Exploring the Reliability of Research Indicators Reported by Romanian Universities in 2019

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Abstract: The paper focuses on the aggregate data published by the National Council for Higher Education Financing regarding the research section of the quality indicators reported by Romanian public universities in 2019 and used for the allocation of the performance-based additional funding. The research section includes 4 indicators, which amount to 46% of the additional funding, i.e. to an average of about 10% of the total institutional funding from the public budget. The data are reported by the Romanian universities each odd year since 2015, and for the first time in 2020 national rankings for most indicators and some national averages have been made public.

The data is extremely valuable for a diagnosis of the Romanian higher education system and for highlighting the performance of various universities. Therefore, the accuracy of these data is crucial. The authors of this paper acknowledge the efforts of the National Council for Higher Education Financing and of its staff provided by the Executive Unit for Financing Higher Education, Research, Development and Innovation to check the data reported by the universities, but also the limits of the current verification process. The paper uses statistical methods to identify outliers and investigates the rankings for a selection of fields of science, by using three among the four research indicators. Thus, it discusses some of the more blatant reporting anomalies which contradict the pre-existing conceptions regarding the comparative performance of universities. While the statistical findings do not support the suspicions of systematic attempts of over-reporting the research outcomes at university-level, they still outline several persisting errors. These

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errors highlight the need to strengthen the verification process, which will require additional resources; the authors suggest that enhanced transparency and organised cross-verification among universities can significantly improve the outcome, and help providing a significant set of reliable public data on the research performance of the Romanian universities.
Key words: research indicators, reliability, fields of science, H-index, CNATDCU standards.

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1. Introduction

Quality education is the fourth of the Sustainable Development Goals agreed by the world leaders in 2015 and it focuses on ensuring inclusive and equitable quality education and promoting lifelong learning opportunities for all. Specific targets stipulate to ensure equal access for all women and men to affordable higher education and to expand globally the scholarships for enrolment in higher education (*UN 2015 A/RES/70/1*, 2015).

At EU level, higher education is recognized as an essential premise to drive forward and maintain the sustainable growth and one of the targets set by Europe 2020 strategy was to increase to at least 40% the share of the younger generation (aged 30 – 34 years) having a tertiary degree (*Europe 2020: A strategy for smart, sustainable and inclusive growth,* 2020). This target has been met at EU level, but achieving inclusive, high-quality education continued to be recognized as a horizontal enabler for sustainable development and a priority for investment (*Reflection Paper*, 2019).

In this context, aspects like the performance of the universities, mechanisms for quality assurance and linking the financing to quality and performance are high priorities for all the countries. A project focused on funding efficiency in higher education systems across European Union found that performance-based funding was perceived differently in various higher education systems, despite the majority of them considering their basic funding allocation mechanisms to be at least partially performance-based for both teaching and research (Pruvot et al., 2015). Another report commissioned by the Dutch Ministry of Education, for the analysis of the higher education in fourteen countries or regions (among which six from European Union), underlines the heterogeneity of the national systems, the difficulty to quantify the performance-based funding from the total government budget for higher education, but also the fact that all the countries

follow different research indicators in their performance-based funding (de Boer et al., 2015). Number of students, including those from underrepresented groups, number of PhDs, research productivity and revenues from knowledge transfer seemed to be used most often by these countries, meanwhile internationalization, quality based on student surveys, employability and research quality occur less frequently (de Boer et al., 2015).

Romania uses as well a system of quality indicators for higher education. The Education Law 1/2011 stipulated that the financing of this field should include three components: core funding (based on the number of students, multiplied by various coefficients, linked to the field of study, level of study program, language etc.), additional funding and institutional development funding. The additional funding should be at least 30% of the core funding, and should be based on the criteria and quality standards established by the National Council for Higher Education Financing (CNFIS) and approved by the Ministry of Education (ME). In 2012-2015 the additional funding was based mainly on the results of the study program hierarchisation undertaken by ME in 2011. Several universities challenged the whole approach, and secured support from ME. In 2013, following to the ME request, the CNFIS started to set up a new combination of indicators, which were supposed to provide transparency, differentiation, and stability to the Romanian higher education system.

The process of defining and calibrating indicators included negotiations with various stakeholders (the National Council of Rectors, the representative national student associations etc.) and ended in 2015 with the selection of a limited set of 15 quality indicators, grouped in 4 categories: teaching and learning (4 indicators), research (4 indicators), international orientation (2 indicators) and regional orientation and social equity (5 indicators) (*Order no. 3185*, 2015). The systematic collection of data started in 2015, and the new scheme for additional was gradually implemented starting with 2016.

