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Alpha Distribution and the Economic Resilience System

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ABSTRACT

A constant concern in the field of mechanical engineering is finding the balance between the costs of machining components and the costs of replacing worn processing devices. Determining the optimal moment, to replace processing tools, involves describing their resilience, due to the stress in use, through an appropriate statistical model, which statistically reproduces the behavior under extreme demands. One such model is the Alpha distribution proposed by Drujinin in 1967. The first applications were in engineering practice, in the field of metal processing, the model best describing the behavior of the processing device to the resistance of the processed metal, the stress exerted on the cutting tool, as well as its subsequent resilience.

Along with the bibliographic investigation and the presentation of the distribution's genesis from a historical point of view, this article presents the estimation of the model's main parameters, the establishment of the lower tolerance limit and a practical application. Somehow forgotten in the specialized literature, the Alpha distribution has numerous applications, exceeding the boundaries of mechanical engineering, such as the modeling of effects, but especially macroeconomic resilience processes following crises, such as the 2008 global slump or the one generated by the COVID-19 pandemic.

Keywords: *Alpha distribution, economic resilience, parameter estimation, extreme loads, cutting tools, tolerance limits*

JEL Classification: *C13, C21, C46, L15, L62, O14*

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1. INTRODUCTION

Entire industries, a wide range of products from household products to automobiles, airplanes, drilling rigs, sea and river ships, depend on the performance of metalworking devices. The knives of the cutting processing devices are simultaneously subjected to technological loads and to mechanical, chemical and thermal attacks. The interest is major to model such processes and to estimate, as accurately as possible, the service life of these devices, due to the high costs generated by industrial users in the field of metal processing, the costs are ultimately found in the price of the products sold.

The Alpha distribution, due to its capacity to quantitatively reflect some processes, can help to improve the design of some systems under the conditions of optimizing the costs between manufacturing and operation. Obviously its scope of application goes beyond the field of metal processing, where this distribution was launched, and it is recommended wherever some processes are to be modelled in which extreme stress can cause failures, such as: the landing gear of aircrafts, the load for aircraft engines to take off, modelling the loads of sloping traction systems on locomotives, modelling the behaviours of the components of propulsion systems on spacecraft, and even the reliability of the human body to extreme demands, such as athletes, fighter pilots, cosmonauts etc.

Such a model was proposed in Russia by Drujinin [1] developed by Katzev [2] used and then completed in Romania by Dorin and Vodă [3], respectively Vodă [4], which develops the issue of sustainability modelling. The model was then taken over by Koutras and Tsokos [5, 6] and resumed by Savchuk and Tsokos [7]. Overall, from the perspective of the time elapsed since the appearance of this distribution (aspect that will be developed in the part intended to investigate the literature) the impact was a minor one in the international literature, most likely both due to the language barrier, as Russian and Romanian have a limited circulation, and to the circulation limits of scientific information in the 1970s, and then the subject was somewhat abandoned, although the model provides a number of facilities in modelling processes in which extreme loads occur, due to its remarkable versatility to adapt to specific processes of a great variety.

Thus, the distribution has applicability in the modeling of processes in which extreme loads occur, of the technical systems' resilience, but also of economic-social macrosystems following crises.

2. LITERATURE REVIEW

Over time, a rich literature has been established on the reliability of cutting tools, contributions that aim to highlight the diverse range of methods proposed for estimating their reliability, and reaching the Alpha distribution has been the result of gradual accumulations. Thus, Sherif, 15 years away from Drujinin, develops a version of the truncated normal reverse distribution, as a model of reliability for systems that suffer a high rate of wear and failure, but with a different truncation point compared to the Drujinin model. Sherif [8] argues that tool defects in cutting processes may be due to sudden stress, environmental aggression, hidden defects, violation of procedures in the manufacturing process or improper use. Moreover, he considers this distribution to be appropriate for the case of high-speed cutting tools, so he also cites the work of Katzev [2], but under the name of Katsey. The field of reliability and durability of cutting tools has proved fertile in statistical modelling, including using the Alpha model. Both theoretical and experimental research has been a real development of descriptive models of cutting processes. Dorin and Vodă [3], then Vodă [4], effectively used the Alpha model in data processing, coming from reliability tests on some drills, and developed maximum likelihood estimators for the parameters of the repair proposed by Drujinin [1]. Koutras and Tsokos [5, 6] resume and develop the subject treated by Dorin and Vodă [3] and present it in the journal *Statistica* in Italy. An original element is given by the quotation of Katzev which appears erroneously in the bibliography V.M. Katzev instead of P.G. Katzev. The article in *Statistica* (Bologna) is later included in the volume "Bayesian Theory and Methods with Applications", coordinated by Savchuk and Tsokos [7], a volume that brings together new practical applications in the fields of health sciences, engineering, environmental sciences, business and economics, as well as the social sciences.

In the last edition of the famous treatise on statistical distributions [9] Johnson & al also approaches the Alpha distribution very synthetically (p 173), Salvia [10] being invoked as the initiator of the model, and he makes a reference on the Alpha distribution (he also cites Katzev as Katsey in the paper). Vladimirescu and Tunaru [11] proposed hypothesis tests for discrimination between the populations of two Alpha distributions. The tests developed here are uniformly most powerful unbiased and can be used to test various general hypotheses related to this probability distribution which is less known by professional statisticians. Wager and Barash [12], on the basis of numerous tests performed on high-speed steel tools used in the processing of low-carbon materials, obtained results indicating that the service life of these tools corresponds to statistical distributions that can be approximated by the

normal distribution, with a coefficient of variation of about 0.3. Wiklund [13] prefers a Bayesian approach, from an engineering perspective, to describe the cutting processing and makes a prediction of the service life of cutting tools. Gertsbakh [14] develops a university treatise, which focuses primarily on the maintenance, collection and processing of statistical data in order to optimize preventive interventions. Rausand and Høyland [15] carry out a complete and updated theory of the reliability of mechanical processing systems, this work being at its second edition, which is enriched with the latest acquisitions and developments. Pearn and Hsu [16] propose a model for replacing cutting tools by establishing an alert level based on the defective fraction. Lin [17] provides a study in which the failure rate is used to describe the reliability of cutting tools, by constructing a reliability equation, based on the risk function dependent on the reliability of the cutting tool. Deng & al [18] propose a tool replacement model in the processing process based on the log-normal distribution, aiming to achieve a balance between the costs of tool replacement and the cost of damage caused by quality defects of products resulting from the use of worn out processing devices.

