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Students' perception of online education in the COVID-19 pandemic framework

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ABSTRACT

Due to the wide worldwide spread the COVID-19 pandemic has reached at the beginning of 2020, many countries have imposed strict measures of social distancing, the result of which was a sudden shift towards the online environment for most institutions of each state. This study explores students' perception of the quality of online education during the COVID-19 pandemic, right after the shift from traditional face-to-face learning to online education. Using an online questionnaire, feedback from the respondents regarding their perception of online education, sources of information used and preventive behavior is collected. A total of 238 students from different levels and fields participated in the study which concludes with a general opinion reflecting that although in favor of online education, students are unsure if the quality of it matches the quality of the traditional face-to-face education.

Key Words: *Students' Perceptions, Online Education/E-Learning, COVID-19 Pandemic*

JEL Codes: *D90, I21*

1. INTRODUCTION

The technological realities, the effortless means of communication as well as the environmental, educational, health and equality issues that become increasingly global, lead to a level of globalization that not only allows for the creation of solutions to current problems but to the global exposure to certain crises with tremendous negative consequences on human life. The COVID-19 pandemic represents an example of such crises that threatens global economies and the standards of living around the world. COVID 19, initially reported in China, in December 2019, was in a span of a few months declared as pandemic, by the World Health Organization (WHO). The information received about COVID-19, in early March, was consistently spread globally; the virus spreads generally from individual to individuals through personal touch, saliva or by touching contaminated surfaces, hence social distancing was the most imposed measure across the world.

One by one, following the WHO's declaration, about 60 countries worldwide (Bao, 2020)the outbreak of the COVID-19 caused Chinese universities to close the campuses and forced them to initiate online teaching. This paper focuses on a case of Peking University's online education. Six specific instructional strategies are presented to summarize current online teaching experiences for university instructors who might conduct online education in similar circumstances. The study concludes with five high-impact principles for online education: (a, started closing the educational institutions, suspending traditional face-to-face activities and moving towards an online set-up. Some educational systems had more experience than others; some were more prepared than others, whereas students were completely unprepared for the swift change and ongoing development. China, the country that has been first and most affected, had already stepped into the 21st century with a large portfolio of online courses and available technologies to sustain such a shift (Bao, 2020)the outbreak of the COVID-19 caused Chinese universities to close the campuses and forced them to initiate online teaching. This paper focuses on a case of Peking University's online education. Six specific instructional strategies are presented to summarize current online teaching experiences for university instructors who might conduct online education in similar circumstances. The study concludes with five high-impact principles for online education: (a. Overall, there was an overwhelming impact on the educational system, more than 90% of the world student population across all levels of education, was impacted (Pragholapati, 2020). Although there is no unique definition for online education or e-Learning, we can obviously agree on the fact that it is a form of education where students and teachers

are generally separated one from the others and from the educational institution setup. Furthermore, we can safely agree as well, that the internet and a multitude of tools, platforms and technology are used to create, deliver and disseminate the education towards enhancing individual knowledge and performance (Rosenberg, 2006).

Several studies were conducted over the last decade to determine the students 'perception (as instruction recipients) towards the quality of online education (Bagriacik Yilmaz, 2019), (Bhagat et al., 2016), the teachers perception, as instruction providers (Ghamdi et al., 2016), (Parsons et al., 2019), as well as their interactions (Hershkovitz & Berger, 2019).

In a study conducted by (Wim Van L., Zachary, P. 2020), it was determined that the closing of schools in the COVID-19 context represented a difficulty for students from low-income households to continue properly their studies. As presented, in Europe approximately 5% of children don't have appropriate conditions in their homes for doing homework, and 6.9% don't have access to internet. In USA it was estimated that 2.5% of students in public schools are dealing with the instability of residence. The concluded idea in this case was that children from low-income families will struggle in completing their homework and being present at the online classes. A similar approach was taken in a study concerning the Vietnamese students. As in the (Wim Van L., Zachary, P. 2020) study, the demographics, implying the family environment with the income and number of members, as well as the type of school and grade, proved to be significantly influential upon students' learning habits during the lockdown. Nevertheless, beside these aspects, the perception of students of how important it is to continue the studying process even in the pandemic, proved to have a more significant influence on how they succeed with the online education. (Tran T., Anh-Duc H., Trung Tien N., Viet-Hung D., Yen-Chi N., Hiep-Hung P., 2020)

We can also refer to the study of (Suzanne R., 2020) that implied medical students, and which revealed that the general perception in regard with the online classes was good, students considering enjoyable the fact that they will have access to all the material updates. However, due to the fact that their teachers should change the curriculum in order to comply with the context, they will have postponed the clinical practical experience, that represents actually, an important step in the formation of the medical student. The postgraduate pediatric students from India considered the online education very useful and informative, as well as feasible and cheap. Even the interaction was limited, they concluded that the online courses helped to keep up their morale and acquire knowledge even related to clinical practice. (Sakshi A., Jaya S. K., 2020)

The goal of this study is to analyze the university students' perception of face-to-face and online instruction in the context of the COVID-19 pandemic, considering the channels of information used, as well as their take on credible content, while covering different behavioral aspects among which to be mentioned are compliance with state regulations, undertaking preventive methods that limit the spread of the virus and humanitarian acts.

2. DATA AND METHODS

For this study, a self-reporting instrument was used to gather the participant's point of view regarding the quality of education in the context of the COVID-19 pandemic and the online media and social media sources they use for staying informed on the COVID-19 pandemic. The questionnaire is structured in three main sections which address the perception of students towards online education, the sources of information used in this period, including social networks, and some behavioral aspects that influence the activities carried out by the students in the intervening time. The three sections account for a total of 30 closed format, multiple-choice and linear scale questions (registered on a 5-point Likert scale).

The questionnaire was developed in English, in Google Forms in the month of April 2020, during the COVID-19 pandemic, by the master students of the Behavioral Economics program, from the University of Bucharest, and was available and distributed online for one month, starting with April 15th, 2020 on different online platforms, including Facebook, Instagram, Reddit, WhatsApp groups, etc. That was a period when universities were implementing flexible learning measures in response to the online switch of formal instruction. Participation to the questionnaire was voluntary. The participants were instructed that their answers are anonymous, the sole purpose of the research being to explore student's perception of a current issue.

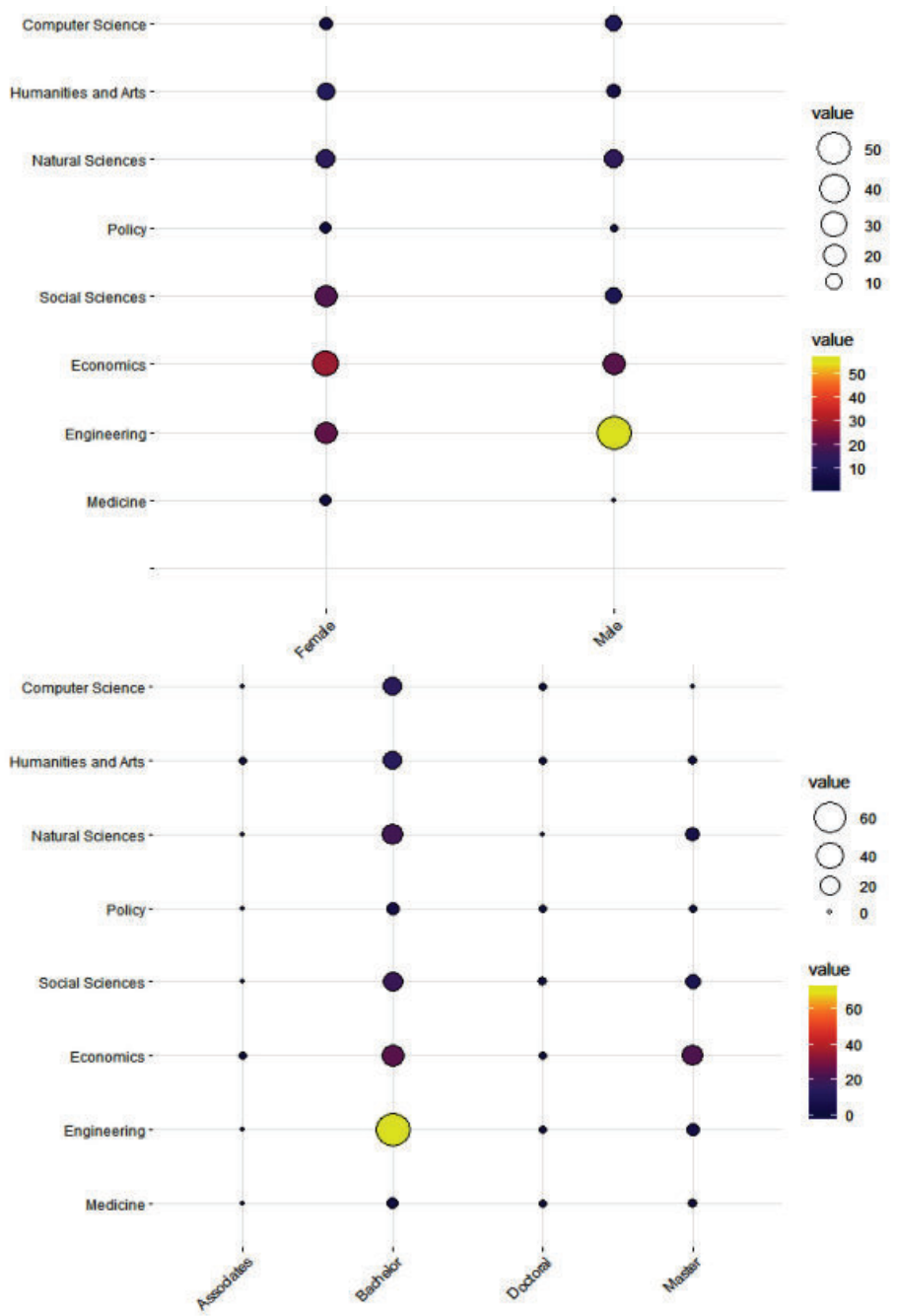
The data gathered was analyzed using R-Studio version 1.3.1073, descriptive statistics and tests of hypothesis being performed.

3. RESULTS AND DISCUSSION

The data consists of 238 respondents, with a distribution of 47.5% males and 52.5% females students, 74.5% enrolled in a Bachelor's program, 21.4% enrolled in a Master's program, 3.4% enrolled in a Doctoral program and 0.8% pursuing an Associate's degree program in eight different fields. The questionnaire had worldwide exposure, 42.8% of the respondents were European, 47.1% from North America and 10.1% from Asia.

Respondents distribution in the study

Figure 1



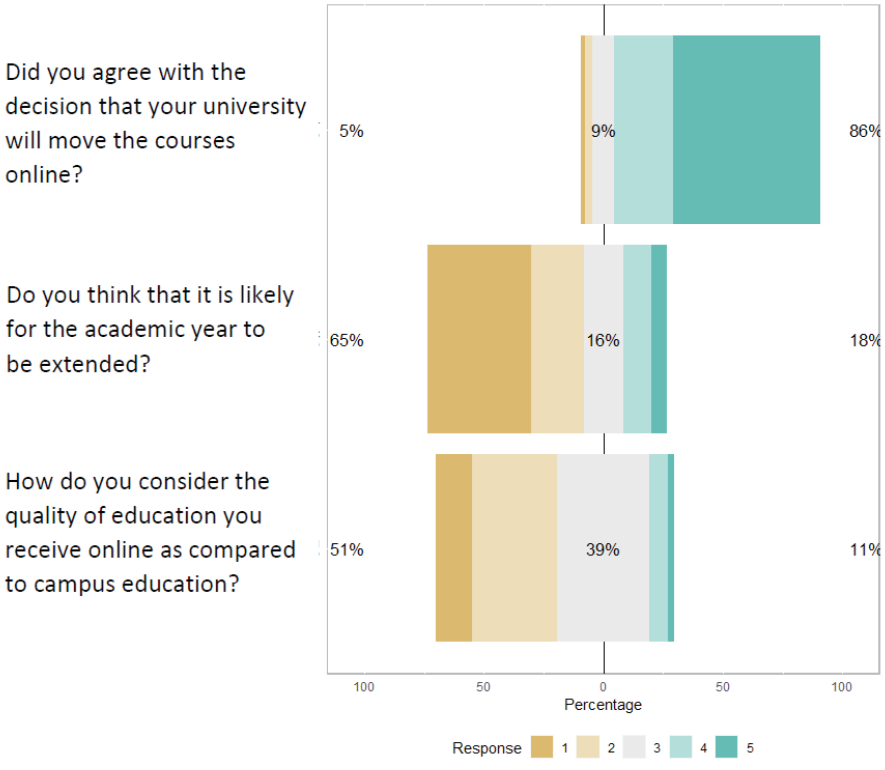
Most of the males were Engineering bachelor's students (44.8% of the male respondents), while most of the women were Engineering bachelor's students (18.6% of the total female respondents) and Economics master students (15% of the total female respondents), Figure 1.

3.1 Perception of online instruction in the context of the COVID-19 pandemic

The respondents were asked to comment on the move to the online instruction, how they perceive the quality of the education received and given the uncertainty on how the academic year will continue, what is the likelihood for the academic year to be extended.

Perception towards Online Education

Figure 2



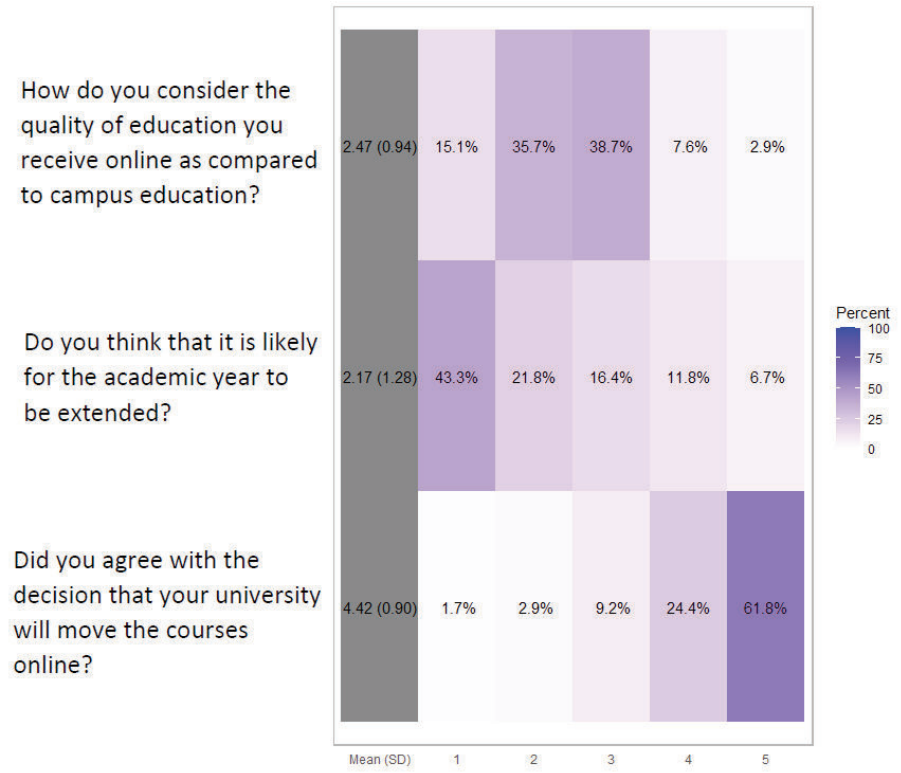


Figure 2 shows that students generally agreed to the move towards online classes (M =3.04), they were undecided regarding the quality of the education received online versus the face-to-face setup, cautiously saying that it is about the same (M = 2.48) leaning more towards not an extension of the academic year (M = 2.14), with M representing the average.

3.2 Perception toward sources of information for COVID-19 pandemic

Asked about the sources of information used in respect to the COVID-19 pandemic, the three most used sources were: online publications/ newspapers (77.73%), social media platforms (67.65%) and other websites (61.76%), as seen in Table 1. Nonparametric statistical analyses using Mann-Whitney U test revealed that there was a significant difference in the preference towards social media among female respondents (p-value = 0.0082). A significant difference was observed for the university websites as the source of information, with the bachelor students more active in consulting them then the master students (p-value = 0.0019).

Perception toward sources of information

Table 1

What are your sources of information about the status of COVID-19?	**University website**		**Television**	**Online publications/ newspapers**		**Social media**	**Websites**	**Family**
	43.7%		47.27%	77.73%		67.65%	61.76%	33.61%
Which social networks do you use for information?	Facebook	Twitter	WhatsApp	WeChat	Instagram	YouTube	Linkedin	Reddit
	41.18%	28.15%	12.61%	1.26%	31.09%	49.16%	10.50%	14.71%
Which social networks do you think provides accurate information, close to what competent authorities are providing?	Facebook	Twitter	WhatsApp	WeChat	Instagram	YouTube	Linkedin	Reddit
	19.33%	25.21%	3.36%	0%	6.72%	33.61%	9.66%	8.35%
Which social network do you trust the most?	Facebook	Twitter	WhatsApp	WeChat	Instagram	YouTube	Linkedin	Reddit
	12.61%	20.17%	2.52%	0%	3.36%	24.79%	5.46%	8.40%

With respect to the preferred social networks used for information, the analysis revealed that a significant difference exists for Instagram and YouTube, with women preferring Instagram (p-value = 0.0196) and men preferring YouTube (p-value = 0.0026). A significant difference was observed for YouTube as the preferred social network, with the bachelor students more active in consulting them then the master students (p-value = 0.0363) and also between the Engineering and Natural Sciences students in their preference for WhatsApp (p-value = 1.908e-05). The Humanities and Arts students exhibited a significant difference in their preference for Instagram as compared with the student in the other domains (p-value = 0.0166).

When asked which social network provides the most accurate information (close to what competent authorities are providing), female students showed preference for Twitter (p-value = 0.0017) and Facebook (p-value = 0.0435) and male students for YouTube (p-value = 0.0026) and Reddit (p-value = 0.0369).

Significant differences were reported for the level of education with bachelor students more in favor of Facebook than the master students (p-value = 0.0099), the master students considering YouTube the most accurate source (p-value = 0.0125). No significant differences were identified by the field of study.

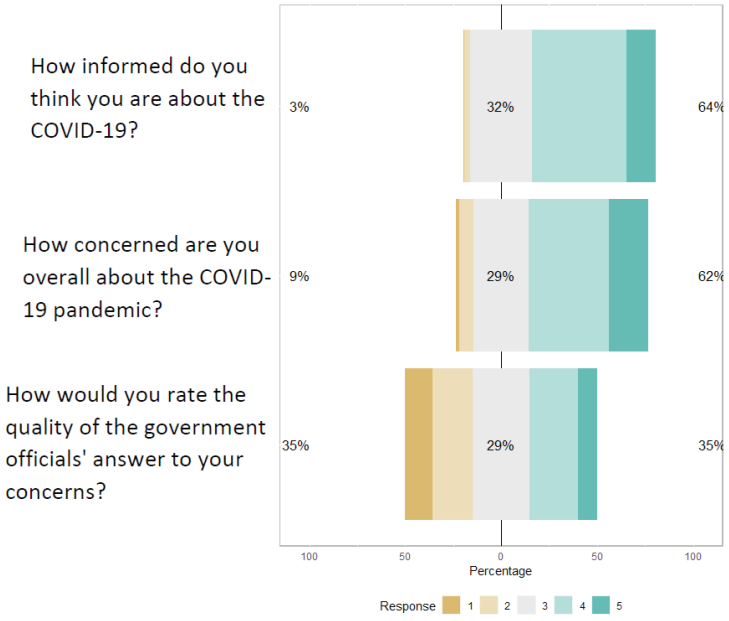
3.3 Actions undertaken by the students starting March 2020

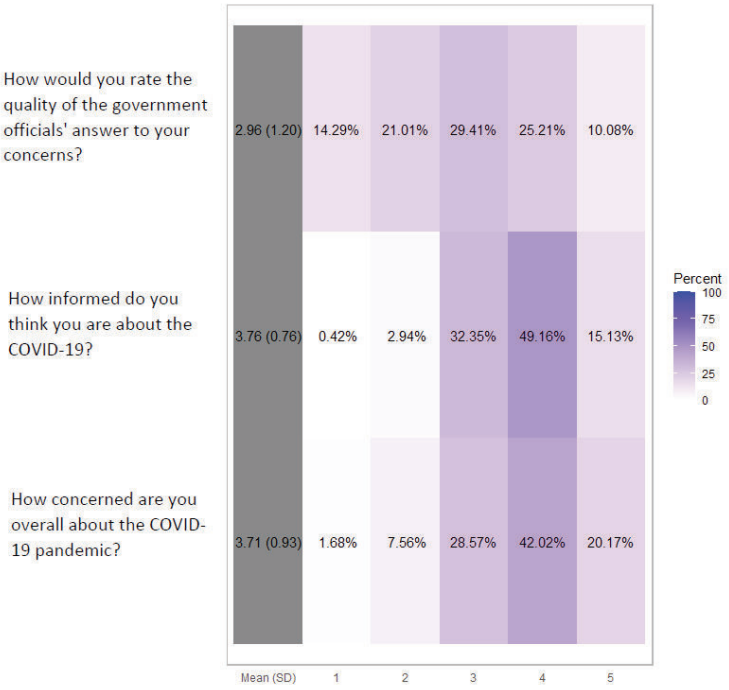
The respondents were asked to comment on the overall awareness on COVID-19 and government actions. Figure 3 shows that on average, respondents consider themselves to be somewhere between neutral to informed about COVID-19 (M = 3.75 , 49.26% consider themselves informed about COVID-19), they are somewhat to moderately concerned about the pandemic (M = 3.71, 42.02% moderately concerned) and tend to have a somewhat neutral opinion on the quality of their government officials answer to their concerns (M = 2.96, 75.63% in the bad or good opinion about the government responses), with slightly less that 25% in the extremes.