The four research indicators are especially important both because of their cumulated weight in financing (they initially represented 40% of the additional funding, and this share has been increased to 46% in 2020 and to 48% in 2021), and because of their relevance to the comparative prestige of various universities and departments. These research indicators and their legal definition are described further on:

a) IC2.1 Quality of human resources - calculated for each science field as an average of the National Council for Attesting Titles, Diplomas and Certificates (CNATDCU) scores obtained by the teaching and research staff of the university. The CNATDCU score is calculated only for the teaching and research staff who have the didactic position of professor and associate professor or its equivalent; it is determined as a ratio between the score reported for them by the university and the minimum score set up by CNATDCU for the field, where the faculty members hold the respective title.

b) IC2.2 Impact of scientific activity/artistic creation/sports performance - calculated as an average of the Hirsch scores obtained by all teaching and research staff of the university. For natural sciences, bio-medical sciences and engineering IC2.2 includes the Hirsch scores in 3 databases (Web of Science, Scopus and Google Scholar), while in the social sciences and humanities only Google Scholar is considered. In order to mitigate the distortions caused by the non-homogeneous distributions of the values from the arithmetic average of the Hirsch score, this score is raised to the power 3/2.

c) IC2.3 Performance of scientific activity/artistic creation/sports performance – calculated for each science field as an average of the final scores obtained in the last four years, through the publication of papers/works in reviews or volumes indexed ISI, ERIH+, ISI Proceedings, IEEE Proceedings or ISI Emerging, as well as through obtaining patents by the teaching and research staff of the university. The scores granted for each publication

are different according to the category to which the journal where the paper was published belongs.

d) IC2.4 Funds for scientific research / artistic creation / sports performance - calculated at university level, as an average of the valid data of the last four calendar years, for the ratio between the amount of funds from research / artistic creation projects (including those financed from the university's own budget) and the total number of teaching and research staff.

For the first three indicators, data is collected at the level of fields of science (RS)[1], while for the last indicator data is aggregated at university level.

The general philosophy of the CNFIS (chaired in 2011-2015 by professor Adrian Miroiu, as president) in designing these indicators was to measure different aspects of research activity by using only a small number of field-relevant, simple and easy-to-check indicators. Another important aspect was to ensure that the indicators are stable and fair. For instance, although the president Adrian Miroiu had personally published on the relevance of the g-index for measuring academic performance (Vîiu et al., 2012; Vîiu & Miroiu, 2015; Miroiu, 2013; Miroiu et al., 2015), the Hirsch-index was finally chosen as measure of the impact of publications (IC2.2). At the same time, in order to take into account different components of academic performance, the council cared to define indicators with a certain degree of complementarity one to another. For example, IC2.1 (Quality of the human resource) and IC2.2 (Impact of scientific activity) measure life-long achievement of faculty members, while IC2.3 (Performance of scientific activity) and IC2.4 (Research funding) measure only the scientific output and the share of research funding during the last 4 years. While IC2.2 and IC2.3 are closely linked to modern scientometry,

[1]The Romanian regulations recognize for higher education 39 fields of science (RS); as some of these RS include several academic fields (there were a number of 77 academic fields in 2019).

and therefore differently accepted by the prevailing academic traditions in various fields of study[2], IC2.1 starts from the existing standards defined by CNATDCU, which reflect more closely the variety of professional criteria established in different academic fields.

In our study we aimed to analyse research indicators reported by the state-funded public universities in Romania in 2019 for selected RSs and to identify the atypical situations when universities reported unusually high values in comparison with the ensemble of all the other universities.

2. Data and Methodology

In this paper, we undertook an exploratory analysis on the aggregate data reported by CNFIS regarding the research section of the quality indicators reported by Romanian public universities in 2019 and published in 2020. We used the following data sources: i) Indicators of quality per universities and fields of science, 2020 (CNFIS 2020-1); ii) Statistical values for IC2.1, IC2.2 and IC2.3 (January 1st, 2019) (CNFIS 2020-2) and iii) Median values for H-indexes (per CNATDCU academic fields and academic positions) (January 1st, 2019) (CNFIS 2020-3).

We included in this analysis the first three quality indicators (IC2.1, IC2.2 and IC2.3) which weighted 14%, 12% and respectively 14% of the performance-based funding, i.e. about 10% of the total institutional funding from the public budget.

We have analysed data reported by all universities for each of the three research indicators in five RS: Mathematics, Economic sciences (without Cybernetics, Statistics and Business Information Systems and

[2]As an element of flexibility, the Council included alternative criteria and standards for impact and performance in arts and sports.

the programmes Agro-food economics and Agro-food and environmental economics), History, Veterinary Medicine and Medicine.

The choice of these RS was conducted both in terms of the competence area of the authors and in terms of the variation degree recorded among universities, by RS, for data registered for the same performance indicator.

The statistical methods applied in the exploratory analysis were graphical descriptive and numerical methods.

The identification of the RSs which recorded the highest variations among universities in terms of the values reported per each research indicators was performed by calculating the variation coefficients, as a ratio between the standard deviation and the mean of the corresponding indicator.