Karandikar [19] assumes that the tool life decreases with increasing cutting speed, to which additional factors can be added, such as the nature of the material being processed, the service life of the processing tools being generally considered a stochastic process. As a method, he uses Bayesian inference to make a model for estimating tool life. Salonitis and Kolios [20] use stochastic methods and modelling, by using low-volume data sets in wear and tear modelling, including the simulation by Monte Carlo method. Hsu and Shu [21] propose to evaluate the reliability and determine the optimal replacement time of a machine tool under conditions of tool damage, using an inhomogeneous Markov process combined with a cost function. Nadarajah and Kotz [22], in the line of generalizing some classical distributions, proceed to develop one of the most frequently used distributions in reliability modelling, namely the exponential distribution, building the variant called by the authors "exponential beta", based on the logit of a random beta variable, and based on the generating function, the calculation of the first four moments, as well as of the entropic indicators is performed. The authors propose the introduction of an alternative form of generating the asymmetric normal distribution, which allows the framing of unimodal and bimodal data sets. The basic properties of this new distribution, the moments, the maximum probability and the Fisher information matrix are studied, and the theoretical development is strengthened with a real-life application.

Vagnorius & al [23] aim to optimize tool replacement times, balancing the replacement moments with the costs generated by premature replacement,

respectively the losses generated by the deterioration of product quality, and they propose in the wear and tear modelling process a combination of Weibull distributions and Poisson processes. Wang & al. [24] provide a study based on a mathematical model of dynamic reliability for the machining process, using the failure rate, finalized by proposing an algorithm to identify the optimal time to replace the processing tool. Chen & al [25] consider that traditional methods of assessing reliability, based on large samples, are inefficient for numerically controlled cutting tools and machining robots, and propose the semi-normal function as a solution to define the operational reliability of the cutting tool. Kalpakjian and Schmid [26] provide detailed descriptions of modern manufacturing processes and operations in a state-of-the-art manufacturing and technology manual, including QR codes that provide access to video examples. Gaddafee and Chinchanikar [27] are the editors of a volume that brings together the selection of papers presented at a symposium on the wear and tear of metalworking tools and the modelling of these processes. Elal-Olivero [28] introduces an alternative to generate a normal distribution with strong asymmetry. The basic properties of this distribution are studied, such as stochastic representation, moments, maximum probability and informational matrix. Shafiei & al [29] introduce a new class of asymmetric distributions, by extending the normal alpha skew distribution proposed by Elal Olivero, developing the statistical properties of this new distribution family. The moments and shape parameters are developed, including the slope, the kurtosis coefficients and the generation function, being appreciated the quality of the estimators obtained through a Monte Carlo simulation study. Cordeiro and de Castro [30] develops generalized forms of some classical distributions, being identified by the authors by adding the prefix "Kw" (as this distribution was originally proposed by Poondi Kumaraswamy) for example the Kw-normal distribution, Kw-Weibull, Kw-gamma, Kw-Gumbel and Kw-inverse Gaussian etc. Kumaraswamy's double bounded distribution [31] is a family of continuous probability distributions defined on the interval (0,1). It is similar to the Beta distribution, but much simpler to use especially in simulation studies since its probability density function, cumulative distribution function and quantile functions can be expressed in closed form.

In 1978 James J. Filliben released Dataplot, a free public-domain, multi-platform software system for scientific visualization, statistical analysis, and non-linear modeling [32]. This allow to compute the alpha probability density function (ALPPDF) and also related commands that: compute the alpha cumulative distribution function (ALPCDF), compute the alpha percent point function (ALPPPF), compute the alpha hazard function (ALPHAZ), compute the alpha cumulative hazard function (ALPCHAZ). The sources

of the statistical method used are Johnson et al [9] (p. 173) and Salvia [10] (pp. 251-252). Likewise, SciPy.org [33], a Python-based ecosystem of open-source software for mathematics, science, and engineering, provides functions for Alpha distribution, using the same sources [9] and [10] for the statistical methods.

3. DESCRIPTION OF THE ALPHA MODEL

The distributed random variable Alpha represents the inverse of the normal variable $N(t;\mu,\sigma^2)$ truncated at the origin.

Indeed, if X is a random variable with the density $f_x(x;\theta)$, $x \in R$, $\theta>0$ *and* x_t is a truncation point to the left, i.e. $x>x_t$, then the density of x_t is

$$x_t: f_{x_t}(x;\theta) = \frac{1}{1-F_x(x_t;\theta)} \cdot f_x(x;\theta), x > x_t \quad (1)$$

Here $F_x(x_t;\theta)$ is the distribution function of X, calculated at the truncation point. If $F_x(x;\theta)$ is the normal distribution function, then the normal density truncated to the left has the following form:

$$x_t: f_{x_t}(x;\mu,\sigma^2) = \frac{(\sigma\sqrt{2\pi})^{-1}}{1-F_0\left(\frac{x_t-\mu}{\sigma}\right)} \cdot exp\left[-\frac{1}{2}\left(\frac{x_t-\mu}{\sigma}\right)^2\right], x > x_t \quad (2)$$

where:

$$F_0(u) = \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{u} exp(-t^2/2)dt \quad (3)$$

It is clear that if the truncation point is $x_t = 0$, then:

$$f_0(x;\mu,\sigma^2) = \frac{1}{(\sigma\sqrt{2\pi})F_0\left(\frac{\mu}{\sigma}\right)} \exp\left[-\frac{1}{2}\left(\frac{x_t-\mu}{\sigma}\right)^2\right], x > 0 \quad (4)$$

As the distribution function of the variable X_t^{-1} is:

$$F(y) = Prob\{X_t^{-1} < y\} = 1 - Prob\left\{X_t < \frac{1}{y}\right\} = \\ = 1 - \left(\sigma\sqrt{2\pi}\right)^{-1}\left[F_0\left(\frac{\mu}{\sigma}\right)\right]^{-1}\int_0^{\frac{1}{y}} \exp\left[-\frac{1}{2}\left(\frac{x_t-\mu}{\sigma}\right)^2\right]dx \quad (5)$$

The following form results in the end:

$$F`(y) = \frac{\left(\sigma\sqrt{2\pi}\right)^{-1}}{y^2 F_0\left(\frac{\mu}{\sigma}\right)} \cdot exp\left[-\frac{1}{2}\left(\frac{\frac{1}{y}-\mu}{\sigma}\right)^2\right], y > 0 \quad (6)$$

The name *Alpha distribution* assigned by Drujinin is given by the notation $\mu = \frac{\alpha}{\beta}$, $\sigma = 1/\beta$, $\alpha, \beta > 0$ so that the density of the function resulted in the form:

$$T: f_T(t;\alpha,\beta) = \frac{\beta}{t^2 F_0(\alpha)\sqrt{2\pi}} exp\left[-\frac{1}{2}\left(\frac{\beta}{t}-\alpha\right)^2\right], x > 0;\ \alpha,\beta > 0 \quad (7)$$

(expression in which the notation *x* has been replaced by *t* to maintain the unity of the symbols in the following).