More students were self-isolating before their government imposed the social distancing measure (53.8%) with slightly more men doing so than women (30.3%). At the time the questionnaire was filled, the respondents have been complying, on average, with the self-isolation for about 6 weeks (M = 5.71). 97.8% of the respondents declared that they are informed about the preventive methods regarding the COVID-19, hence based on the type of preventive methods they followed, a prevention score was computed. The results show that we only observe a gender effect, female students get a significantly higher score in prevention (p-value = 0.02988) and no other effects are identified (level of education or field of study).

Actions regarding COVID-19

Figure 3





4. CONCLUSIONS

Based on the data collected in the second part of April 2020 (4 to 6 weeks after moving to online classes), we can conclude that although the students surveyed were in favor of online education, they were uncertain if the quality of online education matches the traditional setup.

With respect to sources of information differences can be observed by gender and level of education. More difference is noticed regarding the social media preference and trust, a strong gender effect and some (less strong) level of education and field of study effects. With respect to actions undertaken for preparation and preventive measures, male students tend to comply with social distancing before it was imposed by the government, while female students score higher on the preventive measures than male students do.

As far as the limitations of this study, it needs to be mentioned that the study used a self-reporting instrument to gather the students' perception on the quality of online education, which is always subjected to biased responses. The period in which the student's responses were collected was immediately after the shift to online education took place, which could explain why there was not a well-defined opinion on whether the quality of online education exceeds the quality of the traditional education. It is possible that students did not have enough time to get used to to the new setup or truly experience every aspect of online education to form an accurate opinion of it.

A more extensive analysis is suggested as follow-up regarding online education, investigating various national approaches, faculty training, hardware and software equipment and standardization of measures.

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Performance indicator variance analysis as the statistical method for downsizing / rightsizing

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ABSTRACT

Purpose: *This article elaborates method for downsizing/rightsizing in public sector enterprises, commonly burdened by the number of employees. Our goal was to develop an understandable, quantitative, objective, reliable and efficient method.* ***Design/methodology/approach:*** *The method design criteria were practical applicability, minimisation of subjectivity and maximisation of procedural justice. Our approach analyses performance indicators, and the amount of invested work, computing variability of the productivity time-series in the observed period. Excessive variation of ratio between performance indicators and amount of invested work indicate downsizing/rightsizing needs, as explained in the article. Method is based on internal benchmarking and thus in the first iteration it gives larger headcount estimation than comparison with industrial leaders, or best public enterprises, but it converges towards optimal headcount in the longer time span with more iterations.* ***Main findings:*** *This method has been applied in 21 different public sector organisation during the successful processes of downsizing/rightsizing, which identified a total of 1 819 redundant workers among 18 806 total employees. After the implementation of our method, we found that the application was the first successful massive downsizing program in that group of enterprises after more than five decades.* ***Originality/value:*** *A novel approach to analyse performance indicator as a measure to estimate downsizing/rightsizing goals.* ***Conclusions/Recommendations:*** *With such trait, it is appropriate as the first step in convergence toward the optimal number of employees. The lateral output of our method is that it demonstrates care about employee performance, tracks it and observes*

inconsistencies, and it offers a chance to employees to increase productivity in order to avoid downsizing.

Keywords: *downsizing, rightsizing, performance analysis, public sector, performance indicator*

JEL Classification: L32, L97, M12, M54

1.INTRODUCTION

The public sector is prone to overstaffing and workforce redundancy (Rama 1999; Feldheim 2007). General instability incited by speculative mortgage lending crisis 2007^{th}-2009^{th} lead to recession and economic problems in countries like Greece, Spain, Italy, Portugal, Ireland (Gros & Mayer 2010) and Romania (Savoiu & Dinu 2012) has not been completely solved. Similarly, Eurozone crisis has intensified attention on structural reform (Lapavitsas et al, 2010). Whelan (2009) includes overemployment in the public sector as one of the important sources of economic instability. Inadequate, often larger than required number of employees bloats structure and often burdens public governance finances (Aharoni, 2000; Birdsall & Nellis 2003; Kessides, Miniaci, Scarpa & Valbonesi 2009). Such problems pressure commercial activity and economic development, decrease efficiency and too many employees that were hired in the past may lead towards the "mixed services" problem, provided by both private and/or public institutions, which include public resources and lots of regulations. Due to that, strategies for organisational change often include downsizing in the context of the public sector and administration reform (Awortwi, 2010), with recent examples of layoff interventions in the public sector worldwide (Eliason, 2014; Kopelman & Rosen, 2016; Zahariadis, 2016; Laird, 2017).

Downsizing need may be especially emphasised as the COVID-19 pandemic effects influence the global economy (Bartik, Bertrand, Cullen, Glaeser, Luca & Stanton, 2020; Guerrieri, Lorenzoni, Straub & Werning 2020; Fernandes, 2020). Early reports show that worldwide downsizing and layoff wave is expected as one of the COVID-19 impacts on the global economy. There are also indications that new workplaces will be created (Altig, Barrero, Bloom, Davis, Meyer, Mihaylov & Parker, 2020), which is in line with the rightsizing aspect of our approach. So-called "Age of Austerity" (Wells 2018) in the public sector preceded the expected downsizing wave caused by the COVID-19. This is not the first and most probably will not be the last wave of downsizing, a common practice since the 1980s (Mckee-Ryan & Kinicki 2002; Lapavitsas et al. 2010).

The paradigm of state-led organisation directs organisational structures in the public sector to the forms of professional and machine bureaucracy

(Mintzberg, 1993). Also, among the public sector organisations, we can expect to see "orange" organisations of Lalaux (2014), with a rigid structure, strictly defined procedures, predictable behaviour and other bureaucratic traits. During our consulting experience in the South-East Europe, we have experienced that public sector organisations lean to the "red" forms of Lalaux typology, power-hungry hierarchical organisations with a strong emphasis on personal power, where cliques are formed and intrigues are used to fight towards the top of the hierarchy. In such form, Lalaux's "orange" (as bureaucratic, objective) administrative form is just institutional facade for what is really going on behind the sight of the public. This combined influence of organisational forms and culture leaves much to be desired in the situation where layoff has to be performed.

This paper describes downsizing/rightsizing method for the public and public utility enterprises. Rightsizing is a term popularised by early research (Hitt, Keats, Harback, & Nixon 1994; Zeffane & Mayo, 1994), following lack of success of blunt downsizing approach during the 1980s and early 1990s. Hitt et al (1994) defined rightsizing as is an integrated, internally consistent and externally legitimated configuration of organisational processes, products, and people. Decision basis in that is found in the analysis of performance indicator variance. Our goal was to develop a comprehensible, quantitative, objective, reliable and efficient method for downsizing/rightsizing in the public sector, as the previous era of layoff imposed a search for increased flexibility and rationality during layoff (Raudla, Randma-Liiv & Savi 2015). Besides downsizing, our approach permits partial increase in employee headcount in organisational departments that lack employees, effectively fitting goals and amount of work in the enterprise with the number of employees. The method was originally developed to calculate the optimal number of employees in the public sector, based on the consulting experience of more than 20 projects of restructuring public and public utility enterprises from South-Eastern Europe (Cudanov, Jasko & Savoiu 2012), but it was later applied in other business contexts. Basically, our approach is founded on gathering commonly accessible data in e-form, e.g. salary calculation reports or output measurements related to performance indicators. Employee's overall output is observed as a statistical population, using collected data as a sample. Second step is the calculation of standard performance. Next, similar positions, according to this performance are grouped in categories based on Porter's value creation chain (Porter & Millar 1995). We will describe background data necessary for the method in section 2, performance indicator analysis in section 3 and quantitative calculations in section 4, followed by the discussion in section 5 and finally a conclusion.

2. METHODS AND DATA

Basic data for our method includes: a) organisational charts and job descriptions/job systematisation act; b) salary calculation reports; c) performance reports (at least on monthly basis). Main issues were practical availability (often data is too hard to gather by external consultants in the public utility companies) and data reliability. Thus we have followed the famous Einstein recommendation, making data background "as simple as possible, but not simpler". Our method is based on data generally available to gather with required accuracy by interviews, in order to be practically applicable to the consultants and researchers (Cudanov & Jasko, 2012). Key issue for our method is the quality of gathered data. Inaccurate or incomplete data would lead to wrong conclusions, i.e. "garbage in, garbage out" results (Goh 2011; Cervo & Allen 2011), so it is better to gather a small set of accurate and reliable data, than a huge database of questionable accuracy and reliability.

The first source of data aimed at giving general understanding are organisational charts, graphic representations of the organisational structure. In observed organisations, they were not always available or up-to-date. However, even old organisational charts give comprehensive insight and clarification. Data on organisational positions containing job titles, subordination and similar data in tabular forms can replace organisational charts in the case they do not exist in organisational documentation. Job descriptions are second part of necessary data, defined as formal documents which describe "duties, responsibilities, contributions, outcomes, required qualifications, reporting relationship and common collaborating relations of a position in an organisational structure" (Cudanov, Jasko & Savoiu 2012). These documents formalise job allocation according to job analysis and point out the critical issues regarding the functions of each position in the organisation. When job division is clearly understood, consultants can identify the performance indicators that are substantial to be included in the assessment of employees. Job descriptions are considered to be too formal and bureaucratic, but are still handy tool for human resources, as well as for management and organisation in general (Torrington, Hall & Taylor 2005; De Bono, Van Der Heijden & Jones 2009). This source of data is commonly accessible since companies, especially in the public sector, are often legally obliged to have a formal job descriptions and systematisation act.

Payroll reports are our next primary source of data. Salary calculations are commonly performed by using specialised software which provides a suitable form of spreadsheets for our method. Our method does not require actual individual salary amounts, so they can remain confidential. Observed

data sheets also include employee identification, attendance, wage rates, deductions, earnings, and cumulative earning totals (Frankel, 1984), and if the salary depends on the employee performance, indicators that measure that performance, commonly on a monthly basis. Key data for us is the record of employee attendance time. It is usually part of automatically generated reports, as in our example table below. These reports can be accessed easily, and they can be generated in a very short period of time from salary databases. There are numerous categories classifying employee attendance and payment categories are often differently titled in different enterprises. Accuracy of observed data is often questionable since it differs from regular attendance, or even from overall attendance sum. Public enterprises often have legally restricted, capped or "frozen" salary limits (Glassner 2010; Grimshaw, Johnson, Marino & Rubery 2017), so management in response "puffs up" attendance records interpretation for additional employee monetary benefits, without explicitly breaking the law. However, in all enterprises, there was at least one attendance category which tracked employee attendance with maximum available technical accuracy. That attendance category was tangential in the large majority of observed enterprises, e.g. hot meal reimbursement – a small part of the salary, and thus often unaltered. To find out that information, direct contact with the accounting department is, from our consulting experience, precious in this step. Their open explanation on where correct data on actual attendance is can often point to unexpected, insignificant remuneration categories, like the mentioned hot-meal allowance.

Performance reports are third, and crucial data input for our method, easy step if companies have adopted a balanced scorecard approach, which is unfortunately rare among public enterprises in South Eastern Europe. With balanced scorecard "individuals and teams articulate personal, business unit and corporate objectives, as well as initiatives for achieving them, and then define up to five key performance measures for their objectives and set targets for each measure" (Kaplan & Norton 1996). A performance indicator is "quantitative or qualitative indicator that reflects the state/progress of the company, unit or individual" (Popova & Sharpanskykh 2007), and it can be the partial measurement which reflects overall work, e.g. public procurement department performs various, and numerous tasks, but all those tasks are indicated by or correlated with a number of executed public procurements. Sometimes, performance is measured through monthly, quarterly or annual employee reports, which is also alternative with acceptable reliability. The practice showed that the indicators should not be surfeited during data gathering. According to our empirical consulting experience, a smaller number of adequate indicators is better than a larger number of questionable

indicators, because performance indicators are often correlated among themselves (Popova & Sharpanskykh 2007). We should always remember we are not gathering overall performance data but performance *indicators*. If for example, one employee manages 58 public procurements in January, it does not mean that employee's worked only that for 176 hours – there were lateral, connected supplemented tasks related to those public procurements. Nevertheless, if in March employee conducts 18 public procurements, this does not undoubtedly prove that the observed employee works three times less than in January, but it definitely indicates that not everything is right with the performance and organisation. If these situations happen often, and for more than one worker, the indications are much stronger. Also the category of the public procurement process, for example, we can form subcategories as e.g. small and large size public procurements law defined, and assign appropriate ponders to them. Thus we can aggregate several related indicators to one general, e.g. small procurement requires four times less work so the ponder is 0.25, and it is added to large procurements.

More examples of measurements which can indicate performance are a) raw materials or energy used, b) produced output or c) interaction with the customers. The first type can be illustrated with the amount or caloric value of the fuel used in heating boilers, correlated with total engagement of the "Boiler operator" employee. The second example can be illustrated with the number of meals served in company restaurant as direct food serving job engagement, but also administration, hygiene maintenance, food storage and other related jobs depend on the total monthly quantity of served meals. Also, in context of the "Boiler operator" employee second type can be illustrated with the amount of heat output in Joules produced by the boiler (also correlated with the amount of fuel). Third example is for employees in a call-centre - the number of accepted calls, or the total time spent in talking to the customers. If possible, two or mere indicator on the same phenomenon can be compared to see if there is any discrepancy, e.g. for the "Boiler operator" we can track both amount of fuel used and output heat generated. Performance data should be selected to maximise the reliability of measuring employee output, while in the same time minimising consultant's time and effort needed to gather such data.

For further calculation, it is of utmost importance that these indicators are kept in the record by maximisation criteria, i.e. that higher value indicates better results. If that is not the case, e.g. for the average service time per customer indicator (where lower values are better), we can calculate reciprocal indicator like the average number of customers served in one hour (higher values are better). It is also necessary that the performance indicators are gathered for

a longer time period, as far as the data sources provide. We strongly suggest to use months as time periods, because there are no great internal variations in productivity during these periods of 30 days, so proposed indicators can be reliable. Performance variation in most cases balances within the period of one month. With 36 months, according to a central limit theorem the data distribution will incline to a normal distribution since generally "a sample larger than 30 measurements is considered sufficient for the central limit theorem to take effect" (Trevor & Nyberg 2008). Our practical experience shows that even 18 months period can give reliable results – or at least better than the subjective assessment of the excessive number of employees. During the process, ICT department is the key source for ensuring data support for this, confirming the ICT usage relations with organisational change (Cudanov, Savoiu & Jasko 2012), whether ICT is the cause or catalyst of organisational change. Data extracted with the help of ICT department makes results more accurate and reliable, and restructuring efforts much easier.

3. LABOR TASK CATEGORISATION AND ASSOCIATION WITH PERFORMANCE INDICATORS

After gathering data, we need to classify employees by the criteria of performance contribution. The main idea is to make groups that will consist of employees contributing to the same performance indicator. There are several approaches for employee classification that can be used: "a) the bottom-up approach which considers criteria of collected performance indicators; b) the process approach, using criteria of processes which are described in quality management system; c) the typified organisational structure approach, which are based on Porter's and Mintzberg's models; d) the existing organisational structure approach, that is using criteria of departmentalisation" (Cudanov, Jasko & Savoiu 2012). When all employees belong to some group, calculation of productivity indicators can be performed. There are four alternatives to the calculation of productivity indicators.

1. The first alternative for further steps in our method is to perform an analysis of the obtained performance indicators and match those with the existing job descriptions/actual employees. Every employee must be connected with at least one performance indicator. Employees can be related with more than one performance indicators, which can be combined using the PLS method as described in (Stancu, Stancu, Naghi & Baltenau 2018) That can increase the precision of calculation if correct ponders are determined.

2. The second alternative is based on the idea to classify employees and later connect those classes with performance indicators. The basis for that classification is often described in the documentation of the quality management system (QMS).
3. The third alternative is used where the quality management systems are non-existent or insufficient, so the consultants have an alternative to use Mintzberg's organisational structure or identify activities according to Porter's value chain, where specific instructions for activity identification can be found in the literature (Jasko, Cudanov, Krivokapić, Jevtić & Savoiu 2011; Jasko, Krivokapić, Cudanov 2011). This concept has massive potential since it enables the creation of patterns that can be used for different types of enterprises. Porter's value chain model enables comparison among the companies that are entirely different and can be a basis for the benchmarking. For example, one may ask why the marketing as a typical job engages 1.9% of total workhours in one public utility company, while it is connected with 0.7% workhours in another similar company.
4. The fourth and the last alternative is classification of employees, based on organisational structure, where performance indicators are assigned to the departments (of the lowest possible organisational level) in organisational structure. It is expected to provide the least reliable results which are also hard to compare. On the other hand, practical application of this method is simple, organisational departments are obvious criteria for employee classification, without ambiguous clues, thus observed performance indicators can be connected to the organisational structure within few days of consultant engagement, and identified in regular reports from analysed organisational department.

5. RESULTS CALCULATION

Collected data should be organised into indicators - quantitative basis for downsizing/rightsizing. This approach can be based on following steps: a) productivity indicators calculation for each month in the observed period, as a ratio of pondered performance indicators and hourly employee engagement; b) total average productivity calculation for the whole time period of observations; c) computing of variability indicators – most commonly, as suggested in the formulas below, the standard deviation of monthly productivity indicators in the observed period; d) application of mathematical expression (4) to compute

the standard performance for the employee/group of employees; e) final computing of average percentage of achieved standard performance for each group of employees.

In order to perform the calculations, we form a spreadsheet with calculated performance indicator productivity in separate columns for each month, for each employee in different spreadsheet row. Performance indicator productivity is calculated by dividing the performance indicator of the pondered sum of each performance indicator (PI) with total workhours invested in achieving that performance during that month. Average PI productivity is calculated as the arithmetical mean in the observed period:

$$A.PI.PR = \frac{\sum_{i=1}^{i=n} PI.PRi}{n} \quad (1)$$

Next, we calculate the standard deviation of average PI productivity:

$$\sigma_{A.PI.PR} = \sqrt{\frac{1}{n}\sum_{i=1}^{i=n}(PI.PRi - A.PI.PR)^2} \quad (2)$$

Calculated standard deviation is added to average PI productivity.

$$S.PI.PR = A.PI.PR + \sigma_{A.PI.PR} \quad (3)$$

Presuming standard normal distribution of productivity variable, and in line with the three-sigma rule (Pukelsheim, 1994), there is approximately 85% chance for the observed variable to be at array below μ + σ. In other words, using the same methods, tools, in the same organisational context, in the 15% of the cases the same employees would produce better results. Example of the calculation, based on the productivity of accountancy and salary calculation are given in the table 1 below. To save space and protect confidentiality, only first and the last month data is presented to illustrate the approach.

Example of statistical analysis of productivity indicators

Table 1

Job group	Indicator	Month1	…	Month 36	A.PI.PR	σ (A.PI.PR)	S.PI.PR=
Accountancy	Total turnover (000 RSD)	844511		125749			
	Number of different suppliers	389		293			
	Number of lines on supplier account cards	10616		2872			
	…	1255		1156			
	Total hours worked on accountancy department	3920		3664			
	Pondered performance indicators / hour	**3.8630**		**1.9072**	**1.99**	**0.44**	**2.43**
Salary calculation	Hours worked	6870		6208			
	# of calculated salaries	6134		6263			
	Pondered performance indicators / hour	**0.89**		**1.01**	**0.94**	**0.08**	**1.02**

As downsizing/rightsizing guideline, A.PI.E (average efficiency in achieving standard PI performance) is calculated by the following formula:

$$A.PI.E = \frac{A.PI.PR}{S.PI.PR} \times e \times 100\% \quad (4)$$

Specific factor "*e"* is the key part of the formula, although it is partly subjective. It depends on the objective necessary variation in productivity on a monthly scale. Sometimes there are peaks of demand due to external factors, and that limitation causes variation in productivity, instead of the excessive number of employees, because employees simply have to wait in attendance for demand peaks which are not in their sphere of influence. That situation can indicate a need for better organisation, better coordination of sales and production or a different division of labour rather than the need for downsizing/rightsizing. To determine "*e"* constant for each job, a consultant has to analyse output variability and the reasons for its variability carefully. A good rule of thumb is that the "*e"* constant is roughly 1 + *variability of output due to objective reasons*. Our practice has shown that for most jobs "*e"* ranges between 1.05 and 1.15, while in some jobs with extreme peak demands it can even be close to 1.5. Given that in combination with the "*e"* factor our formula can indicate desired increase, not only decrease of the workforce,

our method is more appropriately associated with the *right*sizing, rather than *down*sizing. Table 1. below shows the average efficiency, corrected with the "*e"* factor as the guideline for rightsizing by each organisational department/ group of jobs.