For each RS and for each of the three quality indicators analysed, the identification of the universities that reported different values in comparison with all the other academic institutions was undertaken by means of the graphical representation of the boxplot diagrams.

These diagrams allow both the identification of atypical cases of universities and the comparative analysis among the research indicators for the same RS. In order to create boxplots, we used the median as the center of the box and Q1-IQR and Q3+IQR as the extreme limits of the whiskers, where Q1 and Q3 are the 1st and the 3rd quartiles respectively, while IQR represents the interquartile range. We analysed the RS individually (as they belong to different fundamental areas), except for *Veterinary medicine* and *Medicine*, which are both included in the fundamental area *Biological and Biomedical sciences*.

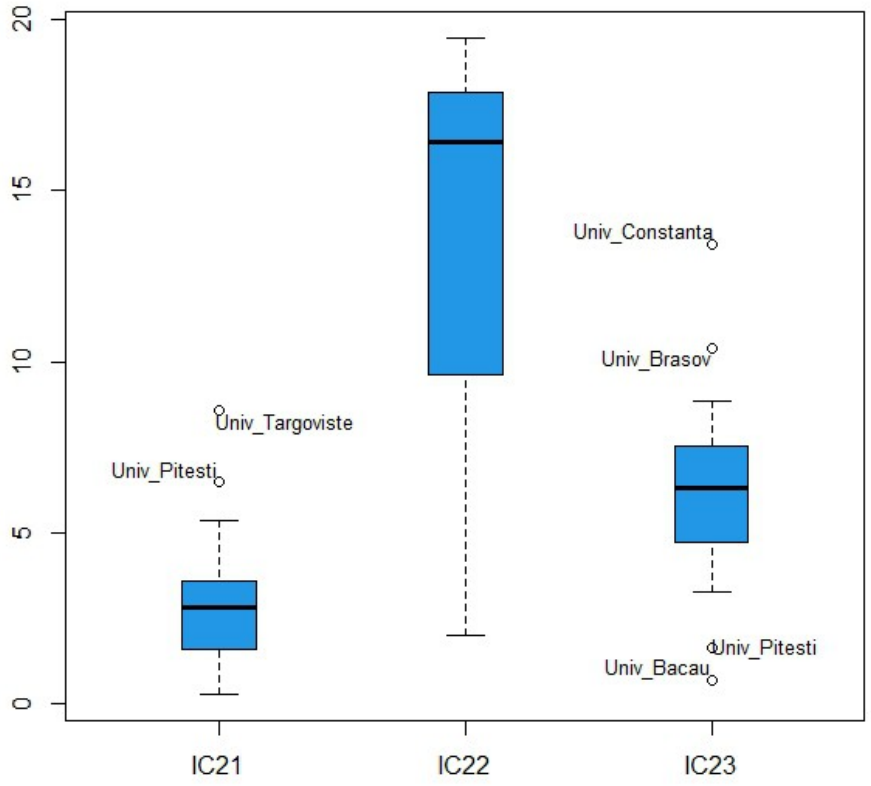
Also, we focused on the positive outliers that came up in all science fields and we calculated the ratio of RS with positive outliers over total RS reported per university.

3. Exploratory Analysis of the Research Indicators Reported by Universities

3.1. Exploratory analysis of research indicators for the RS MATHEMATICS

The RS *Mathematics* is quite well represented in the Romanian higher education system. On the one hand, note that 15 from 47 public universities reported data related to the research indicator for the field of Mathematics. On the other hand, looking at the other indicators published by CNFIS, we see a different number of universities that reported data for the Mathematics field. Indeed, when considering the 4 indicators for teaching and learning denoted by IC1.1, IC1.2, IC1.3, IC1.4 (cf. CNFIS 2020-1), we see that the number of universities that reported data for Mathematics is different than 15: there are 19 universities for IC1.1, 20 for IC1.2, 21 for IC1.3 and 17 for IC1.4. We suspect that these differences are due to some reporting errors: for instance, certain members of the academic staff report teaching data for Mathematics and research data for other fields; or certain members of the academic staff report teaching data for Mathematics but they do not do research anymore and, instead of having a 0 for research, we have an empty cell, etc. Nonetheless, we are aware that these differences could be due to other factors. To summarize, we suspect that, in fact, the total number of universities that (should) report for research in Mathematics field is greater than the one provided by CNFIS data and also considered in this study, that is 15. *Figure 1* provides the graphical representation of the box-plot diagrams for the three quality indicators.

Figure 1. *The values of the scientific research indicators for the RS Mathematics*



As it can be noticed, for the indicators IC2.1 and IC2.3, the data for several institutions are outside the main range of data.