In relation to the distribution density (7) "α" is the essential parameter, a situation that made Drujinin to assign the name *Alpha* to the distribution. Katzev also remarked that, in most experimental cases, $\alpha \gg 2$. For example, if α is even equal to 2, then 0.98 results, and an increase by only 0.3 generates a value of 0.99 and $F_0(\alpha = 2.5) \cong 0.99959$ and, therefore, we can practically consider $F_0(\alpha > 2) \approx 1$. In which case the density in the form (8) may be used without any significant loss of precision:

$$\tilde{f}_T(t;\alpha,\beta) = \frac{\beta}{t^2\sqrt{2\pi}} exp\left[-\frac{1}{2}\left(\frac{\beta}{t}-\alpha\right)^2\right], t > 0;\ \alpha,\beta > 0 \quad (8)$$

Tsokos and Koutras [6,] took over and analysed the distribution under this form.

The main elements that describe the Alpha distribution:

• Distribution function: $\tilde{F}_T(t;\alpha,\beta) = 1 - F_0\left(\frac{\beta}{t}-\alpha\right)$ (9)

• Reliability function: $\tilde{R}_T(t;\alpha,\beta) = F_0\left(\frac{\beta}{t}-\alpha\right)$ (10)

• The mean value: $E(T) = \frac{\beta}{\alpha}\left(1 + \frac{1}{\alpha^2}\right)$ (11)

• The variance: $Var(T) = \frac{\beta^2}{\alpha^4}\left(1 + \frac{8}{\alpha^2}\right)$ (12)

• *The second quartile* (or the median): $t_{me} = \frac{\beta}{\alpha}$ (13)

(a note is required: if α is high enough, then the value of the mean coincides with the value of the median).

• The mode (or modal value): $t_{mo} = \frac{\beta}{4}(\sqrt{\alpha^2 + 8} - \alpha)$ (14)

• The *coefficient of variation:* $CV(T) = \frac{(\alpha^2+8)^{1/2}}{\alpha^2+1}$ (15)

• Disturbance coefficient: $SNR = \frac{(\alpha^2+1)}{(\alpha^2+8)^{1/2}}$ (16)

Signal-to-Noise Ratio (SNR) is an indicator borrowed from the engineering field, where it is used to compare the level of an expected signal with the background noise level. Informally taken over and used, the signal-to-noise ratio is sometimes used to refer to the relationship between useful information and irrelevant data, off-topic posts and spam are considered "noise" that interferes with the "signal" of relevant information. The signal-to-noise ratio is defined as the ratio of the strength of a signal to the strength of the background noise. In the processing of data from tests/ exploitation it has the significance of an indicator of disturbances.

4. ESTIMATION OF ALPHA DISTRIBUTION PARAMETERS

Based on the expressions of the indicators presented above, the method of least squares, the method of moments or method of maximum likelihood estimation, can be used successfully to estimate the parameters α and β.

The method of moments is fast enough and ensures sufficient accuracy in practical applications. Starting from the coefficient of variation, that does not depend on the value of the parameter β, we can write:

$$\widehat{CV(T)} = \frac{s}{\bar{t}} \tag{17}$$

where $\bar{t}$ and s are the mean, respectively the standard deviation, established on the basis of the sampling data.

The value of β results easily if the theoretical mean (11) is equaled with the survey mean, obtained from the experimental data, therefore:

$$\bar{t} = \frac{\hat{\beta}}{\hat{\alpha}}\left(1 + \frac{1}{\hat{\alpha}^2}\right) \tag{18}$$

The equation that generates the β estimator:

$$\hat{\beta} = \frac{\hat{\alpha}^2 \bar{t}}{1+\hat{\alpha}^2} \tag{19}$$

The estimations of parameters, using the same method of moments, can also be completed using the median. Thus, if t_{me} is the median of the sample:

$$\widehat{t_{me}} = \begin{cases} t_{(k+1)}, if\ n = 2k+1 \\ \frac{1}{2}\left[t_{(k)} + t_{(k+1)}\right], if\ n = 2k \end{cases} \tag{20}$$

Therefore: $\hat{t}_{me} = \frac{\hat{\beta}}{\hat{\alpha}}$

and by equaling the theoretical median (13) we get:

$$\hat{\beta} = \hat{\alpha} \cdot t_{(k+1)} \tag{21}$$

hence:

$$2\hat{\beta}(\sqrt{\hat{\alpha}^2 + 8} - \hat{\alpha}) \tag{22}$$

and combined with $E(t) = \bar{t}$ follow:

$$\hat{\alpha} = \left[\frac{t_{(k+1)}}{\bar{t} - t_{(k+1)}}\right]^{1/2} \tag{23}$$

Based on the modal value (14):

$$t_{mo} = \frac{\beta}{4}(\sqrt{\alpha^2 + 8} - \alpha)$$

the following solutions are obtained by a simple calculation:

$$\hat{\alpha} = \sqrt{6} \cdot t_{mo}/3t_{me} \tag{24}$$

$$\hat{\beta} = 2\sqrt{6}t_{mo}/3 \tag{25}$$

If the ratio between the modal value (14) and the median value (13) is used:

$$\frac{t_{mo}}{t_{me}} = \frac{\alpha}{4}\left(\sqrt{\alpha^2 + 8} - \alpha\right) < 1 \tag{26}$$

Thus $t_{mo} < t_{me} < E(T)$ which means th at the distribution is asymmetric to the right. The values of the constant

$$K(\alpha) = \frac{\alpha}{4}\left(\sqrt{\alpha^2 + 8} - \alpha\right)$$

calculated (table 1) for
$\alpha = 2(0.1), 4(0.2), 5(0.25), 7(0.3), 8(0.4), 10(0.45), 15(0.5), 20(0.75), 30(1.0), 40,50$
simplify, for practitioners, the obtaining of the α parameter value.

Values for $K(\alpha)$

Table 1

alpha	K	alpha	K	alpha	K	alpha	K	alpha	K
2.00	0.7321	3.80	0.8902	7.90	0.9699	15.00	0.9913	26.00	0.9971
2.10	0.7470	3.90	0.8947	8.00	0.9706	15.50	0.9918	26.75	0.9972
2.20	0.7608	4.00	0.8990	8.40	0.9732	16.00	0.9923	27.50	0.9974
2.30	0.7737	4.20	0.9068	8.80	0.9754	16.50	0.9928	28.25	0.9975
2.40	0.7857	4.40	0.9137	9.20	0.9774	17.00	0.9932	29.00	0.9976
2.50	0.7968	4.60	0.9200	9.60	0.9792	17.50	0.9936	29.75	0.9978
2.60	0.8072	4.80	0.9256	10.00	0.9808	18.00	0.9939	30.00	0.9978
2.70	0.8169	5.00	0.9307	10.45	0.9823	18.50	0.9942	31.00	0.9979
2.80	0.8260	5.25	0.9364	10.90	0.9837	19.00	0.9945	32.00	0.9981
2.90	0.8344	5.50	0.9414	11.35	0.9849	19.50	0.9948	33.00	0.9982
3.00	0.8423	5.75	0.9459	11.80	0.9860	20.00	0.9950	34.00	0.9983
3.10	0.8497	6.00	0.9499	12.25	0.9870	20.75	0.9954	35.00	0.9984
3.20	0.8567	6.25	0.9535	12.70	0.9879	21.50	0.9957	36.00	0.9985
3.30	0.8632	6.50	0.9567	13.15	0.9887	22.25	0.9960	37.00	0.9985
3.40	0.8693	6.75	0.9596	13.60	0.9894	23.00	0.9962	38.00	0.9986
3.50	0.8750	7.00	0.9622	14.05	0.9901	23.75	0.9965	39.00	0.9987
3.60	0.8804	7.30	0.9650	14.50	0.9907	24.50	0.9967	40.00	0.9988
3.70	0.8855	7.60	0.9676	14.95	0.9912	25.25	0.9969	50.00	0.9992

[1] Authors' own calculation

The estimation of the parameters by the method of moments can also be done using the SNR perturbation coefficient, using the values in the table with $SNR = (\alpha^2 + 1)/(\alpha^2 + 8)^{1/2}$ for different values of the α parameters. From the tables [34] and based on the value of the perturbation coefficient, the value of the α parameter is easily obtained.

