bor Copper is planning to carry out mining activities in accordance with international standards, to improve production efficiency and product quality and maintain high standards in safety and environmental protection. It is expected that under the new management team, the several thousand employees of Zijin Bor Copper will be part of the major forces driving the economic growth in eastern Serbia. Lan Fusheng, President of Zijin Mining Group, expressed Zijin Mining's strong confidence in Zijin Bor Copper's future, saying that Zijin sees Zijin Bor Copper as a key project under the BRI. In 2017, RTB Bor produced 700 kg of gold, 5 tons of silver and 43,000 tons of copper cathodes. "It is expected that after reaching the designated production capacity, approximately 120,000 tons of copper, 1.45 tons of gold and 10.6 tons of silver can be produced from the mines annually" [29]. Zijin Bor Copper, in the period January-May in 2019, became the 6th largest Serbian exporter with the amount of 105.1 million EUR [18]. A USD 800 million by Zijin Mining to expand its Serbia portfolio was responsible for the increases of BRI investments in the first half of 2020 during the Covid-19 pandemic [22]. Zijin Bor Copper is the second strategically important company in Serbia which is taken over by a Chinese company. These two factories, with increasing production and increasing exports in the future, may become the key force in the development of Serbia's industrial sector.

BRI in the manufacturing companies

The Mei Ta Europe d.o.o. has opened a factory in Obrenovac in 2016 for manufacturing automotive parts, engine parts and general industrial parts. In exchange for the opening of the factory and employment, Serbia gave 14 hectares of land and exempted the company from taxes for a period of three years. The potential risk of the factory is the spillage of toxic substances, due to the proximity of the city's water supply.

The Chinese tire manufacturing company Shandong Linglong in the northern Serbian town Zrenjanin in the Zrenjanin Free Trade Zone officially started the construction of the plant on 30 March 2019, with a completion date set for March 2025. The plant is expected to produce 13 million tires a year and will employ 1,200 workers [7]. It is around 800 million EUR investment. Shandong Linglong will be built on 500,000 square meters. This is the first Greenfield Chinese investment in Serbia. The construction of a tire factory in Zrenjanin is important for this Chinese tire manufacturer because of opening the possibility to get closer to the European Union market. For the company Shandong Linglong, the project in Zrenjanin is their second-largest project abroad. Chinese company Shandong Yanggu Huatai Chemical signed a memorandum of understanding in Zrenjanin under which the company will invest between EUR 30 and 40 million in the construction of a raw material production plant for the rubber industry as a subcontractor of Shandong Linglong. This project is planned to contribute to the economic development of Serbia, especially the Banat area, and further development of the Serbian-Chinese relations. But the problems started with the depopulation of Zrenjanin and its surroundings, the lack of labor and the bringing in of Chinese and Vietnamese workers, with questionable working conditions. The construction of a high-profile highway from Belgrade to Zrenjanin was also announced and at the investor's request, it should connect middle Banat with the center of South Bačka, and facilitate the bringing of investors.

Some other BRI activities

Other planned investments are also under development in Serbia. At the Second Belt and Road Forum for International Cooperation several bilateral cooperation documents were signed between China and Serbia regarding future investments. China and Serbia agreed on a USD 3 billion package of economic investments and military purchases. Also, at the global Belt and Road conference in late April 2019, several agreements were also signed, especially in the fields of innovation and infrastructure. As part of this agreement, Serbia and the Power Construction Corporation of China (PowerChina) will cooperate on the construction of a new metro network in Belgrade. Signed agreements with PowerChina that are aimed at implementing a road construction project around Belgrade, as well as the reconstruction and modernization of railroads close to Serbia's border with North Macedonia. The Chinese presence is becoming very visible in Serbia, and especially in Belgrade: Huawei, a semi-private Chinese company, the Bank of China, which was opened a representative office, etc. The National Bank of Serbia issued on 20 December 2016 an operating licence to Bank of China in Serbia [20]. Bank of China was opened and started to work in 2017 in Belgrade.

The Serbian Minister of Finance signed an agreement on the construction of the Industrial Park of Friendship in Borča, Belgrade, with the Chinese company CRBC in Beijing on 17 September 2018. To the left of Pupin's Bridge, a huge industrial park is planned to be built on 320 hectares in the next couple of years. This park should attract over 1,000 Chinese companies and will create nearly 10,000 new jobs. The CRBC is the company which will invest in the park. If this project comes to life, it will be the biggest Chinese industrial park in Europe. It will be located in Belgrade, Serbia, so that companies coming to Europe from China would come here first. The CRBC announced its plans to invest around EUR 220 million in the Industrial Park of Friendship, and taking into consideration all the companies which will arrive, the total investment will amount to around EUR 2 billion. The government of Serbia has to start investing in the infrastructure, while the Chinese should start building factories one by one. Serbia is hoping that Chinese information technology companies are interested in coming to Serbia to launch their production but also build development centers. The construction of the new Port of Belgrade next to Pupin's Bridge has also been announced [8]. The Serbian Government estimates that the value of projects implemented in cooperation with the PR China is about 7 billion EUR, and the value of potential projects is around 8 billion EUR.