For the indicator IC2.1, we can remark the surprising values of 8.56 and 6.48 reported by "Valahia" University of Târgoviște and the University of Pitești respectively; meanwhile the IC2.1 median value of this indicator for all 15 universities is only 2.79.

The traditional universities from Bucharest, Cluj, Iași and Timișoara are quite on top of the IC2.1 ranking, but at an important distance compared to the first two "champions". So, West University of

Timişoara has an average IC2.1 indicator of 5.33 (ranked 3 for IC2.1), "Alexandru Ioan Cuza" University of Iaşi has an average of 3.87 (ranked 4 for IC2.1), the University of Bucharest' IC2.1 score is 3.31 (ranked 5 for IC2.1), while "Babeş-Bolyai" University of Cluj-Napoca has an average 2.79 (ranked 8 for IC2.1).

Taking a look now to the IC2.3 indicator, several remarks can be made.

First, notice that "Ovidius" University of Constanţa and "Transilvania" University of Braşov have the highest IC2.3 indicators, outside the main range, with values of 13.44 and 10.41 respectively. This fact is quite surprising, when looking at the median of this indicator that is 6.29 and also at the average IC2.3 scores of traditional universities: 8.31 for "Alexandru Ioan Cuza" University of Iaşi (ranked 4 for IC2.3), 6.79 for "Babeş-Bolyai" University of Cluj-Napoca (ranked 5 for IC2.3), 6.29 for the University of Bucharest (ranked 8 for IC2.3), 4.63 for West University of Timişoara (rank 12 for IC2.3).

Second, notice that two institutions have the smallest IC2.3 indicators, outside the general range; these are the University of Piteşti with a 1.61 average IC2.3 and the "Vasile Alecsandri" University of Bacău, with a 0.68 average IC2.3. For the University of Piteşti, this score for the indicator IC2.3 (related to the number of publications) is extremely surprising when comparing it with the score of 6.48 for the IC2.1 indicator (related to the CNATDCU score).

Moreover, having a low IC2.3 score and a high IC2.1 score is surprising for the field Mathematics, since the CNATDCU standards revised in 2016 (considered for IC2.1) are more restrictive than the IC2.3 publication score. Indeed, on the one hand, the CNATDCU standards for the Mathematics field include only publications that have AIS (Article Influence Score); the AIS score is normed, obtaining thus the so called SRI (relative score of influence). CNATDCU considers for evaluation only articles published in journals with SRI score ≥ 0.5. On the other hand, the IC2.3 score is composed of several types of publications, not necessarily having an AIS score.

Concerning the indicator IC2.2 which reflects the three Hirsch indexes, first of all notice that we have an important variability and asymmetry; second, it is worth mentioning that most of the institutions that have the first positions for the other indicators are also well-ranked here. Thus "Transilvania" University of Braşov is ranked 2/15, "Alexandru Ioan Cuza" University of Iaşi is ranked 3/15, etc.

A surprising case is the University of Piteşti that is the last one in the IC2.2 ranking, while ranked in the 2nd position for the IC2.1 indicator, as we have previously mentioned. Another surprising case is the one of the "Ovidius" University of Constanţa, ranked 10/15 with respect to the IC2.2 indicator, but ranked on the 1st position, further above all the others, for the IC2.3 indicator related to the total number of publications.

3.2. Exploratory analysis of the research indicators for the RS ECONOMIC SCIENCES[3]

The RS *Economic sciences* (without Cybernetics, Statistics and Business Information Systems and the programmes Agro-food economics and Agro-food and environmental economics) includes 7 academic fields (Business administration, Accounting, Economics, Finance, Management, Marketing, Economics and International Business), affiliated to the Economic sciences and business administration CNATDCU committee.

This RS has a significant weight in the Romanian higher education both from the point of view of the high number of academic study fields and of the high number of public universities running programs in economic sciences. Within this RS, 25 from 47 public universities reported data regarding all research indicators.

[3]Economic sciences are considered without Cybernetics, Statistics and Business Information Systems and the programmes Agro-food economics and Agro-food and environmental economics

For the RS *Economic sciences*, the boxplot diagrams for the three quality indicators regarding the scientific research activity are shown in *Figure 2*.