An interesting property is that of the distribution of the first order statistics in an Alpha population:

$$F_{T_{(1)}}(t, \alpha, \beta) = 1 - [1 - F_T(t; \alpha, \beta)]^n = 1 - F_0^n\left(\frac{\beta}{t} - \alpha\right) \tag{27}$$

It is easy to show that $1 - F_{T_{(1)}}(t, \alpha, \beta)$ is precisely the reliability of an automatic processing line, in which the machines are arranged in series. Indeed, the Alpha reliability function being:

$$R_T(t; \alpha, \beta) = F_0\left(\frac{\beta}{t} - \alpha\right)$$

for a series type system its reliability will result from the shape R_S:

$$R_s = \prod_1^n R_T(t; \alpha_i\beta_i) = \prod_1^n F_0\left(\frac{\beta_i}{t} - \alpha_i\right)$$

If $\alpha_i = \alpha\alpha_i = \alpha$ and $\beta_i = \beta$ for any $i = \overline{1, n}$ then:

$$R_s = F_0^n\left(\frac{\beta}{t} - \alpha\right)R_s = F_0^n\left(\frac{\beta}{t} - \alpha\right) \tag{28}$$

which is exactly:

$$1 - F_{T_{(1)}}(t; \alpha, \beta) \tag{29}$$

In the case of parallel arrangement, the reliability is given by the expression:

$$R_p = 1 - \left[1 - F_0\left(\frac{\beta}{t} - \alpha\right)\right]^n = 1 - \left[1 - C_n^1 F_0\left(\frac{\beta}{t} - \alpha\right) + \right] + C_n^2 F_0^2\left(\frac{\beta}{t} - \alpha\right) - \cdots - (-1)^{n-1} C_n^n F_0^2\left(\frac{\beta}{t} - \alpha\right) = C_n^1 F_0\left(\frac{\beta}{t} - \alpha\right) - C_n^2 F_0^2\left(\frac{\beta}{t} - \alpha\right) + \cdots + (-1)^{n-1} C_n^n F_0^2\left(\frac{\beta}{t} - \alpha\right) = \sum_{k=1}^{n} (-1)^{k+1} C_n^k F_0^k\left(\frac{\beta}{t} - \alpha\right) \quad (30)$$

With regard to the estimation of the parameters using the maximum likelihood method, this generates results both if it is assumed to be known and if both parameters are unknown. The solutions developed in Dorin and Vodă [3], or Dorin & al [34] present the case when both parameters are unknown, a situation in which the system of maximum likelihood is the following:

$$\frac{\partial \ln L}{\partial \hat{\beta}} = \frac{n}{\hat{\beta}} - \hat{\beta} \sum_{i=1}^{n} \frac{1}{t_i} + \hat{\alpha} \sum_{i=1}^{n} \frac{1}{t_i} = 0 \quad (31)$$

$$\frac{\partial \ln L}{\partial \hat{\alpha}} = \hat{\beta} \sum_{i=1}^{n} \frac{1}{t_i} - n\hat{\alpha} = 0$$

a system that ultimately leads to the solutions:

$$\hat{\alpha} = \left[n \sum_1^n \frac{1}{t_i^2} - \left(\sum_1^n \frac{1}{t_i}\right)^2\right]^{-\frac{1}{2}} \cdot \sum_1^n \frac{1}{t_i} \text{ and} \quad (32)$$

$$\hat{\beta} = n\left[n \sum_1^n \frac{1}{t_i} - \left(\sum_1^n \frac{1}{t_i}\right)^2\right]^{-1/2}$$

Form a practical point of view, it is of interest to determine a lower natural tolerance limit (L_I) for durability [35] which implies the construction of the $L_I(t_1, t_2, \ldots, t_n)$ statistics, so that:

$$P\left\{\int_{L_I}^{\infty} \tilde{f}_t(t; \alpha, \beta) dt \geq P\right\} = \gamma \quad (33)$$

which is successively transformed in this way:

$$P\left\{\tilde{F}_t(\infty; \alpha, \beta) - F_t(L_I; \alpha, \beta) \geq P\right\} = \gamma \quad (34)$$

respectively:

$$P\left\{F_0\left(\frac{\beta}{L_I}-\alpha\right)\geq P\right\}=\gamma \tag{35}$$

and:

$$P\left\{\left(\frac{\beta}{L_I}-\alpha\right)\geq F_0^{-1}(P)\right\}=\gamma \tag{36}$$

at last:

$$P\left\{\frac{1}{\beta}\leq\frac{1}{\alpha+F_0^{-1}(P)L_I}\right\}=\gamma \tag{37}$$

As shown in (5), the maximum likelihood estimator for $1/\beta$ is distributed approximately normally, of class $N\left(\frac{\alpha}{\beta},\frac{1}{n\beta^2}\right)$, in which case (37) can be written:

$$P\left\{\frac{n^{-1}\sum_{i=1}^{n}t_i^{-1}-\frac{\alpha}{\beta}}{\beta^{-1}n^{-1/2}}\leq\frac{\frac{1}{\alpha+F_0^{-1}(P)L_I}-\frac{\alpha}{\beta}}{\beta^{-1}n^{-1/2}}\right\}=\gamma \tag{38}$$

in which the second part of the inequality (38) is γ, the standardized normal distribution quartile. Thus, the lower tolerance limit is:

$$L=\frac{1}{[\hat{\alpha}+F_0^{-1}(p)]\left(\frac{u_\gamma}{\hat{\beta}\sqrt{n}}+\frac{\hat{\alpha}}{\hat{\beta}}\right)} \tag{39}$$

5. RESULTS

In theory, in some cases, the proposed models for the behavior of different characteristics of product optimization, or modeling economic processes, do not find instantly or always correspond in the real world [36, 37, 38, 39, 40, 41]. However, this is a way to reduce and simplify the interaction between theory and practice. In most cases, the theory goes beyond the practical possibilities of its illustration and application. Thus, a statistical model, which describes the behavior at extreme demands, is the Alpha distribution, which has a theoretical justification and can illustrate a real case with the collected data.