Rightsizing guidelines, from organizational modules to job groups

Table 2

Org.dept.1	Org.dept.2	Org.dept.3	Job type	A.PI.E	Rightsizing goal
Birostructure	Auxilliary activities	Safety and security	Security guards	0.942	-0.058
		Safety and security	Fire protection employees	0.943	-0.057
		Safety and security	Security managers	0.943	-0.057
		Safety and security	Health and safety employees	0.943	-0.057
		Internal restaurant	Restaurant cooks	0.921	-0.079
		Internal restaurant	Restaurant servers	0.920	-0.080
		Maintenance and hygene	Building maintenance	0.841	-0.159
		Maintenance and hygene	Hygene maintenance	0.762	-0.238
		Other auxiliary activities	Courier	0.811	-0.189
		Other auxiliary activities	Info and mail desk	0.811	-0.189
	HR	HRM operations	HRM staff	0.911	-0.089
Inbound logistics	Commerce	Public procurement	Public procurement managers	0.666	-0.334
		Public procurement	Public procurement administative staff	0.666	-0.334
Operations	Transport	Core transport	Transport support employees	0.895	-0.105
		Core transport	Managers of core transport	0.898	-0.102
		Core transport	Administrative staff in core transport	0.820	-0.180
		Core transport	Buss drivers	1.000	+0.007
		Core transport	Tram driversy	1.000	+0.024
		Core transport	Troley drivers	1.000	+0.015

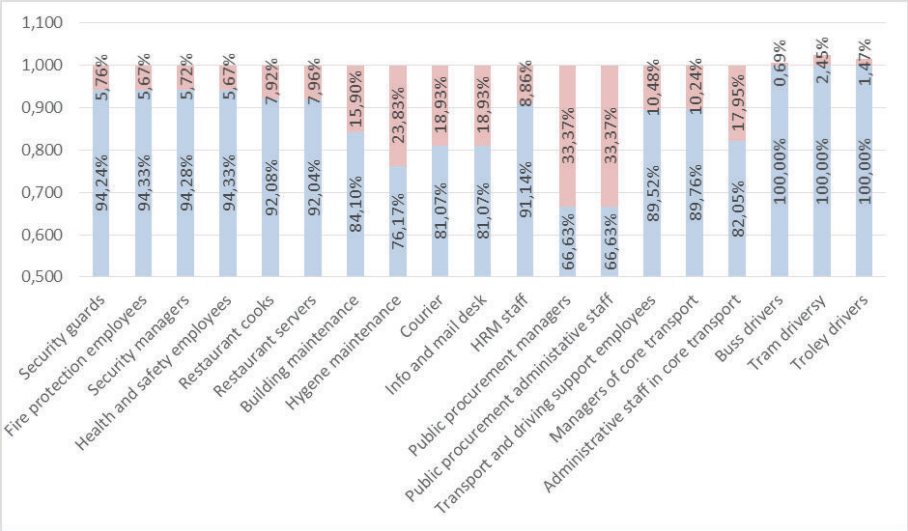
Instead of using standard deviation as statistical measurement of variability for the fluctuation of performance indicator by months, we can use Gini – Struck coefficient to measure inequality, as described in Savoiu, Craciuneanu and Taicu (2010). The difference is not to be measured between the smallest and highest income as the Gini coefficient is commonly used, but instead between the smallest and highest indicator of productivity within the observed group of workers in the enterprise. Values of Gini-Struck between 0 (perfect equality) and 100 (perfect inequality) can be used instead of the ratio of average and standard productivity (A.PI.PR and S.PI.PR) to calculate the downsizing/rightsizing guideline in the form of percentage (e.g. A.PI.E = (1 - G-S coefficient of performance indicator productivity) + e). Our future research plan is to test Gini-Struck based formula in the practical context, just like previous formulas were tested on public sector companies with more than 18,000 total employees.

6. DISCUSSION

This method has been applied in 21 different public sector organisation during the successful processes of downsizing/rightsizing, which identified a total of 1 819 redundant workers among 18 806 total employees, out of which 679 employees within the total 4 983 employed on non-core and support activities and 1 140 out of 13 823 in the core activities of the observed public enterprises. The basis for that significant organisational change was above explained calculated average efficiency in achieving standard performance indicates standard efficiency, expected to be achieved by most of the employees in the current organisational, technological and socio-behavioural context. Downsizing/rightsizing directions have been applied in all of the observed enterprises, and the goals were reached within three consecutive years. Each rightsizing goal was available per group of jobs, as illustrated in the figure 1.

Calculated productivity variance translated to expected rightsizing goals - headcount percentage

Figure 1

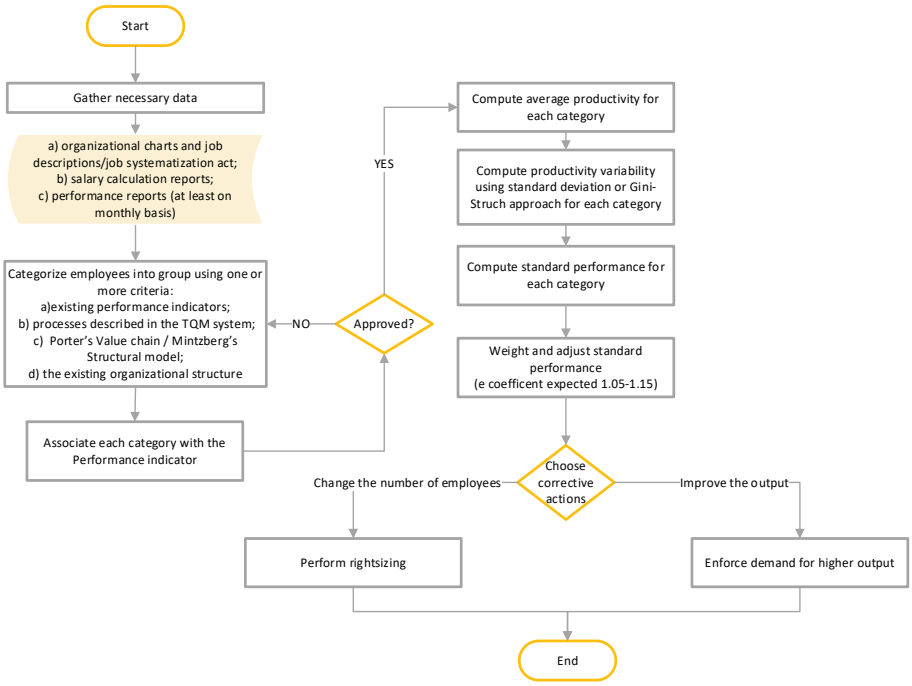


When the achieved specific efficiency is less than 100%, it means that observed organisational section can provide more services or produce more output with the same number of employees, or that demanded output can and should be created with more efficiency, i.e. fewer work hours. Fewer work hours in most cases can, but do not have to, lead to fewer employees. Other approaches can be used, and less demanded workhours can be obtained by voluntary unpaid vacations, leaves and similar strategies for responsible restructuring (Cascio, 2002). If the downsizing might not be the most appropriate solution, salary, or some other cost reduction is often a rather better alternative. If, e.g. average efficiency in achieving standard performance is 89.56%, it means that in this period observed a group of employees either can have 10.44% less employees, or the same number of employees can have 10.44% less paid hours or that number of employees can achieve 10.44% more output. If this group of employees, related to that performance indicator by any of the four methods described below has 100 employees that made 1000 value of PI, they should either (a) increase output to 1104.4 units, or (b) decrease workforce input – in the downsizing case decrease the number of employees by 10.44 (rounded to 90 employees). This decision depends on the strategy of the organisation and customers' need for additional output. In both cases, engagement is proactive (Adizes, Cudanov & Rodic 2017;

Adizes, Rodic & Cudanov, 2017), i.e. organisations can initiate the change without intense external pressure. If the decision is to implement downsizing/ rightsizing, our method cannot point to concrete employees, but to a group of employees with the contribution to the same PI. The exact method of rightsizing can be line reduction, voluntary leave, or targeted discharge, and our approach limits none of it. A general overview of the whole method is graphically represented in the Figure 2.

Expected workflow of the performance improvement project using indicator variance analysis

Figure 2



Interpretation of results is of utmost importance. Our method does not only point to reducing headcount – benefits can be attained by reducing costs or increasing efficiency. Results can point to concentrating unproductive tasks of several public enterprises to one small specialised enterprise, changing the structure to the organisational network of similar enterprises. Downsizing/rightsizing is a very delicate issue, and our results are just suggestions, not final action, but it is very important that suggestions are objective and just. Detailed analyses can increase trust in the objectivity of results, and communication quality has a critical positive influence on the attitude of employees who remain in the workforce (Chipunza & Samuel 2008). Remaining employees have significantly lower performance if they perceive downsizing process unfair (Armstrong-Stassen 2004). Employee morale depends on procedural justice more than on distributive justice (Van Dierendonck & Jacobs 2012), and reduction of employee number is connected with the drop in employee morale so respectful and just treatment is needed for employee commitment and trust (Tsai & Shih, 2011) because such approach can bring long-term benefits to organisational performance (Cascio, 2002; Tsai & Shih, 2011). The main source of resistance to our method resides in the corporate political power balance with employee syndicates, resulting in strike threats and spreading of rumours among employees. Syndicate resistance is expected (Burnes, Katsouros & Jones, 2004) and can be negotiated through increasing specific factor e, subjective part in our equation. Our exciting experience is that during the practical implementation of this method in 21 different public sector organisations, trade union representatives strongly opposed reduction in the number of employees on several official meetings and discussed against downsizing. However, in informal discussion, after each meeting, they explicitly complimented precision of analysis and stated that gaps in productivity and number of employees are exactly where pointed to by the analysis.

7. CONCLUSIONS

This method aims to provide an objective and fair approach to downsizing/rightsizing, which, compared to a subjective estimation of downsizing/rightsizing parameters, improves negotiating positions with employees and union representatives during the downsizing process. Also, application of this method during the downsizing/rightsizing process has beneficial effect on all three groups of employees involved in the process – employees that loose the jobs, employees that stay employed after the process with the potential "survivor syndrome" (Sahdev 2004) and employees that

execute the process. However, this approach has several limitations. Some companies have large seasonal oscillations in demand so which result in large estimated gaps between existing and desired number of employees. Typical example includes employees in communal heating plants, who perform with completely different dynamics and workload during winter and summer months. It would be wrong to perform downsizing/rightsizing because there is no need for most of their core activities during summer months – much better solution is to redistribute their work to other communal companies with different mission, where summer months take demand peak. Future research should be directed towards special cases where our set of formulas does not provide best results

Lateral contribution of our method's application is that it sobers up employees, enforces reality check and objectively showing how problems in the enterprise are also partly their fault, and that governing entities care very much for their performance, track it and observe the inconsistencies. Analyses of productivity, fair and achievable standards can motivate employees and improve their results. In general, this approach offers efficiency improvement as alternative to frightening rightsizing/downsizing since cost savings can be achieved without performing these unpopular actions. Employees begin to carefully track and widely use performance indicators, which presents another solution to the problems in the organisation, rather than to perform downsizing. Downsizing is delicate and hard organisational change and should be the last alternative, chosen only in situations where other restructuring approaches are not possible. Planning for that change needs to be elaborate, and change success should be estimated with quantitative methods, like the change equation (Cudanov, Tornjanski & Jasko 2019). Also, our experience with this method shows that if the company has to perform downsizing due to the excessive number of employees, that excessive headcount is more the effect then the cause of the real problem, minor among the organisational issues, compared to core mistakes that lead to the undesirable situation.

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The analysis of CO2 emissions determinants in accommodation and food service activities using quantile regressions

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ABSTRACT

Purpose: *The present research studies the determination elements of carbon dioxide emissions (CO2) in accommodation and food service activities for 26 EU countries over the period 2008-2014.* **Design/Methodology/Approach:** *The quantile regression method is used to analyze the relationships between important variables.* **Main findings:** *Our main finding suggests that GDP per capita and capital investments are the most important regressors of CO2 emissions in tourism, whilst other two selected variables, i.e. visitor exports and electricity generated from renewable sources become significant under the four quantiles.* **Originality/Value:** *According to the results of quantile regression, there is evidence that confirms the Environmental Kuznets Curve (EKC) hypothesis.* **Conclusions/Recommendations:** *The results emphasize the need for corrective actions in order to reduce the CO2 emissions in tourism, and thus combating global warming. Therefore, this paper identifies some mitigation strategies that can be implemented by accommodation and food service sectors toward lowering the CO2 emissions in the tourism industry.*

Keywords: CO2 emissions; quantile regression; accommodation and food service sectors

JEL classification: L83, Z32

1. INTRODUCTION

The raise of greenhouse gas (GHG) emissions generates considerable consequences on the quality of the environment. This remarkable increase represents the consequence of the diverse activities developed by the world

population, also connected to agricultural, forestry, construction, industrial activities (UNWTO 2003), bringing tremendous consequence on the livelihood. From all GHG emissions (carbon dioxide (CO2); methane (CH4); nitrous oxide (N2O); fluorinated gases (F-gases) emitted by human activities), CO2 is the most common, and it is responsible for 65% of total gas emissions.

CO2 emissions continued to grow in the recent years, due to various factors, but most commonly associated to the economic development and other variables related to demand and supply in business and energy consumption (Abdullah and Khalid, 2014). According to UNWTO and World Travel & Tourism Council (WTTC), tourism industry has a significant influence at global level, in terms of contribution to GDP, exports, investments, job creation, being an undeniable driver of economic development and, in the next decades, it is expected to keep growing. On the other hand, tourism development also generates an increase in resource consumption and energy use, as this economic sector comprises sub-sectors with energy-intensive activities, which furthermore contribute to GHG emissions and upping these gases in the environment (Dubois G and Ceron JP, 2005). Thus, tourism destinations became more intensive generators of CO2 emissions as similar sized spots, due to diverse activities such as cooking, cleaning, heating, lighting, disposing waste, cooling, etc. which need to take place in order to provide qualitative tourism services (Kelly and Williams, 2007).

Inevitably, tourism's contribution to GHG emissions, and obviously to CO2 emissions, will continue to grow as tourism activities continue to develop and diversify, contributing also to the decrease in tourists' satisfaction and their willingness to visit certain world destinations (Hunter and Green, 1995, Holden, 2000, Sharpley, 2009).

As a review of existing tourism literature has shown, tourism contributes to global energy utilization and emissions of CO2 (Perch-Nielsen et al., 2010, Gössling, 2002, Patterson and McDonald, 2004, Becken and Patterson, 2006, Kelly and Williams, 2007, Forsyth et al, 2008, Peeters and Dubois, 2010, Pu and Peihua, 2011, Huang and Wang, 2015, Unger et al., 2016, Becken and Bobes, 2016), with significant consequences on the atmosphere, reducing also the satisfaction of the tourists participating in various activities in world tourism destinations. According to Challenges and UNWTO (2008), tourism industry generates about 5% of global CO2 emissions (the contribution of transportation is estimated at about 75% of all emissions; the lodging sector approx. 20% of emissions from tourism; other activities – museums, theme parks, events, shopping approx. 3.5%). In the projections developed by Peeters and Dubois (2010), it is underlined that tourism development will generate a growth in emissions at over 3% per year

and if this development is unrestricted, the CO2 estimations will be even higher than the global emissions. The business-as-usual scenario developed by Pratt (2011) shows that in the next 3 to 5 decades, tourism industry contribution to GHG emissions will continue to grow by more than 5%, due to the rapid increase in international and domestic travel.

The increasing recognition of CO2 emissions and other GHG emissions as contributing to the decrease in the environment quality underlined the necessity to address this problem in a concerted manner (Becken and Patterson, 2006, Becken and Hay, 2007). Consequently, mitigation actions are more necessary than ever that one may reduce CO2 emissions and the tourism industry is responsible for such actions (Becken and Patterson, 2006). Specialists, institutions, governments, NGOs, etc. have agreed on the need to tackle tourism's contribution to CO2 emissions, derived especially from transport and accommodation activities. Consequently, the operators in tourism industry require finding sustainable solutions to provide hospitality services taking into consideration the necessity to sustain and safeguard the environment, putting into practice the green values. The stakeholders in the tourism industry need to struggle more, to find suitable solutions to reduce CO2 emissions, not just from the perspective of the supply but also from the demand side.

One of the objectives of the present paper is to complete current gaps in knowledge about the generating factors of CO2 emissions produced by European tourism, using quantile regressions. Another objective is to spot the driving factors of CO2 emissions and in particular those that are considered to lower the CO2 emissions in the tourism industry. The third objective is to explore alternative solutions for reducing the CO2 emissions in tourism industry, and reflect on supporting tourism expansion considering on green principles.

The current research is structured in the following manner: the next section shows the review of the literature on the driving factors of CO2 emissions. Section 3 presents both the data and the econometric methodology developed. Section four displays the estimations of empirical models and discusses the results. Last segment concludes the paper and provides future recommendations for reducing the CO2 emissions in the tourism industry.

2. **LITERATURE REVIEW**

In the existing literature, the Environmental Kuznets Curve (EKC) develops a hypothesized connection linking the quality of the environment and the economic development: the quality of the environment decreases with the

development of a country, up to a point, and after that it increases in a certain phase of economic growth. Most often, indicators as CO2 emissions and per capita income express this relationship and it shows an inverted U-shape curve. Many researchers investigated the existing connection between CO2 emissions and economic growth, on the national or the regional level (Holtz-Eakin and Selden, 1995, Friedl and Getzner, 2003, Liu, 2005, Akbostanci et al., 2009, He and Richard, 2010, Iwata et al., 2012, Ece Omay, 2013, Ozcan, 2013, Linh and Lin, 2014, Ren et al., 2014, Kasperowicz, 2015, Kasman and Duman, 2015, Keho, 2015, Dogan and Seker, 2016a, Dogan and Seker, 2016b, Zheng et al., 2016), and the results are different, confirming or not EKC hypothesis.

With the development of the economics literature, the researchers struggled to investigate other driving factors of CO2 emissions, most commonly used indicators being those related to economic growth. Table 1 summarizes some previous results on the existing literature on the linkages connecting CO2 emissions and other relevant regressors.

The decomposition factors used for the global CO2 emissions in the academic literature are related to the following indicators: gross domestic product or income (Friedl and Getzner, 2003,Liu, 2005, Akbostanci et al., 2009, Halicioglu, 2009, Zhang and Cheng, 2009, He and Richard, 2010, Apergis et al., 2010, Sharma, 2011, Hui et al, 2012, Iwata et al., 2012, Omri, 2013, Ozcan, 2013, Wang, 2013, Abdullah and Khalid, 2014, Omri et al., 2014, Linh and Lin, 2014, Ren et al., 2014, Kasman and Duman, 2015, Keho, 2015, Apergis and Payne, 2015, Choi and Abdullah, 2016, Zheng et al., 2016, Jebli et al., 2016, Dogan and Seker, 2016a, Dogan and Seker, 2016b, Gurbuz and Buke, 2016, Halkos and Paizanos, 2016); energy (Halicioglu, 2009, Zhang and Cheng, 2009, Sharma, 2011, Hui et al, 2012, Iwata et al., 2012, Ozcan, 2013, Omri, 2013, Andersson and Karpestam, 2013, Abdullah and Khalid, 2014, Linh and Lin, 2014, Çetin and Ecevit, 2015, Kasman and Duman, 2015, Dogan and Seker, 2016a, Dogan and Seker, 2016b, Gurbuz and Buke, 2016, Wang et al., 2016, Zheng et al., 2016, Behera and Dash, 2017); total/urban population or urbanization (Sharma, 2011,Hui et al, 2012,Zhu and Peng, 2012,A ndersson and Karpestam, 2013, Abdullah and Khalid, 2014, Omri et al., 2014, Çetin and Ecevit, 2015, Kasman and Duman, 2015, Keho, 2015, Choi and Abdullah, 2016, Gurbuz and Buke, 2016, Wang et al., 2016, Zheng et al., 2016, Behera and Dash, 2017); foreign direct investments (Ren et al., 2014, Linh and Lin, 2014, Omri et al., 2014, Behera and Dash, 2017); imports (Friedl and Getzner, 2003,He and Richard, 2010,Ren et al., 2014); exports (He and Richard, 2010,Ren et al., 2014); trade openness (Halicioglu, 2009, Sharma, 2011, Omri et al., 2014, Ren et al., 2014, Kasman and Duman,

2015, Keho, 2015, Dogan and Seker, 2016a, Dogan and Seker, 2016b); capital (Zhu and Peng, 2012, Andersson and Karpestam, 2013, Omri et al., 2014, Halkos and Paizanos, 2016, Zheng et al., 2016), carbon intensity (Hui et al, 2012, Andersson and Karpestam, 2013, Gurbuz and Buke, 2016), industry (He and Richard, 2010, Andersson and Karpestam, 2013, Abdullah and Khalid, 2014, Keho, 2015, Zhang and Cheng, 2009, Zheng et al., 2016), combustible renewables and waste or waste management (Hui et al, 2012,Abdullah and Khalid, 2014), transport (Andersson and Karpestam, 2013, Abdullah and Khalid, 2014, Choi and Abdullah, 2016), renewable energies (Apergis et al., 2010, Apergis and Payne, 2015, Dogan and Seker, 2016b, Jebli et al., 2016), nuclear electricity (Apergis et al., 2010, Iwata et al., 2012), oil price (He and Richard, 2010, Andersson and Karpestam, 2013, Apergis and Payne, 2015), agriculture (Abdullah and Khalid, 2014). The authors have constantly improved their empirical instruments and statistical, econometric and mathematical methodologies.