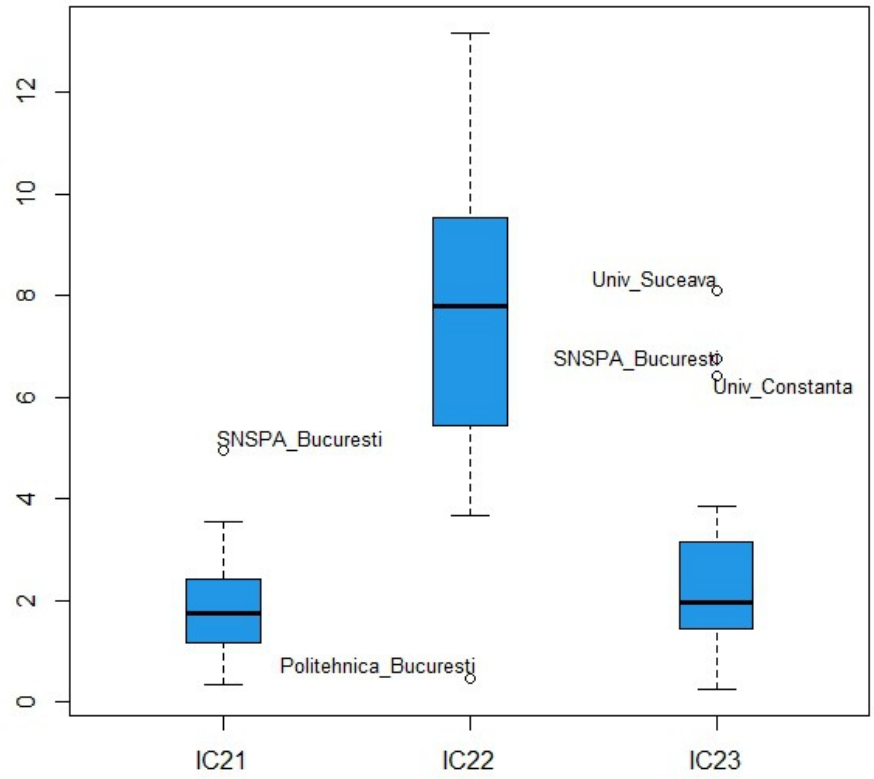


Figure 2. *The values of the scientific research indicators for the RS Economic sciences*

As it can be noticed, for the indicators IC2.1 and IC2.3 certain institutions registered very high values in comparison with the other universities from this field.

For the indicator IC2.1, the higher level was reported by the National University of Political Studies and Public Administration (SNSPA) with an average of 4.95, unlike the median level equal to 1.76. The difference of the value reported by the SNSPA and the second and third universities from this ranking, "Alexandru Ioan Cuza" University of Iaşi and "Babeş-Bolyai" University of Cluj-Napoca is significant, of 1.4 and 1.51. If we compare the value reported by SNSPA with the national median for IC2.1, we can notice that from the 7 academic fields, the highest national median for IC2.1 was registered for Finance field and it was 1.91 for 61 full professors reporting. For 3 others fields the median was 1.00 (i.e. more than half of the reporting faculty members do not meet the CNATDCU standard).

This results could be explained by the small dimension of one heterogenous group of academic staff from RS economic sciences in SNSPA. In fact, the value for this indicator IC2.1 is calculated like an average which could distort the results. This situation was noted also by other scholars: "Reporting the indicators as an arithmetic average favours the smaller-sized universities which do not have an important institutional capacity in that respective field but which do have a few teaching staff with high scores." (Păunescu et al., 2020, p. 7).

For the indicator IC2.3, the higher level was reported by "Ştefan cel Mare" University of Suceava (8.09) in comparison with the median level equal to 1.96, followed by SNSPA with 6.77 and "Ovidius" University from Constanţa with 6.43. We can also notice important differences between these values and the national median calculated for the 7 academic fields, for each teaching degree. The highest national median was registered for the field *Business Administration* for the 61 full professors reporting (4.08). For all other teaching degrees and academic fields, the median is less than 2, excepting for teaching assistants reporting in the field *Economics and International Business* (2.88).

This exploratory analysis of the research indicators highlights that the traditional universities are on the top of these rankings for IC2.1 and

for IC2.2, but not for the number of recent publications (IC2.3). For IC2.1, "Alexandru Ioan Cuza" University of Iaşi and "Babeş-Bolyai" University of Cluj-Napoca followed SNSPA in this ranking but there are on the 6th place, (with an average of 3.58) and 14th place (with 1.95) respectively, according to the indicator IC2.3. Concerning the indicator IC2.2 (Hirsch indexes), the first three positions are occupied by the traditional universities in this field: Bucharest University of Academic Studies (ASE), "Babeş-Bolyai" University of Cluj-Napoca and "Alexandru Ioan Cuza" University of Iaşi.

These positions could be explained by the fact that the minimum standard established by CNATDCU which have been revised in 2016 are more restrictive than the publications reported for IC2.3. The CNATDCU standards include only publications that have a non-zero AIS (Article Influence Score) and don't include the publications in journals indexed ERIH+ or ISI Proceedings that can be reported in IC2.3. The possibility to include these last publications in IC2.3 was in fact changed in 2018, following a ministerial order (Order no. 3047, 2018). Obviously, some of the academic staff followed to accomplish the high standards established by CNATDCU in 2016 and didn't publish in journals which could increase the value reported in IC2.3, but with a smaller impact in term of citations.