The data presented (table 2) are collected by the testing laboratory of the Quality Assurance Department of a truck manufacturer and represent the results of the observation of the durability for a number of 324 helical drills with a diameter of ϕ20 mm, the data being expressed in minutes. Experimental data were recorded at the company Roman S. A. in Brasov [42]. Roman S.A. is a truck and bus manufacturer from Brasov, Romania. It also manufactures various components for trucks like engines, axles, decks etc. The data were systematized in the form of an interval distribution series. The calculations lead to the indicators presented in Table 3.

Durability distribution

Table 2

Interval (min)	Frequencies
under 75	18
75 - 100	43
100 - 125	69
125 - 150	89
150 - 200	39
200 - 250	32
250 - 350	21
over 350	13
Total	324

[1] *Sample data collected at Roman S. A.*

The results of the calculations indicate that the series has a strong asymmetry to the right: mode = 132.14 < median = 134.13 < mean = 155.59 indicates and alpha distribution. Based on this relation (26) the ratio between the modal value and the value of the median results: K = 0.985, and from table 1 the value of the parameter α = 11.35 is extracted, also the parameter β is determined by (19):

$$\hat{\beta} = \frac{\hat{\alpha}^2 \bar{t}}{1+\hat{\alpha}^2} = \frac{11.35^2 \cdot 155.59}{1+11.35^2} = 154.39$$

Descriptive Statistics

Table 3

Statistical indicators	Title 2
mean	155.59
variance	5851.71
standard deviation	76.50
coefficient of variation (%)	49.16
mode	132.14
median	134.13
coefficient of skewness	0.8414

[1] *Authors' own calculation based on sample empirical data.*

Based on the estimated $\hat{\alpha}$ and $\hat{\beta}$ values, the lower tolerance limit L_I can be determined for the durability of the devices in case of the alpha distribution, as follows:

$$P\left\{\int_{L_I}^{\infty} \tilde{f}_T(t; 11.35,154.39)dt \geq 0.90)\right\} = 0.95$$

So, the indicators are: P = 90%, n = 324, $\gamma = 0.95$, $u_\alpha = 1.65$, $\hat{\alpha} = 11.35, \hat{\beta} = 154.39$. Replacing in the relation (39) the calculations lead to: $L_I = 1.071$, thus practically, with a 95% probability, at most 10% of the population considered will have a durability of less than 1.071 minutes.

6. CONCLUSIONS

The economic impact of the durability of cutting tools is major on the efficiency of industrial enterprises with a mechanical profile, as they are essential in optimizing the cost of replacing processing tools with losses generated by the use of worn out devices. This situation of prolonged use of some damaged devices, would impact the deterioration of the components and in the end the loss of the quality of the products assembled from them.

The importance of this subject is also reflected in the multitude of scientific papers and expert meetings dedicated to metal cutting and finding the balance between costs and consequences. These concerns also include the identification of the most appropriate statistical models to describe and allow predictions on the behaviour of cutting devices to stress and extreme loads. This area of interest also includes the Alpha model, proposed in 1968 by the engineer G. V. Drujinin, a model that in our opinion did not have the expected impact in relation to the modelling qualities that this distribution law has.

The interest for this statistical distribution law does not only focus on the practical side, of solving problems strictly related to supply management, stocks of cutting tools and replacement moments, but also strictly theoretically, for the development of methods and procedures for this law, starting with the testing of statistical hypotheses up to the generalization of this function, establishing limits of natural tolerance, indicators with great practical utility, and up to designing methods based on survey data, etc. We consider that theoretical developments and practical destinations have not exhausted their knowledge resources and application destinations. Thus, from the point of view of the applicability of this distribution, a wide horizon opens for contributions regarding the modeling of resilience processes at the macroeconomic level, as a result of various crisis situations.

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Romanian Tourism before and after the Covid-19 Pandemic. A Geostatistical Analysis

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ABSTRACT

The current research aims to analyze the evolution of tourism in Romania before and after the COVID-19 pandemic in the context of the global pandemic crisis. A quantitative research methodology will assess the impact of the pandemic on the tourism sector and highlight changes in the behaviour and preferences of tourists. The study uses various methods and statistical indicators to obtain a comprehensive perspective on tourism within the national economy. Also, it will describe Romania's position in international tourism by presenting some statistical indicators in a multiscalar manner, in a national profile, and a global context. A series of relevant indicators for the tourism industry is provided, such as the size of the tourist accommodation infrastructure, the number of arrivals/overnights in the tourist accommodation structures, the degree of utilization of the accommodation capacity, the expenses and the revenues generated by the tourism sector in Romania. Also, the study proposes an examination of the territorial profile of tourism, analyzing the geographical areas and regional disparities in the territory of Romania. The results obtained will be used in formulating recommendations (strategic directions, public policy proposals, intervention measures) for the tourism sector, aiming to stimulate the recovery and sustainable growth of Romanian tourism in the post-pandemic period. Currently, one of our team members is part of the technical group of the Iași County Council for the development of the Iași County Tourism Marketing Strategy 2023-2030, a position from which he is already capitalizing on the results of this study.

Keywords: *tourism, arrivals, accomodations, tourism and travel statistics, COVID-19, pandemic*

JEL Classification: *L83, Z30, Z31, Z32, Z38, Z39, Y10, Y31*

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1. A STATISTICAL PERSPECTIVE ON ROMANIAN TOURISM

Tourism represents an economic sector with a limited contribution to Romania's Gross Domestic Product (GDP), despite the diversity of tourist attractions (historical, cultural, academic, business, corporate events, leisure, health, balneo-climatic, wellness, etc.) present in all regions of the country, distributed across all types of terrain (plains, plateaus, mountains, the sea, lakes). Romanian tourism is somewhat seasonal: the flows of resident and non-resident tourists are oriented towards mountain resorts during winter and the Black Sea coast resorts in summer.

The analysis of official statistics provided by the National Institute of Statistics (NIS) highlights two other defining touristic features: the prevalence of the business tourism sector (trade fairs, conferences, symposiums, exhibitions, etc.) and leisure tourism (holidays, cultural and sporting events, visiting friends and relatives, transit and other activities). International tourists spend too little time in Romanian destinations (about 2 nights per stay), indicating a weekend tourism pattern with limited expenses. An increasing number of residents in Romania prefer tourist destinations abroad (summer in Greece, Turkey, Bulgaria, and other destinations; winter in Switzerland, Austria, Bulgaria, etc.) in resorts well known for higher quality tourist services, more diverse, and attractive of activity options compared to those offered by domestic travel agencies and tour operators.