According to the China Global Investment Tracker, Chinese investment and construction contracts in Serbia from 2013 to 2019 have amounted to 9.7 billion USD total. The cooperation between Serbia and China has often been broadcasted in Serbia. A special place was given to the visits of a delegation at the highest level. The Chinese influence in Serbia, broadcast through the media, even surpasses the real effect that has on the Serbian economy.

During the 2015-2018, fixed investments grew at an average rate of around 7%, with a cumulative growth of around 30%. In 2018 investment growth picked up to 9.2%, providing a key contribution to GDP growth. Indicators suggest that investment growth will likely pick up to around 10% in 2019, as a result of growth in both the private and government sectors. The share of investment in GDP reached 20.2% in 2018, and that share is expected to continue to grow in the medium term. During 2018 current account deficit amounted to EUR 2.2 billion (5.2% of GDP). Since 2015 Serbia's current account deficit has been fully financed by net FDI, an indicator of long-term external sustainability [19]. In the last two years (2018-2019), around 80% of growth came from fixed investment, adding on average 3.5 pp to annual growth. Serbia growth dynamics in 2020 and 2021, due to the still present coronavirus, depend on the length of the lockdown and other restrictive measures and the immediate pace of recovery right after the lockdown is lifted [20]. It is expected that the cooperation with China within the BRI, with the recovery of the country after the Covid-19 pandemic, will continue.

Despite all the mentioned forms of cooperation, China's economic presence in Serbia is very limited and the EU remains by far the most important economic and trade partner. In Serbia, even still not EU member country, the EU is the most important external actor in shaping socio-

political developments. The most likely future scenario is that the political leadership will try to further expand economic cooperation with China while continue to try to meet the accession conditions [16].

Conclusion

The People's Republic of China launched the Belt and Road Initiative with numerous projects in order to empower its role in the global economy. The BRI leaves out the US and enhances cooperation within the Asian continent as well as ties with Europe. China's motive is the creation and opening of new markets for Chinese goods and services, as well as finding a place where Chinese money will be invested. With increasing investment and placement of goods, China is expanding its economic influence in the world.

On the European continent, as a non-EU country, Serbia has found its place in this China's initiative. The location of Serbia could even play an important role in China's long-term plans for the BRI. Improved transport and energy infrastructure in Serbia and the region will support the flow of Chinese goods from the Chinese-acquired Greek port of Piraeus farther north towards the wealthier EU economies. China considers the region where Serbia is located as a key corridor into Europe and part of its Initiative. Serbia has already seen the results of China's initiative through new roads, bridges, railway reconstruction and modernization, energy projects and economic cooperation with Chinese companies. Serbia is not a rich developed country, it still has a fragile economy, problems with unemployment, especially among the young. Among others, Serbia is still building stronger democratic institutions, struggling with corruption, and fighting to catch up with stronger and sustainable EU economies. On the road to EU membership, in an attempt to achieve faster economic growth, the country is in a position of susceptibility to Chinese loans and investments. Serbia still lacks in crucial infrastructure projects and is in great need of new roads, modern railways, power plants, and strong basic plants. So far, the Chinese initiative has been able to provide investment in Serbian infrastructure (bridges, roads, and railways), solving the problem of state-owned enterprises (the steel mill Železara Smederevo, the copper mining and smelting complex Bor), reconstruction of a power plant, help in solving unemployment, etc. The main advantage of the achieved cooperation is that China can help to alleviate some of Serbia's infrastructure deficiencies and help the country on its way to stronger economic development.

Observing the past years, with the exception of coronavirus slowdowns, cooperation between China and Serbia has an upward trend. Within the BRI, Serbia has continued to further strengthen its political and economic relations with China, and with each new year, this cooperation has brought new projects. In addition to increasing volume, cooperation has also developed in its content. Initially, Chinese companies were building road and rail infrastructure through Chinese loans. Then came the privatization of two state-owned enterprises, and recently, a greenfield investment in the construction of an industrial park has begun. This current form of cooperation between China and Serbia through the BRI initiative could be a driver for the arrival of a larger number of smaller Chinese companies, as well as a driver for technological advancement that has long been necessary for Serbia, and is in line with Serbia's plans for technological progress and digitization.

The cooperation has progressed over these last years, numerous memoranda have been signed, some projects have already been completed, while others are under construction or in the stage of preparation of plans for realization. The BRI has accelerated this collaboration and made it more receptive in Serbia. From experience in the past years, we can see the intention of China to expand its investments in Serbia. As a result, Serbia is setting up as China's top partner in South-East Europe.

Despite the upward trend, Serbia should pay attention to a several important risks connected with this cooperation. For the Republic of Serbia, the biggest risk in cooperation with China is the repayment of the loans. The terms of the loans are not known for all contracts, the contractors are mostly Chinese companies with Chinese workforce, and public tenders are not issued for such jobs, but the terms of execution are agreed bilaterally. There is also the risk of non-compliance with EU environmental standards and potential environmental pollution by Chinese-invested factories. In addition, issues of respecting the rights of

employees are also raised. Also, the increase in China's presence can possibly weaken the European integration process, which is still the most important strategic goal of Serbia. The closer to closing accession negotiations and joining the EU, it can be expected a decrease in China's presence in Serbia.

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