As we already mentioned, within this RS, there are 7 academic study fields. The comparative analysis of data reported for these study fields highlights significant differences among the values of performance indicators. Even if the minimum standards set up by CNATDCU are the same for all the 7 fields, the values registered by the teaching staff vary very much among the fields of this RS.

According to the data published by CNFIS, the weight of the teaching staff (professors and associate professors) who achieved the minimum standards imposed by CNATDCU vary, for example for professors, from approximately 37% in Accounting to 67% in Business administration, and for associate professors, from approximately 28%

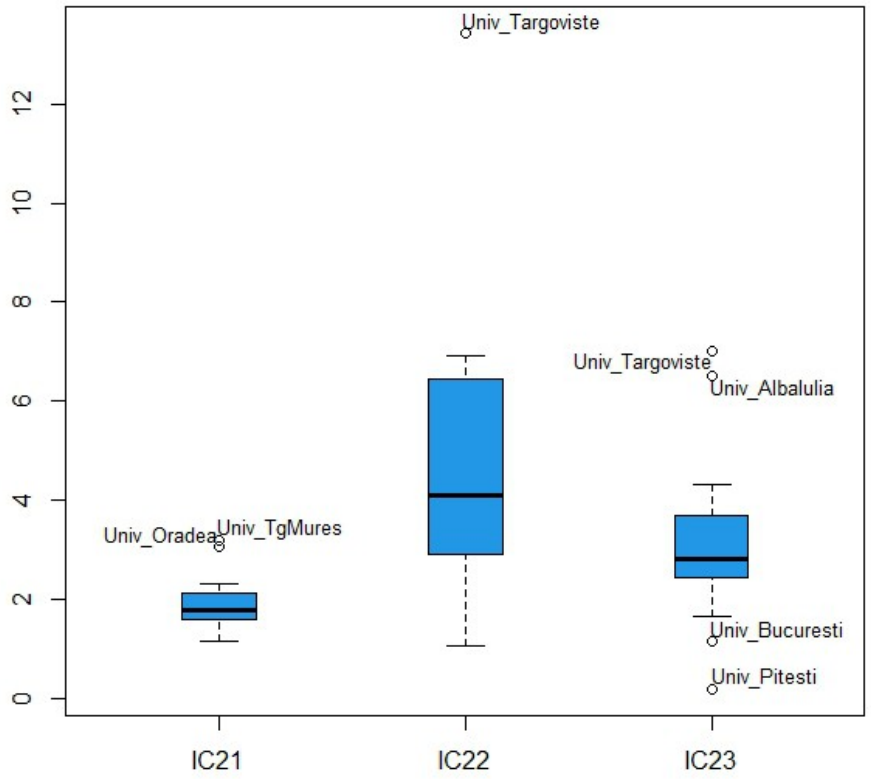
in Accounting to 44% in Marketing, Finance and Economics and International Business.

3.3. Exploratory analysis of the research indicators for the RS HISTORY

History is a field with a rather different situation. In 2019 there were 15 public universities running study programs registered in the field History, but one was the Police Academy which is funded separately by the Interior Ministry and therefore did not report for the quality indicators of the CNFIS; thus, the data published by CNFIS for the RS History originate from 14 public universities.

There are several surprises regarding History (*Figure 3*). Field insiders expected that the traditional universities of Cluj, Iași and Bucharest, which also have larger history departments than other universities, would be on top, while some other universities might capitalize more on specific strengths in niche specializations; using the same data set, but a different methodology, scientometric experts also ranked the history field at ”Babeș-Bolyai” University Cluj-Napoca first, and that of ”Alexandru Ioan Cuza” University Iași second (Păunescu et al., 2020). Yet, the CNFIS data per indicator presents different ”champions”.

Figure 3. *The values of the scientific research indicators for the RS History*



The outliers of IC2.1 are quite unexpected. The universities in Târgu Mureș and Oradea have rather small history departments, and while each of them has isolated well performing professors, the averages of 3.21 and 3.07 are not credible, especially if we consider the specificities of this indicator for the field history. As mentioned previously, indicator IC2.1 is based on the relationship between the scientific production of full professors and associate professors (computed according to the rules established by CNATDCU) and the minimum standard established by CNATDCU for occupying the positions of full professor respectively associate professor.

The CNATDCU standards have been revised upwards in 2016, and are a significant hurdle for some of the existing faculty members (at national level, in 2019 only 67 from 81 professors and 65 from 85 associate professors met these standards). Considering that the total standard for a full professor is 1600 points and 1000 points for an associate professor, a value of 3.21 for indicator IC.2.1 means 5136 points for a full professor and 3210 points for an associate professor, which might be reachable for an individual but is totally unrealistic for an average of at least 5 faculty members; in fact, the national median at IC2.1 for the 81 full professors reporting was 1.53 and for the 85 associate professors reporting was 1.67. A thorough check of the accuracy of the reports regarding the faculty of these outlier universities might help us better understand if this relative ranking is merit-based, or just a result of inflated reporting.