Even though economic entities in the tourism industry have had access to minimis[1] aid schemes, the so-called "incoming tourism", which refers to attracting non-resident tourists, remains problematic. In recent years, the tourism sector has benefited from certain fiscal incentives (tax and fee reductions) granted to commercial entities operating in this industry. According to the National Trade Register Office (NTRO), based on an analysis of data from the period 2014-2017, commercial companies in Romania operating in the hotel-restaurant-cafe sector (HORECA) recorded average revenue increases of 18.10%, decreases in net losses by 24.55%, and micro-enterprises reported increases in declared profits by 92%. As a percentage of GDP, the tourism sector evolved from 1.96% of GDP in 2014 to 2.98% in 2019, prior to the outbreak of the COVID-19 pandemic.

Before the pandemic outbreak, approximately 539 million tourists from around the world visited EU member countries, representing 37% of the

1. De minimis aid is a financial measure provided by the Romanian Government and granted to an enterprise, irrespective of its size, which does not exceed EUR 200.000 over three fiscal years.

total number of international tourists. The importance of this sector for the European economy is also reflected in the share of tourism in the European GDP. According to Eurostat, in 2019, tourism generated 9.9% of the European Union's gross domestic product (GDP) and 11.6% of total employment in EU member countries.

Eurostat (2022) further reveals that in July and August 2020, domestic arrivals at tourist accommodation units in the EU decreased by 9%, while the decline in international arrivals was significantly more pronounced, at 65%, compared to July and August 2019. During the same period, hotels and similar structures were the most affected types of tourist accommodations (-39%), followed by short-stay accommodation structures (-31%), such as guesthouses, hostels, tourist villas, etc. The COVID-19 pandemic affected, to a lesser extent, individual or family-owned tourism focused on camping grounds, amusement parks, caravan parks, and mountain or coastal destinations, as they are more "socially distant" destinations compared to the specific destinations of mass tourism (-13%).

A special report from the European Court of Auditors (2021) specifies that the EU does not play a direct role through public policies in developing tourism but rather indirectly by providing financial support for operators through various assistance programs. During 2014-2020, there was no dedicated EU budget for tourism, and no such support instrument was planned for the 2021-2027 financial exercise. However, it should be noted that the European Regional Development Fund (ERDF) includes a specific objective to support tourism. Additionally, the Recovery and Resilience Facility (RRF), through the National Recovery and Resilience Plans (NRRPs), provides member states with funding pipelines for investment projects in the field of tourism, which must be submitted by the end of 2023.

According to NIS data, 2019 marked a significant milestone in the development of tourism, both in terms of the increase in the number of arrivals and overnight stays in tourist accommodation units and the growth of this economic sector's contribution to the formation of the GDP. In 2019, the direct contribution of tourism to the national economy was 31,564.6 million RON (approximately 6.5 billion euros), with the tourism sector's share in Romania's GDP being 2.98%. During the same year, the ripple effects (direct and indirect impact) on Romania's GDP were 6.1%, but in 2020, this indicator decreased to 2.9% of GDP.[1]

During the pre-pandemic period from 2015 to 2019, the number of foreign tourists arriving in Romania increased by 20%. In the same period,

1. *Cf.* World Travel & Tourism Council, https://wttc.org/research/economic-impact/economic-impact

international tourism revenues showed a milder growth (+14.6% in 2019 compared to 2015). The positive trend observed until 2019 was abruptly interrupted, as the COVID-19 pandemic severely impacted tourism. While in 2019, foreign tourists' expenditures amounted to nearly 1.5 billion euros, in 2020, they decreased to less than 250 million euros, and in 2021, they reached approximately 400 million euros, which is 72.5% less than in 2019. The average expenditure per foreign tourist decreased by 4.6% during the period from 2015 to 2019 and by 11.5% in 2021 compared to 2019.[1]

According to the World Economic Forum (*Travel & Tourism Competitiveness Index*[2], 2019 edition), Romania ranks 56th out of 140 countries, compared to Bulgaria, which ranked 49th, the Czech Republic 37th, Hungary 41st, Poland 47th and Serbia 95th place. Although it scores moderately in most indicators, Romania occupies low positions concerning government prioritization of the tourism and travel industry (120th place), the efficiency of marketing and branding to attract tourists (103rd place), government spending on the development of this industry (111th place), the quality of tourist infrastructure (119th place), the quality of road infrastructure (113th place), and the sustainability of tourism industry development (113th place).

According to research conducted by the National Institute of Statistics (NIS) regarding the spending of international tourists in Romania in 2019, the main reasons for their arrival in our country are primarily business-related (participation in conferences, courses, fairs, exhibitions) and leisure travel. The largest share of expenditures made by international tourists was represented by accommodation expenses (approximately 50%), followed by expenditures in restaurants, bars, clubs, etc. (18%), and various purchases (13%). The same NIS research shows that out of the total international tourists, 48.6% accessed package tours through travel agencies, while 32.3% organized their trips independently. The rest of the trips had different organizers (trade unions, etc.) accounting for 10.6% and a combination of travel agency and international tourist organizing for 8.5%. International tourists arriving in Romania primarily use aeroplanes (80.7%), personal cars (11%), buses and coaches (6.8%), and other means of transportation (trains, riverboats, rented cars, motorcycles, etc., 1.5%). The poor state of roads and rail infrastructure discourages tourism, including the number of arrivals and overnight stays of international tourists in Romania.

1. Romania's National Strategy for Tourism Development 2023-2035, https://turism.gov.ro/web/wp-content/uploads/2022/11/SNRDT-actualizat-var-pt-HG-2023-2035.pdf

2. *Cf.* World Economic Forum https://www.weforum.org/reports/the-travel-tourism-competitiveness-report-2019/#economy=ROU

The COVID-19 pandemic effectively led to the collapse of tourism due to the imposition of necessary sanitary restrictions to prevent and combat this threat to public health (Raiu, Mina Raiu, 2022). The reduction in tourists' spatial mobility was reflected in statistical indicators: a decrease in the number of visitors, arrivals at tourist accommodation units, overnight stays, and revenue from services provided by tourism operators. In the context of the transition from "in-office" work (office/employer's premises) to "remote" work (online), the concept of "online tourism" emerged, referring to the organization of visits, guided tours, and travel itineraries offered by travel agencies, museums, libraries, cultural institutions, and more. In a study evaluating tourism during the pandemic crisis, published in the Journal of Sustainable Tourism (2022), Stefan Gössling and Nadja Schweiggart highlight that online tourism will remain an alternative for many people, considering the increasing costs of travel, financial instability, and concerns related to the seasonality of influenza, coronaviruses, or other infectious diseases.

2. THE IMPACT OF THE COVID-19 PANDEMIC ON INTERNATIONAL TOURISM

At the outset of the COVID-19 pandemic, there were few reasons for optimism regarding the tourism industry, which was heavily impacted by the restrictions on tourist mobility, including post-pandemic considerations. While managing the pandemic crisis, focusing on ensuring health and public safety, specific approaches emerged that essentially proposed a transition from mass tourism to sustainable tourism, as indicated in a research study by Cristiana Păvăluc et al. (2020). According to data from the United Nations World Tourism Organization (UNWTO), the HORECA industry and passenger transport industry were among the most affected economic sectors during the pandemic.