The impressive number of papers which analyse the (causal) relationship linking CO2 emissions and real income (GDP), renewable and non-renewable energy, investments, trade, population, transport etc. underlined the complex nature of the interactions existing between pollution (expressed by CO2 emissions) and various economic, social and technological factors. Table 1 provides an overview of studies highlighting such links.

A survey of existing literature on CO2 emissions modeling instruments

Table 1

Methodology	Used indicators	Case study / period of investigation	Specific results	Sources
EKC, OLS	CO2; GDP/P; Imp; VAS; T*	Austria, 1960-1999	+R [CO2, GDP/P, T*] -R [CO2, I, VAS] A cubic (i.e. N-shaped) of EKC	Friedl and Getzner (2003)
EKC, 3SLQ	CO2; GDP/P	24 OECD countries, 1975- 1990	-R [CO2, GDP/P]	Liu (2005)
Cointegration, ARDL, VAR, Granger	CO_2; E; IN; TO	Turkey, 1960-2005	CO2⇔ IN	Halicioglu (2009)
EKC, ADF, GLS	CO2; GDP/P	Turkey, 1992-2001	R [CO2, GDP/P] N-shape of EKC	Akbostanci et al (2009)
Granger	CO2; GDP; E	China, 1960-2007	E=>CO2	Zhang and Cheng (2009)
EKC, CPM, PLR, Hamilton's models	CO2; GDP/P; Exp; Imp; Exp of oil; Imp of oil; OP; Ind	Canada, 1948-2004	R [CO2, GDP/P] No conclusion about EKC	He and Richard (2010)
Cointegration, Granger, VECM	CO2; nuclear E; RWE; GDP	19 developed and developing countries, 1984–2007	-R[CO2, nuclear E] long-run +R[CO2, RWE] long-run	Apergis et al (2010)
Dynamic panel data model	CO_2; E; GDP/P; P; TO	69 countries, 1985-2005	R [CO2, P, GDP/P]	Sharma (2011)

Cointegration, Granger, OLS	CO2; P (size, structure, U, household size); K	China, 1978-2008	R [CO2, P (structure, consumption)]	Zhu and Peng (2012)
MR	CO2; E; GDP/P; P density; CRW; CI	Malaysia, Thailand; 1971-2006	-R [CO2, CRW]	Hui et al (2012)
EKC, ARDL	CO2; GDP/P; nuclear electricity; Tr; E	11 OECD countries, 1960-2003	+R [CO2, E] Limited evidence of inverted U-shape of EKC	Iwata et al (2012)
EKC, RSM	CO2; GDP/P	Turkey, 1980-2009	No R [CO2, GDP/P] N-shaped of EKC	Omay (2013)
2 SLS, 3SLS, GMM estimator	CO2; E; GDP/P	14 MENA countries, 1990-2011	GDP/P⇔CO2 E=>CO2	Omri (2013)
BSR	CO2; E /GDP; CI; K; L; U, FP, Ind; OP	1973-2007, developed economies	R [CO2, FT] R [CO2, K]	Andersson andKarpestam (2013)
EKC; Cointegration; Granger; FMOLS	CO2; GDP/P; E	12 Middle East countries, 1990-2008	GDP/P=>CO2 Both U-shape and inverted U-shape of EKC	Ozcan (2013)
Cointegration, QR, VECM	CO2; GDP	138 countries, 1971–2007	+R [CO2, GDP]	Wang (2013)
PFLR	CO2; GDP; P; E; B; T; A; Ind;WM, FM	UK, Malaysia; 1990 – 2010; 1981 - 2005	R [CO2, GDP/P, P]	Abdullah and Khalid (2014)
Cointegration, OLS	CO2; TGDP; TA; TBN; NTR; FD; ND	Maldives, 1972-2010	+ R [CO2, TD]	Amzath and Zhao (2014)
EKC, Cointegration, Granger	CO2; E; FDI; IN	Vietnam, 1980-2010	CO2⇔IN, CO2⇔FDI No Inverted U-shape of EKC	Linh and Lin (2014)
EKC, IO, 2 step GMM estimation	CO2; FDI; TO; Imp; Exp; IN	China, 2000-2010	+ R [CO2, TO, FDI] Inverted U-shape of EKC	Ren et al (2014)
DSEM	CO2; FDI;, GDP/P; K stock; TO; U	Global panel of 54 countries, 1990-2011	CO2⇔FDI	Omri et al (2014)
EKC, ADF, Granger	CO2; E; GDP/P; TO; U	new EU member and candidate countries, 1992-2010	E=>CO2, TO=>CO2, U=>CO2, Inverted U-shape of EKC	Kasman and Duman (2015)
Cointegration, Granger, VECM	CO2; E; P	Sub-Saharan Countries, 1985-2010	R [CO2, E, P] CO2⇔ E CO2⇔ P	Çetin and Ecevit (2015)
EKC, Cointegration, ARDL	CO2; GDP/P; P; Ind; TO	Cote d'Ivoire, 1970-2010	EKC hypothesis validated +R [CO2, GDP/P, Ind, TO]	Keho (2015)
Cointegration, Granger, VECM, FMOLS	CO2; RWE; GDP/P; OP	11 South American countries;1980–2010	+R [CO2, GDP/P, OP] CO2⇔RWE	Apergis and Payne (2015)
PFLR, MLR	CO2; GDP; P; T; FM	Malaysia, 1981 - 2005	R [CO2, GDP, T]	Choi and Abdullah (2016)
LMDI	CO2; P; GDP/P; E; CI	Poland, France and Turkey, 2012 - 2050.	+R [CO2, GDP/P, P] -R [CO2, E, CI]	Gurbuz and Buke (2016)
ADF, Cointegration, VAR	CO2; TGR; TGE; Interest Rate; GDP/P; PC; K, adjusted reserves;NRI; EP	USA, 1973-2013	-R [CO2, TGE]	Halkos and Paizanos (2016)
Cointegration, Granger	CO2; P; E	ASEAN countries, 1980-2009	P=>CO2; E=>CO2	Wang et al (2016)
EKC, Cointegration, Granger	CO2; GDP/P; TO; E; financial development	OECD, 1975-2011	EKC hypothesis validated CO2⇔ E; CO2⇔ TO; GDP/P=> CO2	Dogan and Seker (2016a)
EKC, Cointegration, dynamic OLS, Granger	CO2; RWE; non-renewable E; GDP; TO	European Union, 1980–2012 ,	EKC hypothesis validated R [CO2, GDP] CO2⇔ RWE TO=>CO2	Dogan and Seker (2016b)
EKC, Granger, FMOLS, DOLS	CO2; GDP; RWE; nonRWE; IT	25 OECD countries, 1980-2010	EKC hypothesis validated CO2⇔RWE; CO2⇔nonRWE, CO2⇔GDP, CO2⇔IT IT and RWE reduce CO2	Jebli et al (2016)
LMDI	CO2; E; KW; Ind	China, 1990-2014	+R [CO2, Ind] -R [CO2, E, KW]	Zhang et al (2016)

EKC, extended STIRPAT model; LMEM	CO2; P; GDP/P; U; Ind; E	China, 2002–2012	EKC hypothesis validated + R [CO2, P, GDP/P, Ind, E]	Zheng et al (2016)
Cointegration	CO2; FDI; E; U	South and Southeast Asia, 1980-2012	+R [CO2, FDI, E] R [CO2, U]	Ranjan et al (2017)

Notes:OLS – Ordinary Least Squares; DOLS – Dynamic OLS; GLS – Generalized Least Squares; PLR - Partially Linear Regression; 3SLQ – 3 Stage Least Squares; SLS – Stage Least Squares; MR – Multiple regression; MLR - Multiple Linear Regression; GMM – Generalized Method of Moments; BSR - Band Spectrum Regression; QR - Quantile Regression; RSM - Regression Spline Method; CPM - Cubic Parametric Model; DSEM - Dynamic simultaneous-equation models;EKC - Environmental Kuznets Curve; Granger – Granger Causality Test; LMDI - Logarithmic Mean Divisia Index; VAR – Vector Autoregression; ECM - Error Correction Model; ARDL - Autoregressive Distributed Lag; PFLR - Possibilistic Fuzzy Linear Regression; LMEM - Linear Mixed Effect Model;IO – Input-Output Analysis; FMOLS – Fully Modified OLS; VECM - Vector Error Correction Model; 'X ⇒ Y' - causality running from X to Y; 'X ⇔ Y' two-way causality between X and Y; +/-R[X, Y]=positive/negative relationship; A – agriculture; B – business; CO2 - carbon dioxide; CI - carbon intensity of energy use; CE – carbon emission; CRW- combustible renewables and waste; E - energy intensity of economic activity/ energy supply/ energy consumption; EP - energy prices; Exp - export; FDI – Foreign Direct Investments; FD/ND- distance from international airport; FM - fuel mix; GDP – gross domestic product; Imp – imports; IN - income; Ind. - industry production/ goods production/ industrial scale/ % of industry in GDP; IT – international trade; K –capital (annual expenditure); L – labour; NTR – tourist resorts built; NRI - non-residential investments; OP - oil price; P - population; PC - private consumption; RWE –renewable energy consumption; TD - tourism development; TGDP – tourism gross domestic product; TA – tourist arrivals; TBN – tourist bed nights; T* - deviation from long-term mean temperature; TO- trade openness; Tr –Trade; T/ FT – Transport/ freight transport; TGR - Total Government Revenue; TGE - Total Government Expenditure; U- urbanization; VAS-Value added in the service sector; W – productivity; WM - Waste management.

Despite the burgeoning literature, there is a gap regarding the investigation of CO2 emissions and its related variables in the tourism sector. The specialists concentrated more on aspects related to planning, projections, forecasting of CO2 emissions (Abdullah and Khalid, 2014) and less on the generating influences of CO2 emissions in tourism. Since the 1990's, authors have used various mathematical and statistical instruments (i.e. Tourism Satellite Account –TSA, Model of Alpine Tourism and Transportation – MATT, Global Tourism and Transport Model - GTTMbas, Input-Output Analysis - IOA), to approximate or even project/forecast GHG or carbon emissions for hospitality industry at international, national and regional level (Gössling, 2002, Patterson and McDonald, 2004, Becken and Patterson, 2006, Kelly and Williams, 2007, Forsyth et al, 2008, Peeters and Dubois, 2010, Perch-Nielsen et al., 2010, Pu and Peihua, 2011, Huang and Wang, 2015, Unger et al., 2016).

Among global estimation of tourism emissions, tourism and leisure activities may contribute with 5.3% to CO2 emissions at global level(Gössling, 2002). Peeters and Dubois (2010) used GTTMbas to develop 70 scenarios

in order to project global CO2 emissions related to tourism activities at the destination. Patterson and McDonald (2004) applied lifecycle assessment, using IOA, while Becken and Patterson (2006) used two methodologies (bottom-up, top-down) in order to estimate total CO2 emissions from tourism within New Zealand. Kelly and Williams (2007) identified bottom-up' modelling procedure to assess tourism destination contributions to GHG emissions in Whistler, British Columbia.

Forsyth et al (2008) used Australian TSA to estimate total GHG emissions employed by tourism sector. Perch-Nielsen et al. (2010) used the TSA in order to gather GHG information in a bottom-up and a top-down approach to estimate the GHG concentration of the hospitality sector in Switzerland. Pu and Peihua (2011) estimated CO2 emissions from tourism industry in China, using statistical analysis and a bottom-up approach. Huang and Wang (2015) estimated GHG emissions of tourism farms in Taiwan using a bottom-up approach and stepwise multiple regression analysis. Unger et al (2016) used MATT as a bottom-up approach to model GHG emissions in Alpine area and to show ODT's emissions patterns.

Consequently, it is very difficult, if not impossible, to calculate tourism energy consumption and produced CO2 emissions. In their papers, authors have concentrated their efforts more on estimation of CO2 emissions. Moreover, it is important to investigate what are the driving factors that increase or decrease the CO2 emissions so as the public and private institutions can take corrective actions and implement mitigation measures.

3. ECONOMETRIC METHODOLOGY AND DATA SPECIFICATION

3.1 Methodology description

The authors that have investigated the influence of various variables on the CO2 emissions have used different methods, such as OLS, GLS, PLS, 3SLQ, SLS, MR, GMM, BSR, RSM, CPM, DSEM, PFLR, VECM, FMOLS, PFLR, LMEM, etc. Standard methods usually provide the average outcome of predictable variables over a given distribution of the regressand (Keho, 2017). In the last years, quantile regression (QR) has been often used in ecology studies with the aim to investigate the predictive connections linking given variables in situations described by weak relationships or even no relationships between their means. The models generated by QR are relevant when (Cade and Noon, 2003):

- the dependent variable is influenced by more than one indicator,
- these indicators have different effects and consequently generate various responses,

• all these multiple factors interact.

According to Koenker and Bassett (1978), QR offers different estimations of the linear connection existing linking predictor variables X and a specified quantile of the regressand Y.

$$y_i = x_i^T \beta_\tau + e_i \quad (1)$$

In the equation, i=1,…,n, and the τ-th quantile of e_i is zero.

Thus, the assumption of previous equation is:

$$Q_\tau(Y/X) = X^T \beta_\tau \quad (2)$$

In this equation, β_τ is the vector of coefficients connected with the -th quantile.

The conditional quantile regression estimator, the estimator β_τ is presented below.

$$\widehat{\beta_\tau} = argmin_{\beta \epsilon R^p} \sum \rho_\tau (y_i - x^T \beta) \quad (3)$$

Thus, regression quantile is represented as follows:

$$\widehat{Q_\tau}(Y/X) = X^T \widehat{\beta_\tau} \quad (4)$$

Quantile regression represents a useful method used by researchers to estimate models for conditional quantile functions and is regarded as a broad instrument which completes the regression picture (Koenker and Hallock, 2001).

3.2 Data and descriptive statistics

Analyzing both economic literature and tourism literature, we have reached the conclusion that some of the influence factors, generally used to examine the determinants of CO2 emissions, can be replicated and adapted for tourism sector, while others are more specific and require special attention.

Research on the connection between tourism development and carbon emission using regression analysis has revealed that tourism development contribute to the increase in CO2 emission (Amzath and Zhao, 2014), having an important input to the degradation of the natural environment. Within economy, tourism development is generally expressed through tourism contribution to GDP. Nevertheless, authors have tried to take a deeper approach of the problem, considering a decomposition of GDP, looking to investigate what factors have stronger effects on CO2 emissions, for example exports and investments. On the other hand, renewable energy reduces the CO2 emissions and we tried to investigate the effects of a more intensive use of renewable energies in tourism.

The present paper uses the panel data approach in order to investigate the relationship between CO2 emissions and various tourism indicators for 26 EU Member States (Austria, Belgium, Bulgaria, Croatia, Czech Republic, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden) from 2008 to 2014. The sample period was chosen based on the availability of data. All the data collected were further converted into natural logarithm.

The availability of data indicated just the CO2 emissions in accommodation and food service activities, which represents a very good base for analysis because, after transport, these activities are the most energy intensive component of the tourism industry (Pratt, 2011), and consequently highly contributing to the CO2 emissions.

Description of variables

Table 2

Variable	Description	Sample period	Source of the data
LNCO2	Natural logarithm of CO2 emissions in accommodation and food service activities (tons)	2008-2014	Eurostat
LNGDPPC	Gross domestic product at market prices, euro per capita	2008-2014	Eurostat
LNEXP	Visitor Exports (Foreign spending) billionsUS$ (Real prices)	2008-2014	World Travel &Tourism Council
LNINV	Natural logarithm of investments (capital investments) in travel & tourism, billions US$ (Real prices)	2008-2014	World Travel &Tourism Council
LNELEC	Electricity generated from renewable sources, % of gross electricity consumption	2008-2014	Eurostat

Table 3 provides some descriptive statistics of the previously mentioned data. The Kurtosis exceeds the value of 3 in the case of the electricity from renewable energy, suggesting that the series are leptokurtic, and all the other values of the selected indicators show a platykurtic distribution. The skewness test indicates that CO2 emissions, visitor exports, investment, gross domestic product per capita are positively skewed, while the rest of the variables are negatively skewed. Both Skewness and Kurtosis tests, together with Jarque-Bera test statistics, confirm that the data series are not normally distributed. Consequently, estimation techniques that are based on linear models will be less suitable. Therefore, it is recommended to use other estimation technique, and in this case, the QR technique will be performed.

Descriptive statistics

Table 3

	LNCO2	LNGDPPC	LNEXP	LNELEC	LNINV
Mean	11.832	9.882	1.845	2.793	0.609
Median	11.623	9.831	1.876	2.896	0.634
Maximum	15.177	11.402	4.105	4.250	3.748
Minimum	8.749	8.517	-0.137	-1.204	-1.787
Std. Dev.	1.777	0.656	1.220	0.982	1.415
Skewness	0.277	0.020	0.153	-1.077	0.305
Kurtosis	2.042	2.332	1.952	4.823	2.465
Jarque-Bera	9.132**	3.339	8.888**	59.402***	4.904*

Note:*** p <0.01; **p <0.05, *p<0.1

4. EMPIRICAL RESULTS AND DISCUSSIONS

We started the analysis with the performance of panel unit root test (Levin, Lin and Chu, 2002). The panel unit root test was applied to investigate if the variables under consideration are panel stationary or not, and if they are non-stationary, to be used in the developed model in growth form. According to the results, all five different tested variables (namely CO2 emissions, GDP per capita, visitor exports, capital investment in travel and tourism, and electricity generated from renewable sources) are stationary in their level forms. The results of the unit root test are summarized in Table 4.

After establishing the stationary data, we proceed with the OLS and quantile regression estimations to discover the determinants of CO2 emissions in accommodation and food service activities at EU level.

Unit root test for used variables

Table 4

Variables	Levin, Lin & Chu t*
LNCO2	-5.83690***
LNGDPPC	-4.05518***
LNEXP	-2.57468***
LNINV	-16.6415***
LNELEC	-1.82490**

Notes: *, **, *** Null hypothesis can be rejected at 10%, 5% and 1% level, respectively.

Table 5 presents both panel OLS and quantile regression estimates. The estimation from panel OLS are compared with the estimates for separates quantiles (0.1, 0.25, 0.50, 0.75, 0.9) in the conditional distribution of CO2 emissions in accommodation and food service activities. The panel OLS results display a baseline of mean effects.

In order to facilitate the explanations of the results, Fig. 1 summarizes the progression of the coefficients estimated through the model (elasticity) of the five quantile regressions and provide the effects of GDP per capita, visitor exports, investment in travel and tourism, electricity generated from renewable sources, across the CO2 emissions distribution. Two indicators, namely GDP per capita and tourism investments, proved to be significant (under the 5% level) for both OLS and QR, under the five quantiles, the other two regressors confirmed the significance (under the 1% level) for OLS and QR, under the four quantiles (0.25th – 0.90th).

The results of both models, OLS and QR under the five quantiles, show that at the 1% level, investments in travel and tourism have a significant and positive effect on CO2 emissions, at any rate of CO2 emissions quantiles. The investments elasticity goes down under the quantile of 0.25th - 0.90th, suggesting that while CO2 emissions quantiles increase, CO2 emissions register even lower growth than the investments growth. The results indicate that CO2 emissions increase with growth of tourism investments and sector development, thus explaining the increase in electricity consumption and CO2 emissions. The positive influence of investments on CO2 emissions is in line with the previous empirical studies (Linh and Lin, 2014), (Ren *et al.*, 2014), (Omri, Nguyen and Rault, 2014), Behera and Dash (2017).