The discussions regarding the outliers of IC2.2 and IC2.3 will differ significantly. While surprising by its magnitude, the top-position of the historians working at the ”Valahia” University in Târgoviște can be partly explained by the strong performance of its archeologists. These faculty members have developed a pattern of publishing articles co-authored with specialists from various other fields, who have contributed to the multi-disciplinary analysis of archeological relicts. This allowed them to reach Hirsch indexes which are unusually high for the field history[4], and to publish in journals which are well-ranked in Web of Science. While there might be some doubts originating from the absence of public Google Scholar profiles for some faculty members, the level of legitimate suspicion is significantly smaller than that for the outliers of IC2.1.

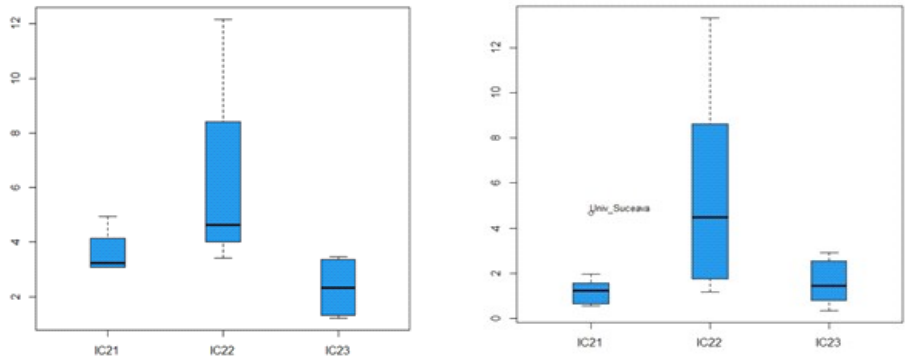
[4]Note that the national median of the Hirsch Index in Google Scholar for all full professors reporting for the field history was 4, and for associate professors it was 2. A good example of the influence of archeology publications on individual Hirsch indexes is the case of an associate professor specialized in medieval history, who has a H-index 4 due to 3 articles co-authored in his youth on paleolithic findings, articles which produce 56 of 70 citations; otherwise, he would have had H-index 2, exactly the national average for history associate professors.

Overall, the situation in the field history reflects some of the general features of the research indicators used by the Romanian higher education system. The CNATDCU standards, which include a large number of forms of scientific output and differentiate only moderately between articles published in different journals, reflect better the more conservative publication patterns of most professional historians, and are expectably more stable than the hierarchies drawn from data regarding H-index or recent articles published in WoS and ERIH+ journals. Therefore, one should not be surprised that the largest faculty, that from the ”Babeș-Bolyai” University of Cluj-Napoca, performs very strongly in the more traditional IC2.1 (average 2.15), has a decent H-index (position 3/14) and is only average in IC2.3 (position 7/14). On the contrary, the ”Valahia” University, champion of IC2.2 and IC2.3, ranks below average in IC2.1 (9/14) and the IC2.1 outliers from UMFTS Târgu Mureș rank only 9/14 in H-index and 10/14 in IC2.3.

3.4. Exploratory analysis of the research indicators for the RSs VETERINARY MEDICINE and MEDICINE

These branches are particular because both are under sectoral regulation of the European Union. They belong to the fundamental area “Biologic and Biomedical Sciences”. Four universities are reporting for Veterinary Medicine and 14 for Medicine. In the Veterinary Medicine RS all universities are mono-profile (homogenous), meanwhile in Medicine 5 universities are homogenous (only programs from the “Biologic and Biomedical Sciences” fundamental area) and the rest are comprehensive, providing programs from different fields of science. To complicate matters, the “Medicine” RS includes three academic fields of study, in fact three types of different study programs (Medicine sectoral 6 years, Medicine sectoral 4 years and Medicine 3 years, either general and sectoral). Three of the comprehensive universities provide only bachelor programs of three years, but not the six-years program of

medicine. The boxplots for the three research indicators are shown in Figure 4.



a. Veterinary Medicine b. Medicine

Figure 4. *The values of the scientific research indicators for the RSs Veterinary Medicine(first) and Medicine (second)*

We noticed more homogeneity in these two fields for all indicators, with no outliers except for Suceava University, in case of IC2.1 - Medicine. This could be possibly due, at least in part, to the sectoral EU regulation framework, that urges the universities to be aligned to the EU standards.

We also notice similarities in medians for IC2.2 between the two branches (4.63 and 4.49 for Veterinary Medicine and Medicine respectively) and this fact could support the hypothesis that staff from the two fields have comparable impact of scientific visibility.