In a dedicated research study on the impact of the COVID-19 pandemic on tourism (Christine Volkmann et al., 2020), perspectives on tourism in Romania were analyzed, and a series of measures were proposed to support this sector, which was severely affected by the exceptional health situation. The methodology used included a series of semi-structured interviews and a questionnaire administered to Prahova County's hotel industry representatives. The research identified the following issues facing tourism during the pandemic: ensuring the cash flow of companies, workforce layoffs, and increased risk of insolvency or bankruptcy with the impact on other economic activities dependent on tourism (production of goods and

services, trade, freight and passenger transport). As solutions, the study proposed providing tourist packages to encourage individual or family tourism in specially protected and physically distanced spaces under sanitary safety conditions.

The study on the ”Impact of the COVID-19 Pandemic on Economic Activities in the Services and SMEs Sectors”, conducted by a group of researchers from the Costin C. Kirițescu National Institute for Economic Research of the Romanian Academy (Bălteanu et al., 2020), revealed that, as early as March 2020, hotel occupancy rates had dropped by 40% in Bucharest and over 50% in resorts. Due to the sanitary restrictions imposed by public authorities responsible for pandemic management, over 90% of accommodation units were closed. The forecasts by the National Institute of Statistics (NIS) during that period indicated that the activity of those units would record a temporary negative balance of -99%, while travel agency activities would see a -97% conjunctural balance. Travel agencies were forced to cancel reservations and reimburse the cost of vacations and tour packages, facing the risk of bankruptcy and exit from the market.

How the COVID-19 pandemic affected the tourism sector has also concerned researchers at the Ovidius University in Constanța. They emphasized in the conclusions of an article published in the Annals of this institution that the global GDP decreased by 3.3% in 2020 compared to 2019. Within the European Union, there was a 6.1% decline in GDP in the pandemic year 2020 compared to 2019. The EU ranked second internationally regarding the decline in international tourist arrivals in 2020, reaching -60% in March 2020. Constanța County represents a seasonal tourist destination that was not spared from the decline in the number of tourists during the pandemic year 2020. However, in the summer of 2021, the number of arrivals in tourist accommodation units in Constanța County increased compared to the 2019 level. This can be explained by the reduction in external travel by resident tourists in Romania to foreign destinations. The Black Sea coast region was the most popular destination for domestic tourists in Romania during the summer season of the pandemic year 2021 (Firică & Popovici, 2021).

In a study conducted by Bianca Mitrică and other researchers (2022) from the Institute of Geography of the Romanian Academy, based on surveys administered to tourists, businesses, and residents in the sub-Carpathian and Carpathian regions of Buzău, attention is drawn to the issues faced by local cultural tourism during and after travel restrictions (loss of income, temporary business closures, and layoffs / technical unemployment), as well as the preferences and travel sentiments of tourists and the attitudes and behaviors of residents. The entrepreneurs interviewed using the questionnaire outlined

the following consequences of the COVID-19 pandemic on local tourism: "reduction in the number of external visitors", "forced closure of the unit", and "reduction in the number of domestic visitors".

The COVID-19 pandemic had an unprecedented impact on tourism worldwide, drastically reducing tourist flows and, consequently, the revenues of businesses in this economic sector. In the first three quarters of 2020, the number of foreign tourists in the EU was 67.5% lower than in the same period of 2019. The decline varied between 46% and 84%, depending on the member state in question. According to the World Travel & Tourism Council (WTTC, 2021), due to the sanitary restrictions in the pandemic year 2020, the EU lost approximately two million jobs in the tourism and travel sector; the contribution of tourism to the GDP was halved compared to 2019 (from around 10% to 5% of GDP).

From the top ten tourist destinations in 2019, eight countries were on the list of the top 20 countries with the highest number of COVID-19 cases, according to an analysis by Le Thanh Tung (2021) based on data provided by UNWTO and Worldometers. The top tourist destination countries accounted for approximately 35.9% of global COVID-19 cases. The same author suggests that the pandemic can be an opportunity for a reset based on different principles, directions of action, and ways of accessing global tourist destinations. The vaccination campaign was expected to change the trends in the global tourism industry and related economic sectors.

In the study by Dong-Shang Chang and Wei-De Wu (2021) regarding the impact of the pandemic on the tourism industry, it is stated that the transmission of the SARS-CoV-2 virus was facilitated by the mobility of tourists from different parts of the world, which is why sometimes radical measures to restrict travel flows became necessary. Throughout history, especially in the era of globalization, human mobility has led to crises, including the spread of viruses and infectious diseases. The study by the two Taiwanese researchers focused on modelling the contradictions/conflicts between stakeholders in the tourism industry (governments, travel agencies, tour operators, transportation companies) to establish the factors for implementing a decision-making model (Gap Model of Tourism Stakeholders - GMTS) in the context of pandemic crisis management.

Both the negative and positive effects on the tourism industry have been the subject of a secondary data analysis conducted by Cláudia Seabra and Ketan Bhatt (2022), who started from the premise of redefining international tourism on sustainable development coordinates. Analyzing UNWTO data, Seabra and Bhatt show that the worst year in the history of international tourism was the pandemic year 2020 when there was a 74% decrease in international

tourist arrivals (approximately one billion fewer tourists compared to 2019). Restricting access at border crossing points, cancelling trips, and the widespread fear of contracting the SARS-CoV-2 virus were the factors that led to a drastic reduction in international tourism. This unprecedented situation caused significant financial losses to tourism entrepreneurs, leading to the closure of many businesses. The mentioned study proposes a conceptual framework for tourism managers and destination planners to identify new opportunities and sustainable solutions during the postpandemic period.

3. RESEARCH METHODOLOGY: STATISTICAL INDICATORS, DATA SOURCES AND HYPOTHESIS

The research methodology consists of a geostatistical analysis based on data from official providers to describe how the data is associated with spatiotemporal phenomena - Romanian tourism before and after the COVID-19 pandemic, in international and European context. The data were processed with ArcGIS Pro and Philcarto computer programs.

Eurostat defines "tourism" as the sum of activities undertaken by visitors travelling to a destination outside their usual residence for less than one year for business or leisure purposes. The tourism sector encompasses a wide range of economic activities that provide goods and services accessed by visitors: transportation services facilitating the movement of people, travel agencies and tour operators; accommodation services; restaurant and catering services; cultural, sports, and recreational facilities, and local tourism goods and services. This study will use a series of relevant statistical indicators to analyze tourist activity. Data for Romania are obtained from statistical research conducted in tourism by the National Institute of Statistics. Among these, we enumerate:

- Existing tourist accommodation capacity (TUR1B),
- Tourist demand from residents of Romania (ACTR),
- Tourist expenditures of non-residents staying in collective tourist accommodation facilities (ACNER and TOUR_PA),
- Frequency of use of tourist accommodation facilities (TUR1A).