The second predictor, which exerts a significant and positive effect on CO2 emissions, is the visitor exports at the 1% level, except for the 0.10th quantile. Also, CO2 emissions proved to be rather inelastic in relationship with visitor exports, the estimates suggest that export elasticity goes up along with rising quantiles. Still, it appears that visitor exports exert a higher influence on CO2 emissions than investments under the quantile of 0.75th - 0.90th, consumption of foreign tourists intensifying the CO2 emissions. The consumption of domestic and foreign tourists varies, as we assume that foreign tourists stay longer, consume more products and services at the destination, leading to increased energy consumption and CO2 emissions for export tourism.

The GDP per capita has a negative influence on CO2 emissions, at 5% level of significance, at any rate of CO2 emissions quantiles. The influence of GDP on CO2 emissions is rather inelastic, decreasing with the increase of the quantiles, thus, for the 0.90th quantile, the GDP per capita is the third influencing factor of pollution, after visitor exports and investments. In the case of developed EU countries, according to EKC hypothesis, we identified a negative relationship between GDP and CO2 emissions, and these outcomes are in accordance with Liu (2005), Ren et al (2014), Kasman and Duman (2015), Keho (2015), Dogan and Seker (2016a), Dogan and Seker (2016b).

As expected, electricity generated from renewable sources has a negative effect on CO2 emissions, which is in line with previous studies (Apergis et al., 2010, Apergis and Payne, 2015, Dogan and Seker, 2016b, Jebli et al., 2016). Except for the 0.10th quantile, other quantiles report significant results (1% level of significance). Under the quantiles of 0.25th, 0.50th, 0.75th, the influence of renewable electricity production is negative but decreasing, and increasing at the 0.90th quantile: still, the coefficient remains to explain the inelasticity of CO2 emissions in relation to the explanatory variable. The results indicate that renewable electricity production helps mitigate CO2 emissions, being more sustainable on the long-run.

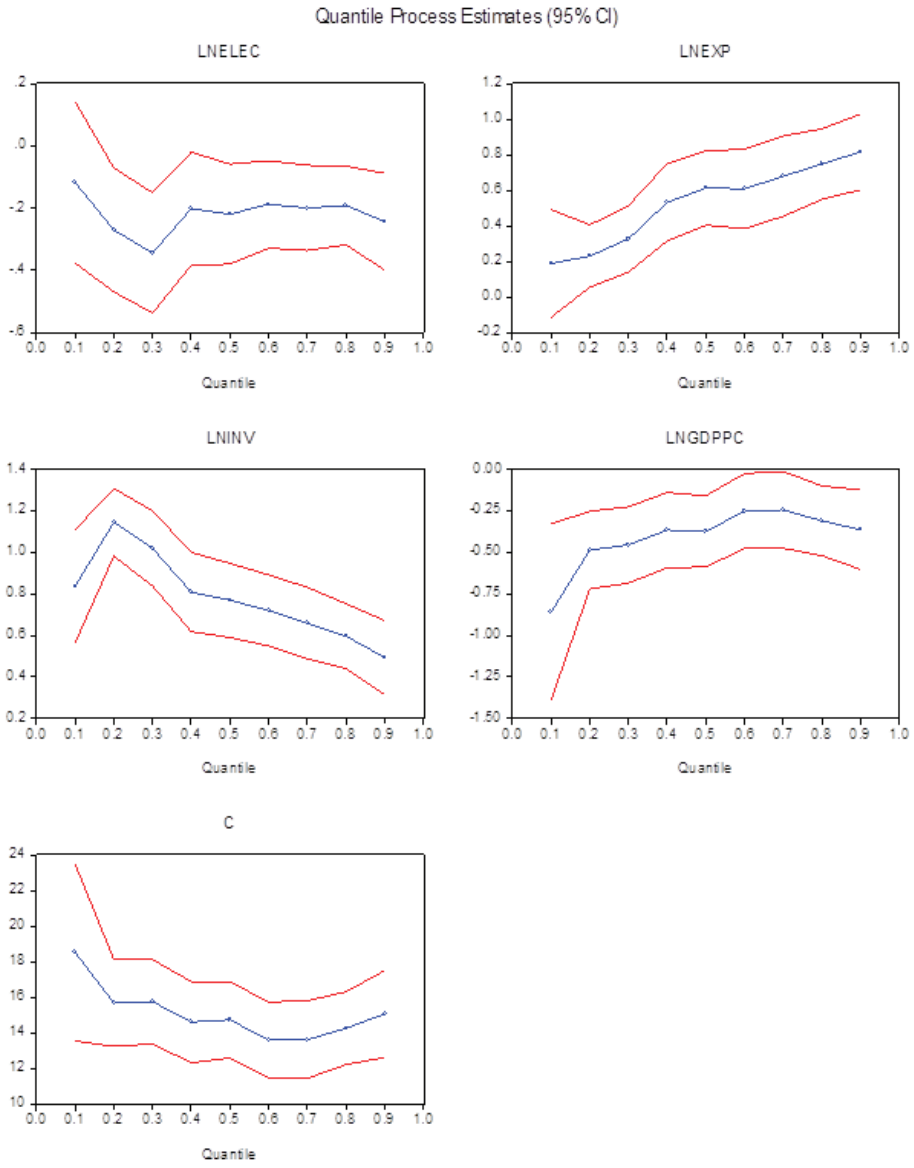
The results for OLS and QR

Table 5

Explanatory variables	Model 1 (OLS)	Model 2 (QR)				
		q=10	q=25	q=50	q=75	q=90
Constant	*14.440***	*18.522***	*15.703*	*14.732***	*13.918***	*15.064***
LNGDPPC	*-0.336***	*-0.861***	*-0.479***	*-0.374***	*-0.275***	*-0.363***
LNINV	*0.805***	*0.836***	*1.115***	*0.768***	*0.633***	*0.492***
LNEXP	*0.533***	*0.189*	*0.264***	*0.612***	*0.704***	*0.816***
LNELEC	*-0.272***	*-0.118*	*-0.292***	*-0.219***	*-0.187***	*-0.244***
R^2	*0.820*					
Pseudo R^2		*0.398*	*0.515*	*0.618*	*0.687*	*0.698*
Adj. R^2	*0.816*	*0.385*	*0.504*	*0.609*	*0.680*	*0.691*
Akaike info criterion	*2.325*					
Schwarz criterion	*2.414*					
F-statistic	*197.73***					
Hannan-Quinn criter.	*2.362*					
Durbin-Watson stat	*0.148*					
Quasi-LR statistic		*95.15***	*186.43***	*369.51***	*499.21***	*410.52***
Equality test (Wald Test)		*39.439***	*30.523***	*30.523***	*30.523***	*40.236***
Symmetric test		*19.662***	*11.245***	*11.245***	*11.245***	*19.662***

OLS estimation; *** p <0.01; **p <0.05, *p<0.1

Figure 1



In order to test the level of reliability on quantile process estimates, we employed the slope equality test (Koenker and Bassett, 1982a)and the symmetric quantiles test(Newey and Powell, 1987). The results of Wald test

used to analyze the equality of slope parameters across various quantiles demonstrate that the slope coefficients differ across quantiles, and QR offer superior estimates. The results of the symmetry tests across 0.10th to 0.90th quantiles presented in Table 5 indicate significant evidence of asymmetry, at 5% level of significance.

5. CONCLUSIONS AND FUTURE RECOMMENDATIONS

This empirical research emphasizes the importance of CO2 emission investigation in the tourism sector at EU countries level. The paper investigates the determinants of CO2 emissions in accommodation and food service activities for 26 EU countries, over the period 2008-2014 in order to emphasize which are the driving factors which significantly contributes to air pollution, to facilitate the implementation of suitable solutions for reducing GHG emissions. Our main results are that GDP per capita and capital investments the main regressors of CO2 emissions in tourism, while other two variables such as visitor exports and electricity generated from renewable sources become significant at the level of four quantiles (0.25th, 0.50th, 0.75th, 0.90th).

The CO2 emissions in the accommodation and food sector might be reduced, especially by renewing and modernizing tourism infrastructure and using existing mature technologies in lighting, heating and cooling that considerably upgrade energy efficiency. This proposed strategy that effectively mitigate the carbon emissions of tourist accommodation has been reported also by Becken et al (2001), Dubois and Ceron (2006), Hall (2007), Ceron and Dubois (2007), Tovar and Lockwood (2008), Ceron and Dubois (2008), Molz, (2009), Ruiz-Molina et al (2012), Chan et al (2013a), Ayoub et al (2014), Gabbar et al (2014), Cadarso et al (2015), Chedwal et al (2015). Moreover, this carbon mitigation strategy in tourism should not just be converted into technological and infrastructure improvements, but also into an orientation of demand towards low-carbon tourism products, with the aim to guarantee the sustainable development. This strategy is in line with those reported byBode et al (2003), Gössling et al (2005), Tol (2007), Nepal (2008), Chiesa and Gautam (2009), Weaver (2011), (Scott, 2011), Rahman et al (2012), Scott et al (2013). The environmental impact generated by CO2 emission of the hospitality industry could also be mitigated without the reduction of total tourists number through increased occupancy rate and increased average stay at hotels with low CO2 emissions, and using renewable energy sources, particularly wind and solar energy and supplementary sources fuelled with biomass or natural gas. The use of renewable energy sources as a mitigation strategy is in line

with Taylor et al (2010), Chan et al (2013b), Colmenar-Santos et al (2014), Lee (2014).

Another solution in order to reduce CO2 emissions can come from the energy-efficiency regulations including careful monitoring, control, investigation mechanism and mandatory inspections in accommodation and catering tourism sectors. These regulations can be reinforced through information and energy-performance certification schemes and reporting systems that should incorporate energy reporting with enhanced tracking and checking. Studies conducted by Deng and Burnett (2000), Deng (2003), Trung and Kumar (2005), Erdogan and Barris (2007), Beccali et al (2009), (Rossellò-Batle et al. 2010) (Rossellò-Batle, Moià, Cladera, & Martinez, 2010), Liu et al (2011), Priyadarsini et al (2009), Teng et al (2012), Wang (2013), Munday et al (2013), Huang et al (2015), Pieri et al (2015) highlight the importance of energy-efficiency regulations as a mitigation strategy. This leads to rewards for accommodation and catering businesses that perform well on carbon emission reduction and penalties measures for those that perform inadequately. This would offer incentives for accommodation and catering businesses not only to save energy, but also to enhance their positive images by acting to offset their negative environmental and ecological impacts resulting from carbon emissions. The government should set up a carbon pricing system in the hospitality industry (Dwyer, Forsyth and Spurr, 2012). In this way, tourists can be encouraged to select the most energy-efficient accommodation by drawing attention to environmental protection while traveling.

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Conditional volatility of Turkish real estate investment trusts: a comparative study of Garch, Egarch and Garch-GJR

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ABSTRACT

In this paper, we estimate the conditional volatility in the excess returns of the real estate investment trust index and Borsa Istanbul 100 index. Three models which are GARCH, EGARCH and GARCH-GJR to their daily excess return were applied and compared. Results showed that GARCH model fails to account for coefficient restrictions, asymmetry and leverage effect. EGARCH and GARCH-GJR succeed to encompass those limitations. Moreover, EGARCH is the most efficient model to estimate the conditional beta in this study.

Key words: *GARCH; EGARCH; GARCH-GJR; Real Estate investment in Turkey (REIT).*

1. INTRODUCTION

Beta stability has always been a shaded area of study. While in the capital asset pricing model (CAPM) beta is assumed to be constant over time, researchers found that beta experience a stochastic behavior due to micro and macroeconomic factors, where it moves randomly through time (Fabozzi and Francis, 1978). One of the first steps toward modeling the time varying behavior of beta was done by Engle (1982) when he introduced the autoregressive conditionally heteroskedastic model (ARCH) that allows the conditional variance to change through time as a function of past errors, yet leaving the conditional variance constant. This model makes the conditional variance prediction error at any time *t* a function of time where the variables are

exogenous and lagged endogenous, and beta is a vector of unknown parameters. This model evolved to a more generalized form by Bollerslev (1986), to the GARCH model (Generalized autoregressive conditional heteroskedastic), that allows more lag structure and a longer memory of volatility. Yet GARCH model have three major drawbacks. First, a negative correlation between current returns and future returns volatility was found by Black (1976), indicating that volatility tend to increase when receiving bad news and yields lower return than expected, whereas volatility tend to decrease when receiving good news and yields less return than expected. Second, the model imposes parameter restrictions that can be violated by estimated coefficient. And finally the last drawback is the difficulty in interpretation of the persistence of the shocks to conditional variance (Nelson, 1991). Numerous models were evolved to account for those drawbacks, and two of them will be handled in this paper. The first model is the EGARCH (Exponential GARCH) developed by Nelson (1991), and the second model is the GARCH-GJR model developed by Glosten, Jagannathan and Runkle (1993). Both of the models successfully account for these drawbacks where they take into consideration the leverage effect, asymmetry and coefficient restrictions.

On the other hand, real estate investment trust is a recent trend invading the financial market. REITs were created to securitize the real estate in every developed/developing country by allowing REITs to invest and finance real estate projects, lands and buildings. They gained reputation among investors due to their high return, inflation hedging and tax shelter advantages. Frequent studies aimed to study the REITs behavior, and their relation to the overall stock market due to their high gain potential. Therefore we aim in this article to study the relationship between the REIT index return in turkey known as "XGMYO" and the overall index return of the market known as "XU100" of the Istanbul stock exchange by modeling the stochastic behavior of excess returns. In addition, Turkish REITs returns experienced high volatility throughout the years. Therefore when modeled correctly, investing in REITs becomes very profitable.

In this paper we aim to model the conditional volatility of the real estate investment trust industry in Turkey. We apply three models that are proven to be efficient in most published articles. The three models are GARCH, Exponential GARCH and GJR-GARCH. We also use two different distributions for each model which are student t and generalized normal distribution. We aim to find the optimal model between these three that can efficiently describe and forecast the Turkish REITs industry.

Turkish REITs offers investors with high profitable opportunities as well as efficient hedging strategies. Due to their historical performance where if you bought all the REIT stocks in the index, or simply an exchange traded fund that imitate the index's performance in July 15, 2003 at 9,660.8 Turkish

liras. You'd have a 340.65% capital gain on your investment where in May 18, 2017 it reached 42,570.65 Turkish Liras, alongside the return from dividends.

Therefore if we find a model that can efficiently forecast the REITs stock prices, it will help us create an optimal portfolio of long/short positions that can yield positive returns.

On the other hand, conditional volatility of REITs sector is a neglected area of study in the Turkish economy. Few articles exists that aim to model their performance therefore this paper is one of few other efforts to study the stochastic behavior of REITs.

In section 2 we Turkish REITs industry, its performance and legal framework. In section 3 we discuss the literature behind the models and the methodology. In section 4 we provide the data and their relative analysis. In section 5 we analyze our results. And finally in section 6 we conclude our findings.

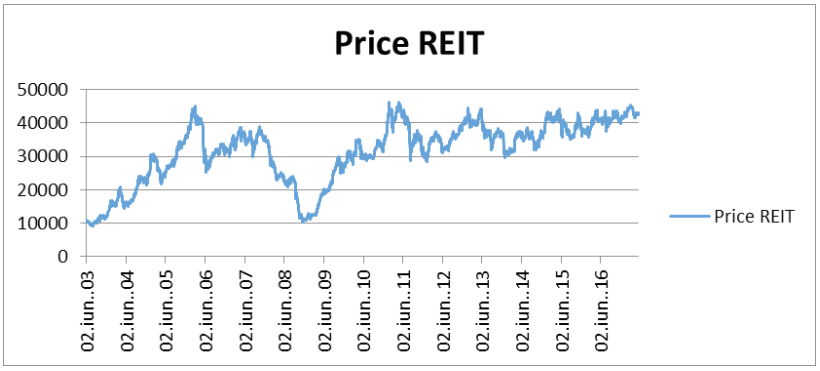
2. REAL ESTATE INVESTMENTS (REITS) IN TURKEY

The real estate investment trust is a capital market instrument that represents real estate projects, which serve as a bridge between corporate capital financing and the real estate sector. REITs serve as a mean for financing residential and commercial projects, and an investment opportunity for investors in the capital market. They are regulated by the capital market board (CMB), yet Turkish ones have several advantages over other countries. First Turkish REITs are tax exempted, i.e. they don't pay corporation or income taxes. Investors are expected to pay taxes only on dividends. On the other hand, another advantage is that REITs doesn't have to pay dividends on a regular basis, rather they can reinvest their earnings in new or existing projects. And finally REITs managers are not restricted to specific types of product investments or a geographic location; rather they are restricted to not invest more than 49% of their asset in foreign real estate. Therefore Turkish REITs are an attractive investment for local and foreign investors, and when forecasted properly offers great return opportunity.

Turkish REIT index is found under the name of "BIST Gayrimenkul Yatırım Ortaklıkları" and the ticker "XGMYO". This index consists of 27 Turkish real estate investment trust companies. These companies vary in their market capitalization from 51.70 million Turkish liras for Marti GYO, to 11.40 billion Turkish liras for Emlak Konut GYO.

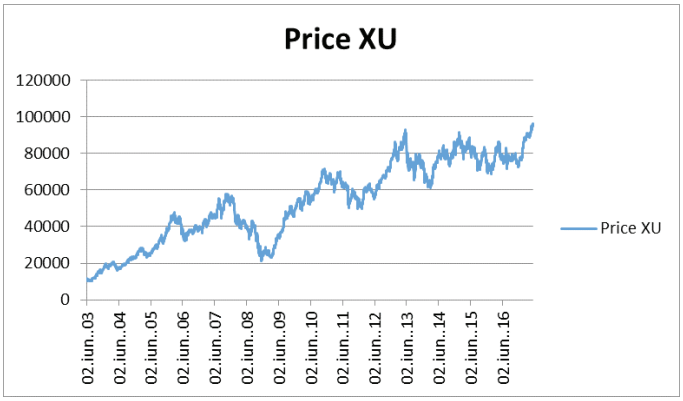
We conduct our study on Turkish REITs from July 15, 2003 until May 18, 2017 as shown in figure 1:

Figure 1



In order to assess the performance of REITs, we divide the time span over three major sections. The first section is from July 15, 2003 until December 31, 2008, where REITs prices increased drastically from 9,660.8 to 34,722.55 Turkish Liras scoring 259.41% increase in price. The second section starts from Jan2, 2008 until Nov 20, 2008. In this time period the REITs had its worst performance since its inception. Due to the global financial crisis of 2008 that was caused by the oversupply of subprime mortgage debt and the creation of collateralized debt obligations (CDOs) that supported toxic debt. The crisis of 2008 known as the worst financial crisis since the great depression of 1930 hit the Turkish market as well. Where XU100 hit the lowest in November 20, 2008 and reached 21,228.27 Turkish Liras from 54,708.42 Turkish Liras at the beginning of the year as shown in figure 2.

Figure 2



In the same day REITs reached 10,269.12 Turkish Liras scoring a loss of -70.14%. The correction began as of November 21, 2008 and prices started increasing at a slow pace till the end of 2008. Our third section starts from November 21, 2008 until May 18, 2017 where REITs recovered and scored new highs. Their performance recorded 314.55% since the crisis compared to a 348.21% increase in the price of XU100.

3. LITERATURE REVIEW

3.1. Theoretical Part:

According to the capital asset pricing model developed by Sharpe (1964), every security bares systematic and unsystematic risk, while unsystematic risk can be diversified; systematic risk denoted beta cannot due to its correlation with other asset returns in the same market or portfolio. In CAPM, unconditional beta is assumed to be constant through time, i.e. all investors have the same expectations of the variance, mean and covariance of returns. It can be calculated using the following formula:

$$\beta = \frac{cov(R_M, R_i)}{Var(R_M)}$$

Where R_i denotes the return of the REIT sector that is the return of XGYMO, and R_M denotes the return of the stock market XU100. We use ordinary least square method to estimate beta (OLS) assuming that the error terms are identically and independently distributed (IDD).

Yet if the covariance between the market's return and that of the stock market is not constant, then our Beta itself isn't constant. We know from Fabozzi and Francis (1978) that the beta coefficient moves randomly through time. Beta depends on the successive price changes of an asset. In addition it depends on the effect of good news and bad news on the price of that same asset. On the other hand, if the volatility of an asset's price at time *t-1* affects its price at time *t*, then we need to account for the volatility effect on the price changes. Therefore it's a must to build a model that can estimate the conditional beta while taking into consideration the volatility effect of each price at time *t* with its preceding one.