For the IC2.1 and IC 2.3, the medians are higher in case of veterinary medicine (IC2.1: 3.22 vs. 1.24; IC2.3: 2.33 vs. 1.44 in Veterinary Medicine and Medicine respectively). However, as "intra-branch" ranking, the median for IC2.3 is higher than that for IC2.1 in Medicine, while in Veterinary Medicine, the situation is reversed.

In the same time, the proportion of the faculty members meeting the CNATDCU standards in the field is very high in Veterinary Medicine compared to Medicine (*Table 1*).

Table 1. Proportion of faculty meeting CNATDCU standards in medical academic fields

Academic field	Full professors (including senior researchers I)			Associate professors (including senior researchers II)		
	Reporting	Meeting standards	%	Reporting	Meeting standards	%
Medicine	507	212	41.84	639	243	38.03
Veterinary Medicine	65	69	92.31	60	68	98.55

Source: The data published by CNFIS include information regarding the number of full professors and associate professors who meet the CNATDCU standards

Such a case occurred due to the fact that the CNATDCU specialty committees enjoyed almost complete freedom to set the standards for their academic field. Thus, the situation varies a lot among different RSs from the same fundamental area, which leads to the fact that in some RSs having high standards, these are met only by minorities of reporting faculty, while in other RSs standards are met by (almost) all the reporting full professors and associate professors.

These results suggest that comparison in case of IC2.1 is mainly suitable within the universities reporting in the same RS, rather than between different RSs, even from the same fundamental area, as long as they use different CNATDCU standards for ranking.

3.5. Exploratory analysis of potential over-reporting

Overall, the number of positive outliers, i.e. universities which have reported in particular fields of science data well above the third quartile, was not very high[5]. Yet, some of these outliers raised concerns about the accuracy of reporting.

While the complexity of the reporting process obviously created opportunities for involuntary errors, it might also raise questions whether some universities did try to over-report. Such a hypothesis cannot be excluded due to the limits of checking capacity and due to the fact that universities have a financial benefit if they over-report and get away undetected. Obviously the statistical analysis cannot provide evidence of data falsification, but it allows to assess whether there is a risk of systemic over-reporting of data. For this purpose, we have related the number of science branches for which each university have reported data which placed them in the position of being positive outliers to the total number of science branches for which they have reported research output data. We have some extreme situations – 100% outlier – but these originate from specialized universities which report in only one science branch for which they are well-known as being the national best (i.e. the "Ion Mincu" University of Architecture and Urbanism for the science branch Architecture and urbanism, or the National University of Physical Education and Sport for the science branch Sports and physical education) and therefore do not substantiate suspicions. There are also other situations of excellence which explain the relatively high percentages of some universities reporting in a limited number of science branches. If we consider the

[5]CNFIS-RS includes research output data amounting to a total of 539 scientific branch reports per university. This number is due to the fact that the size and complexity of the Romanian universities varies a lot, some of them reporting to just one science branch, while the more comprehensive report to more than 20 branches (champion is the University of Oradea, which reported for 31 of 39 science branches). Outliers for at least 1 indicator were registered in only 97 situations, which is below 18%.

universities which report in at least 8 science branches (25 from 47 universities), we see that only one of them is outlier in 50% of the science branches it reported ("Ștefan cel Mare" University in Suceava – 9 outliers from 18 science branches), while all the others are outliers in below one third of the science branches for which they have reported. Under these circumstances, we can safely state that the statistical analysis does not indicate a systematic over-reporting of data at university level. This conclusion does not guarantee the accuracy of data, but suggests that either involuntary errors or over-reporting happened more probably at lower levels.

4. Conclusions

In this paper, we analysed research indicators reported by the state-funded public universities in Romania in 2019 for five fields of science (Mathematics, Economic sciences without Cybernetics, Statistics and Business Information Systems and the programmes Agro-food economics and Agro-food and environmental economics, History, Veterinary Medicine and Medicine). Following the exploratory analysis, carried out by graphical and numerical methods, we identified the atypical situations when universities reported unusually high values in comparison with the ensemble of all the other universities. Although our exploratory analysis did not provide evidence for systematic distortion of data at university level, it indicated that some of the data reported by the universities for the research indicators used by CNFIS are unreliable and need to be checked. Considering that the staff and verification capacity of CNFIS are limited, it is obvious that there is need for additional resources. Such resources could easily come from the academic community in various universities, in the form of cross-checking the data. The publication of statistical values in 2020 for the data reported in 2019 is an important progress in transparency, but in

order to allow easy cross-checking it would make sense to publish the data in a research-facilitating format, and in more detail (values for all individuals who have reported); concomitantly cross-checking could be stimulated by providing to scholars designated by each university the possibility to verify the individual files which document the values reported.

Progress in transparency and access to the data would also attract researchers and stimulate analyses, provide benchmarks and contextual information not only for national decision-makers (the Ministry of Education, the associated consulting councils, the quality assuring agencies etc.), but also for the management of higher education institutions.

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