Engle (1982) developed the first autoregressive conditional heteroskedasticity model (ARCH) that allows volatility to evolve over time by specifying the conditional variance as a function of past squared errors. The model aims to model the conditional volatility and is given by:

$$\varepsilon_t = \sigma_t z_t$$

$$\sigma_t^2 = \omega + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2$$

Where ε_t denotes the error term, z_t is a random variable following IID with mean 0 and variance equal to 1. σ_t is the standard deviation, and $\omega > 0$, $\alpha > 0$ and $i > 0$.

In order to validate his model, Engle (1983) estimated the variance of inflation in the United Kingdom. He conducted his study on quarterly data that ranged over the course of 19 years from 1958 until 1977. He also used quarterly manual wage rates as his independent variable. His estimation found that the model is in good fit, and his estimation errors were less than 1%. His ARCH model allowed a conventional regression specification for the mean function, and a stochastically efficient change of variance.

He then conducted another study using his ARCH model on the inflation rate in the United States. His main finding was that the variance of inflation in the late forties and fifties were higher than the variance in the sixties that is in its turn higher than the variance in the seventies. He then tested the same model in an effort to estimate the same inflation in the United States a year later. He found that uncertainty of inflation tends to change over time (Engle, 1983).

ARCH successfully models the conditional beta and takes into account the ARCH effect on the variance and price. Yet it has several drawbacks that make the model weak and unsuitable for most variables. First the model assumes symmetry in shocks. This means that negative and positive shocks have the same effect on volatility, while in actual terms negative and positive shocks have different magnitude. The second weakness is that the model assumes that volatility continues for a short period. And finally the third weakness is that it's restrictive which creates a serious problem for high order ARCH models.

3.2. GARCH Model

ARCH inspired many other researchers to create a model that follows the ARCH steps but solve for its drawbacks. One of the most pioneering and well known models is the GARCH model. This model developed by Bollerslev (1986) aims to model the successive price changes through a moving average of their past conditional variances, and their dependence on the past behavior of the squared residuals. The squared residuals indicate that if errors at time *t*-1 are large in absolute value, then they will probably be large at time *t*. This creates a clustering manner of volatility. It differentiates from the ARCH

model by three main points. First GARCH allows more flexible lag structure by adding more lags to conditional variances. Second it provides a longer memory of returns whereas ARCH is categorized as a short memory model (Elyasiani, 1998). And third it permits a parsimonious description. This model introduced the GARCH effect, and it is caused by business cycle, margin requirements, information patterns, dividend yield, and money supply that cause volatility clustering (Bollerslev et al, 1992). The model is given by:

$$\sigma_t^2 = \omega + \sum_{i=1}^{q} \alpha_i \, \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \beta_j \, \sigma_{t-j}^2$$

Where σ_t^2 denotes the conditional variance, ω is the intercept, α and β are the coefficients, ε_{t-i}^2 is the residual squared lagged, and σ_{t-j}^2 the GARCH variable lagged.

After explaining his GARCH model, Bollerslev gave an empirical example where he modeled inflation in the United States. He used quarterly inflation data from 1948 until 1983 and used the implicit price deflator for GNP as his independent variable (Bollerslev, 1986). He found that GARCH model not only provide a better fit than ARCH model, but also exhibits a more efficient lag structure.

This model received positive criticism and was widely adopted by most practitioners. The GARCH (1.1) didn't just sufficiently fit most economic time series data (Bollerslev, 1987); it was also the foundation of different GARCH models that evolved and has been used to model the conditional beta of different stock markets throughout the years. Two of the most common models that were created were the exponential general autoregressive conditional heteroskedastic model (EGARCH), and the general autoregressive conditional heteroskedastic with threshold model (GARCH GJR, or GARCH (p.q) with threshold).

3.2.1. EGARCH Model:

According to Nelson (1991), the GARCH model suffers from several limitations. Therefore Exponential GARCH model was developed to account for those limitations accordingly. The first constraint that GARCH model suffers from is the negative correlation observed by Black (1976) between the returns of a stock and the returns of volatility. This indicates that bad news result in a greater volatility and good news result in a lower volatility. Yet the GARCH model only takes into consideration the magnitude, and ignores the

sign of returns. Therefore EGARCH was developed to include the oscillatory behavior ignored by GARCH. The second limitation is the non-negativity restriction imposed on the parameters α and β in the ARCH equation. When restricted to non-negativity, the σ_t^2 remains non negative with probability 1 at any time *t*. The third limitation also observed by Poterba and Summers (1986) is the issue of persistence of shocks to the conditional variance. Whether the shocks are transitory or persistent, definite or indefinite, what will their effect be on volatility?

Therefore the EGARCH model came to improve the ARCH model by first lagging z_t, second taking the Ln (z_t) for linearity, and third making g (z_t) a function of sign of z_t as well as magnitude. The EGARCH model variance equation is given as follows:

$$\text{Ln}\ (\sigma_t^2) = \omega + \sum_{i=1}^{q} \alpha_i \frac{|\varepsilon_{t-i}| + \delta_i\ \varepsilon_{t-i}}{\sigma_{t-i}} + \sum_{j=1}^{p} \beta_j\ \sigma_{t-j}^2$$

Where $\varepsilon_{t-1} > 0$ when there's good news and $\varepsilon_{t-i} = (1 + \delta_i)\ |\varepsilon_{t-i}|$. On the other hand when $\varepsilon_{t-1} > 0$ following bad news, then $\varepsilon_{t-i} = (1 - \delta_i)\ |\varepsilon_{t-i}|$.

This model not only captures the size and sign effects, but also the leverage effect. Where leverage effect is the negative correlation between volatility returns and stock returns. This is due to a higher Debt/Equity ratio in the CAPM model, where the value of equity decreases to account for a higher risk as a result to an increase in volatility.

In order to test his model, Engle (1991) estimated the conditional variance of the excess returns for the value-weighted market index from the Center for Research in Security Prices tapes. He used daily data ranging from July 1962 until December 1987. He finds four important results. First it exist a negative correlation between conditional variance and the estimated risk premium. Second, there's a high significance in the asymmetry between changes in volatility and returns. Third, shocks are persistent. Fourth, the distribution of shock returns exhibit fat and thick tails. Fifth, trading days contribute more to volatility than non-trading days (Nelson, 1991).

3.3. GARCH-GJR:

This model was developed by Glosten, Runkle and Jagannathan(1993) to account for the drawbacks of the GARCH-M model. They found that the negative and positive shocks have different impacts on the conditional variance. Therefore to account for those asymmetries, described as a seasonal variation, they added a dummy variable S_{t-1} to the original model that takes a

value of 0 when innovations ε_{t-1} are positive, and a value of 1 when ε_{t-1} are negative. Therefore when the coefficient of S_{t-1} is negative and significant, then the positive shocks have smaller effect that the negative ones. In addition to seasonal pattern, this model also considered the leverage effect when α is the impulse of positive shocks, and (α + δ) is the impulse of negative shocks. The GJR-Model is given by:

$$\sigma_t^2 = \omega + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^{q} \delta S_{t-i}^- \varepsilon_{t-i}^2 \sum_{j=1}^{p} \beta_j \sigma_{t-j}^2$$

In this model, $\hat{\alpha} + \hat{\delta}$ shows the asymmetry in the impact of good news, whereas $\hat{\alpha}$ shows the asymmetry in the impact of a bad news on our conditional volatility.

Therefore in order to test their model, they conducted a study on the relation between monthly risk return on the Center for Research in Security Prices value-weighted index of New York stock exchange equities and the risk free rate of the Treasury bills form Ibbotson & Associates. They came to conclude five findings. First there's a negative statistical significant relation between conditional variance and conditional mean. Second, risk free rate contains information about future volatility. Third seasonal volatility is statistically significant during the moths of January and October. Fourth, the excess return's conditional volatility isn't exceedingly persistent. And finally positive residuals cause a decrease in variance, while negative residuals causes an increase in variance.

3.4. Empirical Studies

These three models are widely used nowadays and are proven to efficiently estimate the conditional variance, studying the relationship between two variables and forecasting the conditional volatility. Several studies used at least one of these models such as Hansen (2005) who conducted a study comparing 330 ARCH-type models using two sets of data. The first data consists of dollar spot exchange rate, and the second data consists of IBM stock returns. He found that GARCH isn't outperformed by more sophisticated models, yet it fails to account for leverage effect for IBM return data.

Lee, Chen and Rui(2017) on the other hand conducted a study on the daily return of the Chinese stock market using GARCH and EGARCH model; they found strong evidence of time varying volatility and a long memory of returns yet they didn't find any relationship between expected risk and expected return.

Brooks, Faff and McKenzie (1998) used a multivariate GARH model to estimate the conditional volatility for 24 industry groups in the Australian

stock exchange using monthly data. They compared these results with two other models, the Kalman Filter approach and the Schwert and Seguin approach. They found that both GARCH and Kalman Filter were both efficient in improving out-of-sample and in-sample forecasts for the robustness test.

Gokbulut and Pekkaya (2014) estimated the volatility in the Turkish Stock market using GARCH models family. They used daily index data, as well as interest rate, and foreign exchange market data from 2002 until 2014. They found that CGARCH and TGARCH have superiority at forecasting the volatility in the Turkish stock market index due to their outperformance in the robustness test.

Franses and Van Dijk (1996) estimated the volatility of several European stock market indices. They used GARCH, GJR-GARCH and non-linear Quadratic GARCH on weekly return. They found that QGARCH is the best model at forecasting while GJR-GARCH isn't recommended for forecasting.

Contrary to Franses and Van Dijk, Brailford and Faff (1996) conducted a study to compare the forecasting capabilities of different forecasting models on the Australian stock market. They used the Statex-Actuaries Accumulation Index as their dependent variable and the data ranged from 1974 until 1993. Their forecasting models were GARCH, GJR-GARCH, historical mean, exponential smoothing, simple regression, moving average, random walk and exponentially weighted average models. Their results were that the ARCH class models and the simple regression have the highest accuracy in forecasting volatility. Their decision was based on four criteria that are the mean absolute error, root mean squared errors, mean error and mean absolute percentage error. Moreover out of all the ARCH models, GJR-GARCH was the best at forecasting the Australian stock market returns.

Dutta (2014) estimated the conditional voliatlity in the U.S. and Japan daily exchange rate from 2000 until 2012. He used three GARCH family models that are GARCH (1.1), EGARCH and GJR-GARCH following a GED distribution. He found that positive shocks to the exchange rate are more redundant than negative ones and that there exists size effect of news due to asymmetries in volatility.

In this article we handle real estate investment trusts; therefore looking at similar studies we find several that aim to model their behavior. Peterson and Hsieh (1997) tried studying the relation between EREITs and the stock market. They conducted Fama and French's (1993) five factor model on EREIT returns and found that risk premium on REITs are similar to that of a market portfolio of stocks. And that the risk premium of mortgage REITs is significantly related to two bond market factors and three stock market factors

in returns. Chan, Hendershott and Sanders (1990) also used a multi factor capital asset pricing model. They found that EREIT are less sensitive to the factors specified in the model than stock returns. But they do have significance in explaining EREIT return. The five macroeconomic factors were expected and unexpected inflation, industrial pollution, and risk and term structure of interest rate as specified by Chenn, Roll and Ross (1986).

Devaney (2001) on the other hand used a 4 factor arbitrage pricing theory model to invest the relation of EREITs with interest rates. He implemented a GARCH-M model in the mean to test for changes in risk premium through time. He found that interest rates and their relative conditional variance has an inverse relation with EREITs, and that mortgage EREITs are more related to interest rates than equity ones.

Stevenson (2002) on the other hand used the univariate models GARCH and EGARCH to analyze the volatility of the U.S. REIT sector to equity and fixed income sectors. He found a relation between Equity REITs and small cap stocks, and a relationship between equity REITs and other REIT sectors.

Yuan, Sun and Zhang conducted a study using four GARCH models on the daily price of REITs in the Unites States. They use GARCH, EGARCH, GARCH-GRJ and APARCH and compare between them using value at risk estimations. They find that GARCH-GJR is the best model at estimating REITS volatility in the U.S.

Moreover, Winniford (2003) conducted a study on the seasonal volatility of the EREIT sector using GARCH and P-GARCH model. He used the Wilshire REIT index and the National Association of Real Estate Investment Trusts EREIT index data. His study covered the period from February 1972 until December 2002. He found that EREITs are more seasonally volatile than the stock market and highly sensitive to news. Plus he found that the months of April, June, September, October and December exhibit the highest seasonal volatility patterns in the overall return.

Loo (2016) conducted a study on the Asian REIT market. He studied their volatility behavior using ARCH family models. His results suggested that EGARCH model was the best one from the ARCH family at forecasting volatility in Asian REIT market.

In addition, Cotter and Stevenson (2006) examined the REITs volatility using the VAR-GARCH model between REITs and US equity sector. He found a weak relation between the equity sector and REITS by using monthly returns. Rather he suggests that daily returns are more efficient than monthly ones. These studies gave us a reason to further investigate the GARCH models family and their application on the REITs sector.

On the other hand few studies aimed to model the volatility in the Turkish REIT industry. Aksoy and Ulusoy used a GARCH (1.1) and EGARCH to study the Turkish REITs where they search for daily, weekly and monthly variations in index returns. They found that calendar anomalies exist in the REITs index and BIST index on weekly and monthly variations.

3.1. Articles Summary:

The articles used are summarized

Table 3.1

Author	Method	Variables	Results
Hansen(2005)	330 ARCH	• Dollar spot exchange rate • IBM stock returns	No sophisticated model outperform GARCH
Lee, Chen and Rui	• GARCH • EGARCH	Chinese stock market	• Long memory in volatility • No relation between expected return and expected risk
Brooks, Faff and McKenzie (1998)	GARCH	24 Industry groups in Australian Stock Exchange	Passes the robustness test for in-sample and out-of-sample forecasting
Peterson and Hsieh(1997)	Fama Five Factor model	EREITs	Risk premium on REITs are similar to risk premium of a market portfolio of stocks
Sanders(1990)	Multi factor capital price model	EREITs	Significance in explaining EREIT return by the five macroeconomic factors picked
Devaney(2001)	4 factor APT model	ERITs with interest rates	Interest rate and EREITs have inverse relation in the conditional variance
Stevenson(2002)	GARCH EGARCH	U.S. REIT	• There exist a relation between equity REITs and small cap stocks. And one between EREITs and REIT stocks.

Winniford(2003)	GARCH and P-GARCH	EREITs	There exist a seasonal volatility in the EREITs return
Cotter and Stevenson(2006)	VAR-GARCH	REIT U.S.	Weak relation between equity sector and REITs on the monthly return basis.
Aksoy and Gulsoy(2015)	GARCH, EGARCH	Turkish REITs	Existence of calendar anomalies in the Turkish REITs.
Yuan,Sun and Zhang	GARCH,EGARC, GARCH-GRJ and APARCH	U.S.REITs	GARCH-GRJ is the best model at VAR estimation
Gokbulut and Pekkaya(2014)	GARCH family	Turkish stock market	CGARCH and TGARCH have the best forecasting ability
Franses and Van Dijk(1996)	GARCH,GJR-GARCH,QGARCH	European stock market indices	QGARCH is the best model at forecasting
Brailford and Faff (1996)	GARCH, GJR-GARCH	Statex-Actuaries Accumulation Index	GJR-GARCH is the best at forecasting
Dutta (2014)	GARCH, EGARCH, GJR-GARCH	US-Japan daily exchange rate	• Positive shocks are more redundant than negative ones. • Asymmetry exists in the exchange rate's volatility.
Loo(2016)	GARCH family	Asian reit market	EGARCH is the best at forecasting

4. Methodology

In this paper we're studying the excess return of the real estate investment trust index as our dependent variable, while taking the Borsa Istanbul index as our independent variable. We use the daily closing price of Turkish REITs index "XGMYO" and of the Borsa Istanbul index "XU100". The return is calculated as the logarithm of the percentage change in daily

$$r_t = \ln\left(\frac{P_t}{P_{t-1}}\right) \times 100$$

The excess return is calculated using the same method followed by Aksoy and Ulusoy (2015) in their EGARCH application on Turkish REITs. Where excess return is calculated using mean adjusted return approach:

$$AR_t = R_t - \bar{R}$$

Where AR_t is the abnormal return at time *t*, R_t is the daily return for REITs, and $\bar{R}$ is the daily average return of REITs between *t* = -30 (Jun

3,2003) until t = -11 (Jun 30,2003) , and Jun15,2003 is our event date at t = 0. The statistical significance of our abnormal returns is calculated through the standardized abnormal return explained by Brown and Warner (1985) where:

$$SAR_t = \frac{AR_t}{SD(AR)_t}$$

And

$$SD(AR)_t = \sqrt{\frac{1}{T_0}\sum_{t=1}^{T_0} AR_t^2}$$

The Abnormal returns for XU100 is calculated the same way as that of REITs.

On the other hand the three models used are the following:

• GARCH (1.1):

$$\sigma_t^2 = \omega + \alpha\, \varepsilon_{t-1}^2 + \beta\, \sigma_{t-1}^2$$

• EGARCH(1.1)

$$\text{Ln}\ (\sigma_t^2) = = \omega + \sum_{i=1}^{q} \alpha_i \frac{|\varepsilon_{t-i}| + \delta_i\, \varepsilon_{t-i}}{\sigma_{t-i}} + \sum_{j=1}^{p} \beta_j\, \sigma_{t-j}^2$$

• GARCH-GJR (with threshold):

$$\sigma_t^2 = \omega + \sum_{i=1}^{q} \alpha_i\, \varepsilon_{t-i}^2 + \sum_{i=1}^{q} \delta S_{t-i}^{-} \varepsilon_{t-i}^2 \sum_{j=1}^{p} \beta_j\, \sigma_{t-j}^2$$

We run these three models using two different distributions, student t and generalized normal distribution. The logic behind using these two distributions is discussed later in this paper. After estimating these six models we test each mode for serial correlation using the Correlogram of standardized square residuals, normality of the distribution using the Jarque-Bera test and for ARCH effect using the ARCH LM Test. If the model successfully passes these three tests then the model is eligible for application

We then compare their values of AIC (Akaike info criteria) and SIC (Schwartz info criteria) the LogL (Log Likelihood). The lowest the values for

AIC and SIC, the better the model. While the highest the value for LogL the better. And finally we forecast each model independently by first dividing our sample on two years interval. Therefore we forecast seven samples of two years period for each model and for each distribution.

We finally compare the root mean squared error (RMSE) and mean absolute error (MAE) of each sample forecasted first by the rest of the years. Then we compare the values between the different distributions to decide which distribution is the better fitting our data. And finally we compare between the different models to pick the best one with lowest errors at forecasting the conditional volatility of REITs.

5. ANALYSIS

5.1. Summary statistics

Analyzing our REITs daily data we first plot the residuals graph. We notice the high fluctuation in the residuals through time. Where a high volatility is followed by a high one and a low volatility is followed by a low one. This indicates that we can apply a GARCH model to this data.

We then plot the summary statistics table for our 3464 daily closing price of REITs. We notice that the value of our mean and standard deviation are positive, indicating that positive returns are more dominant than the negative ones in the REITs sector. In addition the value of skewness (-0.479594) is far from our standard deviation indicating that our data is negatively skewed. And our kurtosis is 6.317923 indicating that our data is also leptokurtic as shown in the following table.

Table 2

	Observations	Mean	Median	Std. Dev.	Skewness	Kurtosis
Daily AR REIT	3464	0.44724	0.49226	1.77826	-0.4796	6.31792

On the other hand, XU100 experience similar attributes. First the mean and standard deviation are positive. Second it's negatively skewed with a value of -0.1633. Third is leptokurtic with a kurtosis of 6.72361 as shown in the following table:

Daily AR XU100

Table 3

	Observations	Mean	Median	Std. Dev.	Skewness	Kurtosis
Daily AR XU100	3464	0.37261	0.41308	1.72653	-0.1633	6.72361

We then run our estimation with AR REIT as a dependent variable and AR UX100 as an independent one through ordinary least square method (OLS) as shown in table 2. We get:

$$AR\_REIT_t = 0.150958 + 0.795166 * AR\_XU_t + \varepsilon_t$$

We find that our R-squared is equal 59.60% which means that 59.60% of our dependent variable is explained by our independent one.

5.1.2. Test for normality:

Then we test for normlity using the Jarque-Bera test. We find that our Jarque-Bera value of 1721.703 is at P-value of (0.00) for the daily returns in table 4. Indicating that we should reject our null hypothesis of normal distrubtion. We also found our Jarque-Bera value for our residuals in our estimated model which is 2016.621 at (0.00) P-value, which also indicates that our squared returns aren't normally distrubted.

Table 4

	Observations	Jarque-Bera	P-Value
Daily AR REIT	3464	1721.703	0.000
Daily AR XU100	3464	2016.621	0.000
Residuals	3464	2016.621	0.000

5.1.3 Test for stationary

We test the stationary of our data at level using the Augment Dickey-Fuller test. We find that our t-statistic for REITs return is (-55.66963) and it's significant at 1, 5 and 10% where t-critical is (-3.432051), (-2.86211) and (-2.567153). Therefore we accept the null hypothesis that our data is stationary and has no unit root.

In addition we find our data for the return of XU100 is also stationary where our t-statistic are (-57.33808) and it's significant at 1,5 and 10% where our t-critical are (-3.432051), (-2.86211) and (-2.567153).

Table 5

		T-Statistic	Prob.*
AR REIT	ADF test statistic	-55.66963	0.0001
AR XU100	ADF test statistic	-57.33808	0.0001
	Test critical values:		
	1% level	-3.432051	
	5% level	-2.862177	
	10% level	-2.567153	

5.1.4. Test for autocorrelation and serial correlation

To check for autocorrelation we use the Ljung-Box Q test on the squared residuals. We reject the null hypothesis of autocorrelation since our P-values are (0.00) and significant at all lags as summarized in the following table:

Table 6

	Autocorrelation	Prob
Q(2)	0.104	0.000
Q(10)	0.046	0.000
Q(20)	0.036	0.000
Q(30)	0.026	0.000

We then use the Breusch-Godfrey LM test to c heck for serial correlation. We also reject the null hypothesis of existence of serial correlation since our Prob. Chi-Square for 2 lags is 0.1547 which is statistically significant in table 7.

Table 7

F-statistic	Obs*R-squared	Prob.Chi Square(2)
1.86746	3.735205	0.1545

5.1.5. ARCH LM Test:

We use the ARCH LM test to check for our Arch effect in our model. We find heteroskedasticity in our model since P-value is (0.00) and we reject our null hypothesis of homoscedasticity Therefore our model suffers from ARCH effects and can be used to estimate GARCH models.

Table 8

F-statistic	Obs*R-squared	Prob.Chi Square(2)
130.0105	125.376	0.000

5.1.6. Distribution Hypothesis:

According to our previous tests we found that our model experiences a non-normal distribution. Our return has heavy fat tails and a leptokurtic distribution. Therefore in our study we run the different GARCH models through a generalized normal distribution (GED) and a student t distribution. We later compare between them

5.2. Models Estimation:

5.2.1. GARCH (1.1) Estimation:

We run the GARCH model and report our findings from Eviews in the following table 9:[1]

Table 9

GARCH(1.1)	Student t	GED
$\hat{\alpha}$	0.138752	0.132239
$\hat{\beta}$	0.798698	0.792393
$\hat{\omega}$	0.092740	0.099364
Log Likelihood	-5010.711	-5024.850
Akaike info criteria	2.896484	2.904648
Schwartz info criteria	2.907137	2.904648
Jarque-Bera	1317.390	1277.437
	(0.000000)	(0.000000)

The first thing to pinpoint in this table is the sum of $\hat{\alpha}$ and $\hat{\beta}$, where if $\hat{\alpha}+\hat{\beta}<1$, it means that our results are stationary, while a value larger than 1 indicates that there's a unit root. In both student t and GED distribution our $\hat{\alpha}+\hat{\beta}$ is less than 1 (0.93745 and 0.924632 respectively), therefore our model is stationary and it does experience volatility shocks. On the other hand all our coefficients $\hat{\alpha}$, $\hat{\beta}$ and $\hat{\omega}$ are significant at all levels 1, 5 and 10%. We then test both models for serial correlation using the correlogram of standardized squared residuals, we find that

Q (30) test rejects the null hypothesis of serial correlation since P values are more than 5% at all lags. We then run the Jarque-bera test where we reject the normality of distribution since our data is negatively skewed, leptokurtic and our Jarque-Bera p-value is 0.00. And finally we run the ARCH LM test; we find absence of ARCH effects in both where prob chi square is 0.2508 for student t, and 0.2055 for GED. These tests indicate that GARCH model successfully solves for ARCH effect and effectively model the volatility.

In addition it's important to compare the three main criteria AIC (Akaike info criteria) and SIC (Schwartz info criteria) that are all smaller for student t than GED and the LogL (Log Likelihood) is larger in student t than GED. This indicates a better model following the student t in GARCH (1.1).

5.2.2. EGARCH (1.1) Estimation:

We run the EGARCH (1.1) model and report our findings from Eviews in in the following table 10:[2]

1. Tests results are in tables 1C-2C-3C-4C-5C-6C

2. Tests results are in tables 7C-8C-9C-10C-11C-12C

Table 10

EGARCH(1.1)	Student t	GED
$\hat{\alpha}$	0.265186	0.252702
$\hat{\beta}$	0.931929	0.927172
$\hat{\omega}$	-0.184449	-0.127929
$\hat{\delta}$	0.000411	-0.006530
Log Likelihood	-5009.290	-5024.083
Akaike info criteria	2.896242	2.904782
Schwartz info criteria	2.908670	2.917210
Jarque-Bera	1349.436	1286.455
	(0.000000)	(0.000000)

We first notice the asymmetry in our model where good news affects conditional volatility by $1 + \hat{\delta}$ = 1.000411 and bad news affect it by $|-1 + \hat{\delta}|$ = 0.999589 for t distribution. Whereas good news affects our conditional volatility by $1 + \hat{\delta}$ = 0.99347 and bad news affect it by $|-1 + \hat{\delta}|$ = 1.00653 for GED distribution.

We deduct that for the t student distribution the impact of good news is larger in magnitude than the impact of bad news. However in the GED distribution, bad news has a larger impact than that of good news.

We then notice that our coefficients are all significant at 1, 5 and 10% in both distributions except $\hat{\delta}$. We then test for serial correlation where we find presence of serial correlation at first lag only. In addition we find presence of ARCH effect using ARCH LM test in both distributions with a prob chi squared of 0.0457 for t, and 0.0267 for GED Both of our estimations reject the normality of distributions using Jarque-Bera test.

We then find similar results to GARCH (1.1), where AIK and SIC and Log likelihood are also in favor of student t, since they give us better values than GED.

5.2.3. GARCH-GJR Estimation:

We run the GARCH-GJR model and report our findings from Eviews in the following table 11:[1]

1. Tests results are in tables 13C-14C-15C-16C-17C-18C

Table 11

GARCH-GJR(1.1)	Student t	GED
$\hat{\alpha}$	0.138279	0.127590
$\hat{\beta}$	0.798586	0.790595
$\hat{\omega}$	0.092782	0.100273
$\hat{\delta}$	0.001168	0.012274
Log Likelihood	-5010.710	-5024.722
Akaike info criteria	2.897061	2.905152
Schwartz info criteria	2.909489	2.917580
Jarque-Bera	1316.287	1265.501
	(0.000000)	(0.000000)

We first calculate the asymmetry in our model. Where the impact of good news on conditional volatility is found by $\hat{\alpha} + \hat{\delta}$ = 0.936865 and bad news impact by $\hat{\alpha}$ = 0.138279 for student t. whereas the impact of good news is $\hat{\alpha} + \hat{\delta}$ = 0.918185 and bad news impact is $\hat{\alpha}$ = 0.127590 for GED. This indicates that good news in GARCH-GJR affect volatility more than bad news.

On the other hand, running the serial correlation test we find no serial correlation in our Q (30) test. In addition to the absence of ARCH effect with a prob chi squared of 0.2520 and 0.2173 respectively. And finally the results of Jarque-Bera test reject the normality in both estimations.

Moreover it's important to notice that our results for GARCH-GJR follows EGARCH and GARCH when comparing the models using AIC, SIC and Logl where student t yields better values than GED.

5.3. Model Comparison:

Comparing so far between the models and their distributions we find the following table 12:

Table 12

	GARCH		EGARCH		GARCH-GJR	
	Student t	GED	Student t	GED	Student t	GED
AIC	2.89648	2.90465	2.89624	2.904782	2.897061	2.905152
SIC	2.90714	2.9153	2.90867	2.91721	2.909489	2.91758
LogL	-5010.7	-5024.9	-5009.3	-5024.083	-5010.71	-5024.722

Looking at our results so far we find that first the Turkish REITs conditional volatility is more efficient when using student t distribution. Since first AIC and SIC are lower for student t in GARCH, EGARCH and GARCH-

GJR than GED. AIC and SIC are the negative log likelihood penalized for a number of parameters. It's a measure of a model's fitness where the lower the value the better the model. In addition student t also gives us the higher values for LogL where the higher the values the better fit the model is.

On the other hand, we find very close competition in GARCH models between GARCH-GJR, EGARCH and GARCH in the t student distribution therefore in order to pick the best model, we forecast each model over two years span. The reason why we picked two years is to avoid any overlapping problem and any sample effect. Due to the bulkiness of the forecasting data results, we only mention 2015-2017 time-lapse. We then compare our root mean squared error and mean absolute error values for our models. We summarize our findings in table 13:

Table 13

	Student t	GED	Student t	GED	Student t	GED
RMSE	0.8333	0.83416	0.832454	0.833027	0.833308	0.834258
MAE	0.587297	0.58785	0.586907	0.587414	0.587304	0.587947

Comparing the root mean squared error (RMSE) and mean absolute error (MAE) we first find the same result using SIC, AIC and LogL. Which is that student t provides better value for RMSE and MAE. Therefore we can come to a conclusion that Turkish REITs market experiences a student t distribution. Second we find that EGARCH following the t student distribution have the lowest values of 0.832454(RMSE) and 0.586907 (MAE). We compare the forecasted values over the scale of two years to the actual ones; we find that EGARCH following the student t yields the closest values to actual.

The results we found that our results are in line with Aksoy's and Ulusoy's (2015) findings that EGARCH is the best model at forecasting conditional volatility in the Turkish real estate investment trust stock market. Even though the model suffers from serial correlation and ARCH effect, its forecasting ability of our variable surpasses both GARCH and GARCH-GJR that don't suffer from any serial correlation or ARCH effect.

6. CONCLUSION

In this paper we estimated the conditional volatility of Turkish REITs return and we study its relationship with the overall market index. We therefore used three GARCH models that empirically are the best at estimating volatility which are GARCH, EGARCH and GARCH-GJR. We compare between these models over three steps. The first is through choosing which distribution better fits the Turkish REITs industry. We found that the student t gives us a higher

description of the distribution of fat tails and skewed leptokurtic data. The second step was comparing the three models using the Akaike info criteria, Schwartz info criteria and Log Likelihood criteria. Yet we find that their values are very close and indecisive. The third step was through estimating and forecasting each model. We find that EGARCH models hold the lowest value of root mean squared errors and mean absolute error values. Therefore it was our best model at estimating the conditional variance.

Yet the GARCH model had few drawbacks that are important to pinpoint. First the EGARCH model was suffering from serial correlation at the first few lags. Second the model failed at the ARCH LM test where we find presence of ARCH effect. GARCH and GARCH-GRJ on the other hand doesn't suffer from these drawbacks but still their forecasting ability is weaker than EGARCH.

In addition our results are in concordance with Aksoy's and Ulusoy's (2015) study on the Turkish real estate investment trust, where they found that EGARCH was efficient at modeling the conditional volatility of Turkish REITs and accounting for the calendar anomalies in weekly and daily data.

Potential future studies regarding Turkish REITs can be conducted by applying the GARCH family models for Turkish market. Additionally the aforementioned relationship can be investigated using the Kalman-Filter approach and Schwert-Seguin approach to forecast the conditional volatility. A comparison between these two approaches and the GARCH family is a great starting point since several studies prefers the Kalman-Filter approach over the GARCH family derivations.

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Understanding figures related to the number of foreign tourists in Romania: an approach for combining multiple data sources

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ABSTRACT

When looking at the figures related to the number of foreign tourists in Romania there is huge difference between the number of foreign citizens arriving in Romania and registered at the border, on the one hand, and the number of non-residents (tourists) arriving in accommodation establishments on the other hand. The former relates to the border registering as an administrative data source (provided by the Border Police) while the latter to the survey on the occupancy of accommodation establishments carried out by the National Institute of Statistics. According to the latest figures, the ratio of this difference is more than 4 to 1.

The purpose of this paper is to provide a better understanding of this difference and give some explanations on what is behind each of those statistics. In this regard, data series for the period 1991-2018 has been analysed individually for each of the 51 countries of citizenship for which data is available from both data sources. The Pearson correlation index will be used to highlight the correlation together with an average ratio of the values of indicators. Also, data coming from other sources are investigated such as mirror statistics from EU and non-EU countries but also other administrative data provided by different agencies.

It was revealed that although it is well known that traffic from neighbouring countries is largely responsible for this difference, this is not the main reason on why the figures are so different. Other reasons such as partial coverage given by accommodation establishments, transit traffic, different "non-tourism" travellers and local border traffic should also be envisaged. New data sources such as card transaction data of foreign travellers or mobile position data should also be considered in any future endeavours in this field.

Keywords: *number of foreign tourists, accommodation statistics, border traffic, Romania*
JEL classification: *Z30, L83*

1. INTRODUCTION

It is difficult to evaluate the precise number of foreign tourists in Romania in a certain period. There are some related indicators, but these fail to provide an accurate measurement of it. On the one hand, there is the number of foreign citizens registered at the border (data provided by the Border Police) which gives an important over-estimation since all flows of foreign travellers are recorded regardless the purpose of visit in Romania. On the other hand, we have the number of arrivals of non-residents staying in (authorized) accommodation establishments (data collected through a survey by INS – National Institute of Statistics) which provides an under-estimation of the phenomenon since foreigners can stay in different other forms of unpaid accommodation such as staying at friends and relatives or in own apartment/ vacation home or in any other type of unit that is not part of the official supply of accommodation establishments.

In this paper, from now on the data provided by the Border Police will be labelled as border statistics while data on arrivals of foreigners in accommodation statistics will be labelled as accommodation statistics.

At the same time, it is important to define the concept of tourist. United Nations (2010) recommends the term *visitor,* which is seen as a subset of traveller, and further classifies visitor as a *tourist* if his/her trip includes an overnight stay (overnight visitor) or as a *same-day visitor* (excursionist) otherwise. According to international standards, a visitor is defined as being "any traveller taking a trip to a main destination outside his/her usual environment, for less than one year, for any main purpose (business, leisure or other personal purposes) other than to be employed by a resident entity in the country or place visited" (United Nations, 2010, p. 10). Following this view, not all travellers are visitors/tourists/excursionists and we deal also with what might be called "non-tourism travellers" (registered at the border). Implicitly, on the other hand, and for practical reasons, all persons having at least one overnight stay in an accommodation establishment will be classified as tourists regardless of their purpose of trip.

It is important to mention that until 1998 border statistics in Romania had included also purpose of trip among the variables collected (Minciu, 2004). Therefore, starting with 1999, Romania could not rely anymore on border statistics when referring to the number of foreign tourists in our country. So,

only accommodation statistics have been used in reporting the tourism activity of foreigners. Up to 2001 accommodation statistics were carried out quarterly and starting 2002 monthly data are available (INCDT, 2005).

When comparing the figures between border statistics and accommodation statistics there is a significant difference, more precisely in a ratio more than 4 to 1 in the last years but, for the whole period when data are available (starting 1991), the average (and median) value of this ratio is more than 5. For instance, in 2018 there were 11.7 mil. arrivals of foreign citizens registered at the border but only 2.8 mil. arrivals of non-residents in accommodation establishments. There should be multiple reasons for this difference and more clarifications are needed. In this context, the aim of this paper is to provide a better understanding of the figures related to the number of foreign tourists in Romania and try to provide some explanations underpinning a comparison between border and accommodation statistics.

2. METHODOLOGY

Two variables will be considered together. On the one hand there is Pearson correlation coefficient and on the other hand, the average ratio between the number of foreign travellers registered at the border and the number of non-residents in accommodation establishments. Pearson coefficient (r) ranges between -1 and 1 where a value equal with 0 indicates a lack of correlation while a value close to ± 1 shows there is a strong correlation. If $r>0$ there is a direct correlation and if $r<0$ there is an inverse correlation (Anghelache et al, 2005).

At the same time, it is believed that the size of the difference between border and accommodation statistics provides an indication of "non-tourism" traffic ("non-tourism" travellers) since accommodation statistics are the golden data source in the statistical practice that provides the number of tourists (but, once again only those spending at least one night in a destination). Simultaneously, it is implicitly assumed that that the strongest correlation between two variables the higher will be the existence of a tourism flows dependent on the number of travellers registered at the border.

Data series for the period 1991-2018 were used and these were disaggregated for each country of citizenship of travellers/tourists (51 countries for which data are available from both border and accommodation statistics). However, data were not available for all countries starting with 1991 for both data sources due to some state changes in the early '90s. For instance, for Republic of Moldova, Russia, Ukraine, Slovenia, Czechia and Slovakia, data were data available for the period 1993-2018 or for the period 2005-2018 for Bosnia and Herzegovina, Croatia, North Macedonia, Malta,

Cyprus, Lithuania, Latvia, Estonia, India, Korea Republic, Egypt, South Africa, Australia, New Zeeland, and 2012-2019 for Montenegro.

In average, for the period investigated, these 51 countries account for 94% of all arrivals of non-residents in accommodation establishments and 92% of all arrivals of foreign citizens registered at the border. This proves a good coverage in our analysis.

In addition to the study of the relation between border and accommodation statistics other data sources such as mirror statistics will be investigated. Mirror statistics is a promising data source being promoted by the Statistical Office of the European Union Eurostat and typically used in trade statistics, population statistics and tourism statistics (Eurostat, 2020a). Practically, in tourism, mirror statistics refer to data provided by partner countries on their outbound tourism which is considered inbound tourism for the reference country (in our case Romania). Using mirror statistics in our case, the number of trips undertaken by residents of certain country to Romania (data provided by a partner country) will be equivalent the number of arrivals or non-residents coming from a certain country in Romania (data provided by Romanian data sources). Eurostat database will be used in mirror statistics analysis as well as data provided by statistical offices of our non-EU neighbouring countries Ukraine, Republic of Moldova and Serbia.

3. RESULTS

3.1. Border versus Accommodation statistics: is there a correlation?

It is important to see if one can speak about a correlation of data series: border vs. accommodation statistics. But this correlation analysis was completed with the average ratio for the period 1991-2018 between border and accommodation statistics for each country of citizenship of travellers (51 countries for which data are available).

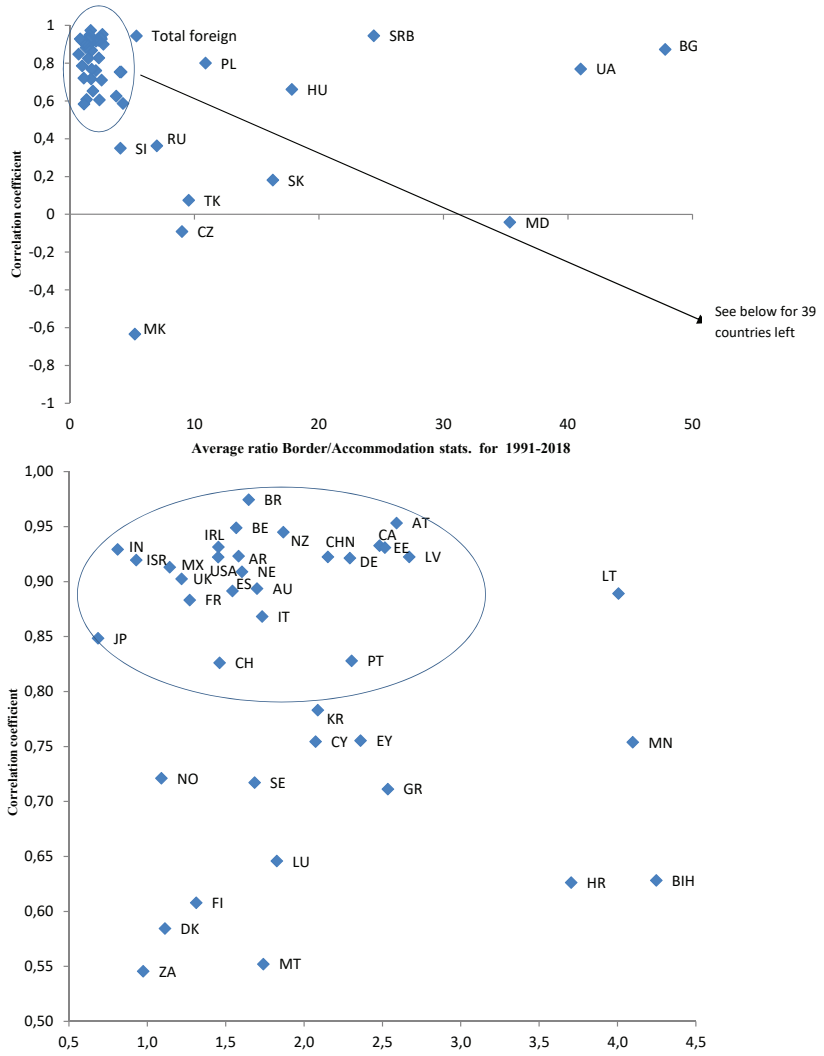
Among the fifty-one countries analysed, twelve of them present some distinctive features (see figure 1). It is important to note that these twelve countries account for 69% (annual average for the 1991-2018 period) of the total foreign citizens registered at the border. The rest of 39 countries posted a high correlation between border statistics and accommodation statistics and a ratio between border and accommodation statistics under the level registered for total foreign visitors (5.3). These twelve countries are Romania's neighbours (Bulgaria, Serbia, Hungary, Ukraine, and Republic of Moldavia), Turkey, Russia and the Central and Eastern European countries such as Poland, Czechia, Slovakia, Slovenia, and North Macedonia.

Although there is strong positive correlation between border statistics and accommodation statistics for countries such as Bulgaria, Ukraine Serbia,

there is a significant difference in absolute terms between number of foreign travellers registered at the border and number of non-residents registered in accommodation establishments. For instance, for Bulgaria this difference (ratio) is more than 47.0 for Ukraine it is 41.0 while for Serbia it is 24.4.

Border vs. Accommodation statistics by country of citizenship of foreign travellers

Figure 1



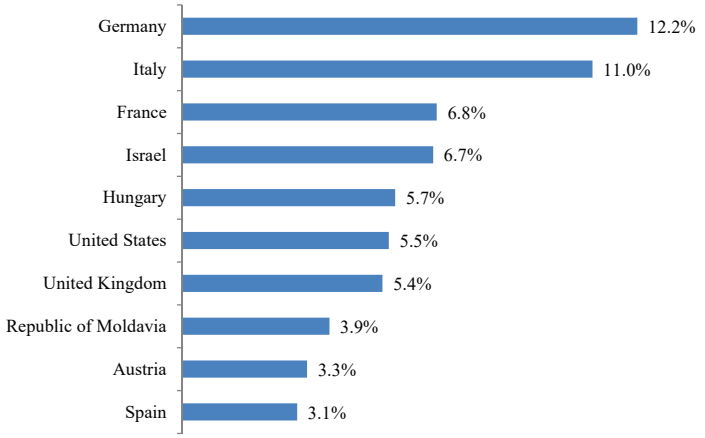
Source: own calculations based on National Institute of Statistics data

There are only 3 countries where the correlation is negative: Republic of Moldova, Czech Republic and North Macedonia. It is important to mention that for these countries the linear correlation is not significant according to t test. According to the rule of thumb one can define a very strong correlation a coefficient higher than 0.8 and a strong correlation for a coefficient higher than 0.6. Therefore for 41 out of 51 countries analysed there is a strong correlation between border and accommodation statistics. Moreover, one can speak about a very strong correlation for a number of 26 countries (a little more than a half of countries studied).

Among countries with a very strong correlation between border and accommodation statistics (marked inside the circle in the figure above) there are the core countries representing most of the main inbound tourism generating markets for Romania (calculated from accommodation statistics): Germany, Israel, Italy, France, United States, United Kingdom and Spain; these 7 countries cumulated together more than a half of total arrivals of non-residents in accommodation establishments (see figure 2).

Top 10 source countries for Romania according to accommodation statistics (based on average market share of arrivals for the period 1991-2018)

Figure 2



Source: own calculations based on National Institute of Statistics data

3.2. Romania as a possible transit country for the citizens of the neighbouring countries

The territory of our country can be transited by foreign citizens residing in the neighbouring countries: Hungary, Serbia, Bulgaria, Ukraine

and Republic of Moldova. Some clues of this situation might be given by analysing the arrivals of these citizens at the Romanian borders, other than their country of citizenship's border. Thus, as regards these foreign travellers (foreign citizens) transiting Romania, the following reasonable assumptions (denoting "non-tourism" traffic) can be made for the following situations:

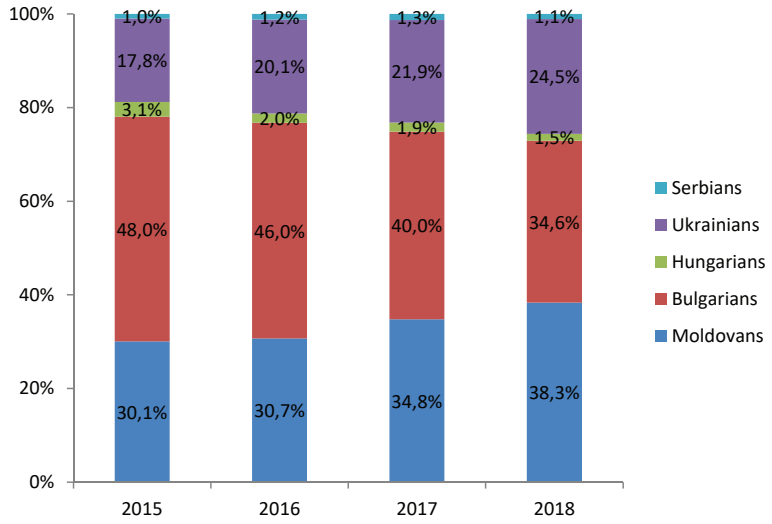
- Bulgarian *in transit* travellers entering Romania by Hungarian, Ukrainian and Moldovan borders
- Moldovan *in transit* travellers entering Romania by Hungarian, Bulgarian and Serbian borders
- Hungarian *in transit* travellers entering Romania by Bulgarian and Moldovan borders
- Ukrainian *in transit* travellers entering Romania by Bulgarian and Serbian borders
- Serbian *in transit* travellers entering Romania by Ukrainian and Moldovan borders

In applying these assumptions, the rule of certain neighbour country not having a border with another neighbour country was believed to be close to a real situation. According to this rule, for instance Serbian citizens will not use Romania as a transit country when returning from to Hungary as there is a border between Serbia and Hungary (so, we will not consider arrivals of Serbian citizens at Romanian-Hungarian border); from the same token will not be considered arrivals of Serbians at the Romanian-Bulgarian border as there is a border between Serbia and Bulgaria. One should note that this assumption was not applied for air borders, as Romania is not a major transit hub of airlines. Not applicable was also for sea border.

In our analysis detailed data from the institution in charge with these statistics (i.e. Border Police) were used (these data were received upon official request). More precisely, for each border crossing points, data on arrivals of travellers by citizenships were aggregated. In absolute values, for the period 2015-2018 it was calculated that the number of these possible transit travellers ranged between 1.12 to 1.37 mil. and this represents 11-12% from the total foreign arrivals of travellers registered at the border. According to the last figures available in 1998 transit as purpose of visit accounted for 26.7% of total foreign citizens arrivals (Minciu, 2004). Even if the comparison with this benchmark figure seems rather outdated, transit remains an important component of the total inbound flows of travellers in Romania. The distribution of *in transit* travellers from neighbouring countries is presented below:

Distribution of *in transit* travellers from neighbouring countries by citizenships, 2015-2018

Figure 3



Source: own estimations based on Border Police data

One can see that there is an increasing share of citizens from Republic of Moldova that are transiting Romania from 30.1% in 2015 to 38.3% in 2018. At the same time, there is a decreasing share of Bulgarian citizens from 48% to 34.6% which might be due to improving road connections between Bulgaria and Serbia (some segments of Sofia - Niss highway been opened in this period). Also, an increasing share of Ukrainian transit visitors was noted which is geographically explained by the fact that Romania is a transit destination for Ukrainians spending holidays to Bulgaria, Greece and Turkey. In this regard, according to the State Statistic Service of Ukraine Ukrstat in 2017 a number of 58,597 of Ukrainian citizens travelled abroad in Bulgaria, 104,774 in Greece and 1.185.051 in Turkey and it is assumed that if travelled by road, Romania might have been the transit country for Ukrainians going to these outbound destinations.

Meanwhile Hungarian and Serbian transit visitors remain at a modest share denoting the fact that our country is used only in a minor way as a transit destination among citizens of these two countries. In fact, one can see that there no major outbound flows of Serbian citizens to Ukraine (i.e. according to Ukrstat (2020) in 2017 only 36,542 of Serbian citizens visited Ukraine).

Though, in-transit travellers are not restricted only to neighbouring countries. Theoretically such type of travellers might come from other

countries located in the proximity of Romania. The following countries might be included: Poland, Russia, Turkey, Slovakia, Czechia, Slovenia and North Macedonia (based on data from figure 1). For all these seven countries, there is not a strong correlation between border statistics and accommodation data which might denote the fact that there are "non-tourism" travel flows. Some assumptions (denoting "non-tourism" traffic) might be made as it follows:

- Turkish *in transit* travellers entering Romania by Hungarian, Ukrainian and Moldovan borders
- Polish *in transit* travellers entering Romania by Moldovan, Bulgarian and Serbian borders
- Russian *in transit* travellers entering Romania by Hungarian, Serbian and Bulgarian borders
- Slovak *in transit* travellers entering Romania by Bulgarian, Serbian and Moldovan borders
- Czech *in transit* travellers entering Romania by Bulgarian, Serbian and Moldovan borders
- Slovenian *in transit* travellers entering Romania by Ukrainian, Bulgarian and Moldovan borders
- Macedonian *in transit* travellers entering Romania by Ukrainian, Hungarian and Moldovan borders

These assumptions are in relation with the direct connecting routes to reach Romania from each of the country above (for instance in case of Slovak visitors there is a higher likelihood to enter Romania by Hungarian and Ukrainian border while entering in Romania by Bulgarian, Serbian and Moldovan border it is assumed to show a "non-tourism" traffic). It was estimated that by adding these 7 countries, the total possible transit traffic reached to 15% in 2015, 14.2% in 2016, 13.4% in 2017 and 13.8% in 2018 from the total number of foreign citizens' arrivals at frontiers. In absolute values *in transit* visitors were estimated at 1.6 mil. in 2018 increasingly from 1.4 mil. in 2015.

3.3. Mirror statistics

In the Eurostat database there are not too many EU countries that posted data regarding the number of trips (of one night and over) having Romania as a main destination. For instance, in the last years, most of the EU countries labelled these data as being confidential or not available. However, only 10 EU countries posted these data and, excepting two countries (Belgium and Spain), all these are labelled as being with low reliability. Moreover, one can see a significant difference (expressed in percentage) between mirror statistics and border registering in case of Luxembourg (617%), Spain (217%), Italy

(180%) and Belgium (162%) denoting an overestimation of trips to Romania. At the opposite, at the same time, the difference is quite small for countries such as Bulgaria (2%) and Greece (18%) denoting an undervaluation of trips to Romania from these countries (see table 1). This is due to the characteristics of data from origin countries which are derived from a demand-side sample survey (not exhaustive) which might imply some difficulties in terms of representativeness of capturing number of trips to Romania.

Number of foreign tourists/travellers in Romania in 2018: Comparing mirror statistics with border registering

Table1

Country of origin	Mirror statistics (1)	Border registering in Romania (2)	Difference (%) (1)/(2)
EU countries			
Belgium	114,892	71,133	162%
Bulgaria	34,672	1,600,224	2%
Greece	18,095	100,654	18%
Spain	279,452	128,723	217%
France	127,479	230,901	55%
Italy	842,553	468,409	180%
Luxembourg	13,690	2,218	617%
Hungary	745,655	1,491,351	50%
Netherlands	68,406	96,537	71%
Austria	110,950	148,110	75%
Non-EU countries			
Ukraine (2017)	1,045,424*	1,219,871	85.7%
Republic of Moldova	31,299**	2,330,440	1.3%
Serbia	4,105***	543,115	0.8%

Source: INS (2019), Eurostat (2020a), Ukrstat (2020), National Bureau of Statistics of the Republic of Moldova (2020), Statistical Office of Republic of Serbia (2020)

Note: for EU countries mirror statistics refer to the indicator *number of trips (with at least on overnight stay)* having Romania as a main country of destination

* <Excluding services personnel of vehicles and military>

** called <*number of departures of Moldovan visitors abroad* (having Romania as destination)> referring to those who benefit from the services of travel agencies and tour operators

*** it refers to the number of Serbian tourists having trips arranged by domestic tourist agencies with Romania as a country of destination

A special case is Hungary where the difference between two data sources is 50% but this might be influenced by the number of day visitors (tourists without overnight stays) which are not captured by the data presented. It should be reminded that the data from mirror statistics for EU countries refers only to number of trips with at least one overnight stays (which for the neighbouring countries is not entirely the case). No comparability is seen in case of Serbia and Republic of Moldova since in both cases the figures are only limited to travel arranged through the intermediation of travel agencies.

3.4. The case of same-day trips

Same-day trips are trips without overnight stays, in our case referring to foreign citizens undertaking these trips on the territory of Romania. Therefore, such trips are not recorded in the accommodation statistics and this might represent one of the reasons for the significant difference between border and accommodation statistics.

Therefore, excepting the transit case, the foreign day-visitor will return in the same day in its country of residence. Considering the geographical location of the territory of Romania, only day-visitors from the five neighbouring countries can be considered.

For total foreign day-visitors, data from National Institute of Statistics (INS) have been used. Moreover, if detailed data by country is sought to be illustrated, then Eurostat data will be used for the EU member countries Hungary and Bulgaria. It is important to mention that only EU countries have such data as there is specific recommendation from Eurostat to collect such data (i.e. Regulation 692/2011 concerning European statistics on tourism).

Number of foreign day-visitors (excursionists) in Romania, 2014-2018

Table 2

	2014	2015	2016	2017	2018
Total day-visitors*, *coming from*	**888,859**	**970,665**	**1,098,936**	**1,338,681**	**...**
Hungary**	529,167***	(1,133,170)	…	739,307***	781,053
Bulgaria**	13,004***	24,540***	***	***	…
Republic of Moldova	***	***	***	***	…
Ukraine	…	…	…	…	…
Serbia	…	…	…	…	…

* Source: INS, *Tourism Satellite Account* (*ro. Contul Satelit în Turism)*, 2014-2017

** Source: Eurostat (2020b)

*** in the data source (i.e. INS publications on Tourism Satellite Account) it is explicitly mentioned that mirror data from that specific country referring to day visitors to Romania were used.

... - lack of data

From these data one can see that data are rather scarce and it is hard to evaluate the number of these day visitors for the entire Romania considering the fact that there are no similar statistics from non-EU members (Serbia, Ukraine, Republic of Moldova). However, from the available data until now, one can see that most of the day visitors are coming from Hungary. Nevertheless, a discrepancy appears in 2015 for Hungarian visitors whose number (reported by Hungarian statistical office) is higher than the total similar figures estimated for Romania. On the opposite site, the figure for Bulgaria seems quite very low. In both cases it must be kept in mind that data (from partner countries) are derived

from a sample survey and this is dependent by the number of cases captured. If there are not many cases covered, accuracy of data is rather problematic. Nevertheless, overall, for 2017 one can calculate the share of excursionists in total foreign citizens arriving at the border (12.7 mil.) which is 10.5%.

3.5. Local border traffic (ro. micul trafic de frontieră) as an important component in border statistics

According to the agreements concluded by Romania and its neighbouring countries, border zone residents may cross the frontier based on local border traffic permit and a valid passport. Usually, this zone is defined as localities situated in buffer zone of 30 km away from the border. In principle, the residents of these localities can undertake a lot of border crossings and these travellers are included in the Romania's border statistics. This is in line with the EU regulations in the field of local border traffic at external land borders officialised in the EC Regulation 1931/2016.

At present, statistics in the field of local border traffic are rather inexistent. However, some estimates on the total eligible population for obtaining local border permits were found in relation with Republic of Moldova and Ukraine, 1.2 million respectively 2 million (European Commission, 2011; Trocan, 2017); this gives just a general idea of the amount of a possible local border traffic coming from the northern and the eastern border of Romania, assuming that half of these numbers are citizens from the two neighbouring countries.

3.6. Other "non-tourism" travellers

Apart from categories mentioned above, there are some types of travellers which cannot be considered tourists according to international standards: the most relevant ones[1] for our case are crew on public modes of transport and long-term students and patients and their family joining them; to these, one can add foreigners/non-residents arriving (in Romania) in order to be employed by a resident entity either for short term or long term (United Nations, 2010).

Up to 1998 Romania had statistics on crew on public modes of transport and this segment had quite an important share in total foreign arrivals at the border: for instance, it was 11.6% in 1998 (Minciu, 2004). Regarding foreign students one can mentioned 36,784 foreign students registered in all cycles of studies (bachelor, master and doctoral degree) in 2017 (UEFISCDI,

1. International standards (United Nations, 2010) mention other types of travellers which are not included in tourism statistics, but these are excluded already from the data provided by Border Police according to INS (2019): *immigrants and emigrants, diplomats, consular representatives and members of army forces when they are travelling to the place of their mission in another country, refugees and nomads* (p. 29).

2018). According to IGI - General Inspectorate for Immigration (2018) a number of 10,521 work permits has been issued in 2018 (it should be noted that since Romania is an EU country since 2007, citizens from EEA countries do not need such permits). Nevertheless, one can appreciate that in both cases (foreign students and non-EU foreign workers) the figures have only a very minor influence on the number of foreign citizens registered at the border (assumed to be roughly below 1%).

4. CONCLUSIONS

This paper aimed to provide some insights on the figures referring to number of foreign tourists in Romania. In this endeavour multiple data sources have been used: border registering of foreign citizens performed by the Border Police, survey on the occupancy of accommodation establishments carried out by the National Institute of Statistics (INS) but also mirror statistics (provided by partner countries and/or Eurostat). Also, to a minor extent, some figures coming from different administrative data sources from Romanian authorities (UEFISCDI, IGI - General Inspectorate for Immigration) have been mentioned. However, it has been proved that, for the time being, mirror statistics are of little use mainly due to the lack of data available, differences in concepts and the not the least, the nature of different methodologies employed.

The limits of border statistics are well acknowledged. For instance, in the Romania's National Tourism Development Master plan 2007-2026 it is stated that "The statistics on foreign arrivals were historically of limited value as they, for instance, did not permit a distinction between day visitors and tourists staying at least one night" (World Tourism Organization, 2007, p. 24). Meanwhile, there are also evident limitations of accommodation statistics as long as "those staying with friends and relatives in private rented or privately owned houses and flats are not included" (Terpstra and Eriksson, p. 113). At present there are no data for these segments and thus no estimations can be produced yet for Romania.

Moreover, another limitation is given by the possibility for a foreign tourist (counted once at the border) to be accommodated in more than one accommodation establishment (in case of itinerary trips) and thus be registered several times as a new arrival (Frenț, 2009). At the same time, this situation of double counting can occur in border statistics as well, for instance in the case of Danube river cruise (it must be mentioned that after entering to Romania, Danube has a route of over 1,000 km long, out of which over 750 km are forming the border with Serbia, Bulgaria and Ukraine). Therefore, a river cruise visitor whose ship moors in several ports on the Danube border will be registered in each port where the visitor will undertake a land excursion. So,

virtually, we will deal with a double counting of the same person. Fortunately, such cases cannot influence greatly the total figures since arrivals by water as a mean of transports account only for 1.3-1.6% from total foreigners arrivals registered at the border in the period 2015-2018.

In comparing figures from border with accommodation statistics, this paper has proved that there are some real explanations on the differences occurred: Romania as a possible transit destination and the evidence of a "non-tourism" traffic, the existence of excursionists (day-visitors) and of "non-tourism" travellers, local border traffic, and not the least, the limited coverage of accommodation statistics. Regarding the latter, even if it envisaged only domestic tourism, one should mention a study conducted in Italy by Guizzardi and Bernini (2012) that indicated an underreporting of the data provided by accommodation statistics in average, of 16%, for the period 2007-2009. Underreporting coming from accommodation statistics is also due to methodological issues, the fact that in Romania these statistics cover only establishments having at least 10 bed-places. Just to have an idea, according to the data from the Ministry of Tourism regarding the list of authorized accommodation establishments, in October 2019 there were 1,694 units having less than 10 bed-places representing 11.4% from the total number of authorized accommodation establishments in Romania (INCDT, 2019, p. 163).

Considering 2017 as the reference year, *grosso-modo* it has been estimated that almost one quarter of the flows of foreign citizens registered at the border can be attributed together to day-visitors and to *in transit* travellers (both not having an overnight stay in Romania). However, the lack of data regarding local border traffic and lack of data regarding number of non-residents staying in accommodation establishments not covered by INS survey (i.e. staying at friends and relatives or in its own house/apartment) makes impossible to perform any further estimates in this field.

More research is needed to capture "traces" of foreign visitors in Romania and in this regard new data sources must be further investigated. For instance, these might refer to card transaction data or mobile position data. Combining these data sources with the traditional data sources such as accommodation statistics, administrative data sources or even newly created surveys designed for foreign tourists would reveal new insights of the phenomenon in the future.

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