The tourist accommodation capacity refers to the descriptive analysis of tourist accommodation units with at least 5 beds, existing as of July 31 each year. Tourist demand from domestic and international travel in Romania provides statistical indicators that describe tourist demand, the number of tourist trips, trip duration, means of transportation used, types of accommodation, number of overnight stays, expenses and their structure, the number of day trips/visits, their purpose and destination.

The paper "Tourist Demand of Residents in Romania" includes indicators such as the number of tourist trips made by residents within the country, duration, modes of transport used, expenses incurred during the trips, and excursions/day visits. The "tourist expenditures of international tourists" research aims to collect quarterly data on their expenditures in collective and private tourist accommodation units (apartments and rental rooms) to compile the Balance of Payments by the National Bank of Romania.

The frequency of tourist accommodation structures is an analysis related to the operational tourist accommodation capacity, the number of arrivals and overnight stays of Romanian and international tourists, the index of utilization of tourist accommodation capacity, and the average length of stay of tourists. All these indicators are disseminated according to the types of tourist accommodation and their comfort categories.

The Tourism Satellite Account (TSA) represents a set of techniques used and authorized by the World Tourism Organization to estimate the share of tourism in the GDP as accurately as possible. It includes expenses generated by tourism, starting from accommodation, food, transportation, cultural services, entertainment, insurance services, domestic product trade, tourist services offered by travel agencies, employment in tourism industries, and all expenses leading to the generation of the tourist monetary flow. The TSA publication allows for a fair comparison of tourism with other sectors regarding its effects on the national economy.

Tourist traffic density is an indicator calculated as the ratio between the number of tourists arriving in a specific area or country and the resident population of that area/country. This indicator aims to provide information about the level of demand in those areas/countries.

High values of the indicator are typically found in areas/countries with few inhabitants and high accommodation capacity. Increased tourist traffic density can impact the natural environment in the destination area. An important indicator used in our analysis is the total contribution of travel and tourism to the GDP. This indicator reflects both the direct and indirect contributions of the travel and tourism sector to economic growth.

The direct contribution of travel and tourism to GDP consists of (1) domestic spending on travel and tourism - representing the total expenditures in a particular country on travel and tourism by residents and non-residents for both business and leisure purposes; (2) government spending on travel and tourism services directly related to visitors. The direct contribution of travel and tourism to GDP is calculated by subtracting the internal (imported) purchases made by these sectors from the total domestic expenditures in these sectors.

In addition to the direct impact, travel and tourism have indirect and induced effects on the economy. The indirect contribution is represented by:

- Investment spending in travel and tourism – an important aspect of both current and future activities, which includes investment activities such as acquiring new aircraft and building new hotels;
- Collective government spending that supports travel and tourism activities in various ways, as they are made on behalf of the community at large (tourism marketing and promotion, administration, security services);
- Domestic (non-imported) purchases of goods and services from the supply chain by sectors directly related to tourists – including, for example, purchases of food products and cleaning services by hotels, fuel and catering services by airlines, and IT services by travel agencies.

The induced contribution of travel and tourism to GDP measures the GDP and employment supported by the expenditures of those directly and indirectly employed in the travel and tourism sector.

The existing tourist accommodation capacity refers to the number of tourist accommodation units registered in the latest reception, approval, and classification document of the tourist accommodation establishment. The data is obtained from the annual statistical survey ”Existing Tourist Accommodation Capacity as of July 31” conducted by the National Institute of Statistics. A tourist accommodation establishment with lodging functions is any construction or arrangement that provides accommodation services and other specific services for tourists on a permanent or seasonal basis (only structures with a capacity of at least 5 units are included in statistical research).

The indices of net utilization of operational tourist accommodation capacity are calculated by dividing the number of overnight stays made by the functional tourist accommodation capacity during the respective period. The arrival of a tourist is recorded when a person is registered in the database of the tourist accommodation facility for one or more nights. One arrival is counted per tourist regardless of the number of overnight stays.

Overnight stay represents a 24-hour period during which a person is registered in the records of the tourist unit space and benefits from lodging under the applicable room rate. Another important indicator is the average length of stay, calculated by dividing the number of overnight stays by the number of tourist arrivals.

The research questions (hypothesis) are: (1) Which is Romania’s position in international and European tourism; (2) how did Romanian tourism evolve in the pre-and post-pandemic period (2019-2022); (3) what

are the regional disparities in Romanian tourism reflected in the official statistics?

4. DATA ANALYSES, CARTOGRAPHIC PROCESSING, RESULTS

The tourism sector has always been a significant factor in the global economy, bringing financial benefits and contributing to the development of nations worldwide. However, the position of each country in the tourism economy can vary significantly based on natural resources, infrastructure, government policies, and other factors.

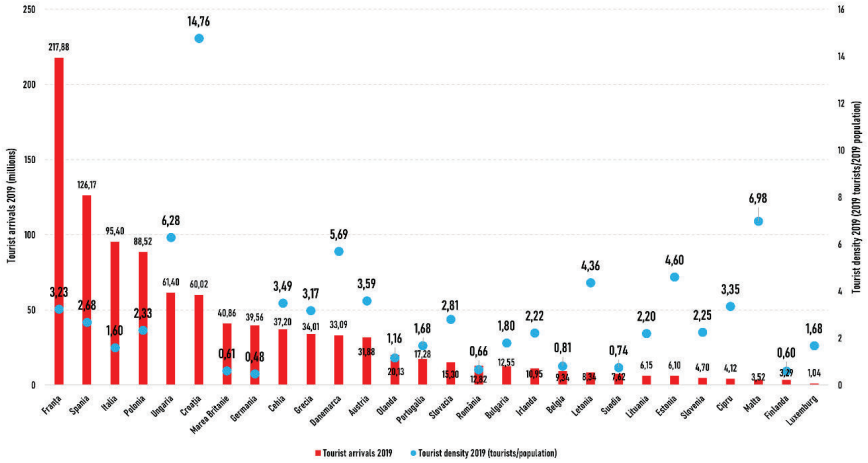
Perspectives on the tourism economy are often shaped by statistics that illustrate the impact of this sector on a country's Gross Domestic Product. In the European and international context, Romania stands out as a tourist destination that experienced significant developments before the onset of the COVID-19 pandemic (March 2020) but is still seeking its distinct position in the global tourism landscape as national economies recover in the post-pandemic period (after March 2022).

4.1. Romania's Position in the International and European Tourism Economy

As official statistics highlight, Romania did not hold a significant position in the tourism economy within the European Union in 2019. France dominated the EU tourism market with 217 million tourist arrivals, representing 22.5% of the European market share and 9.1% of the global market. The following countries held the following positions within the European Union (EU-28) rankings: Spain (126.1 million), Italy (95.4 million), and Poland, with 88.5 million tourist arrivals (Figure 1).

Tourist arrivals recorded at European Union (EU-28) and tourist density for 2019

Figure 1



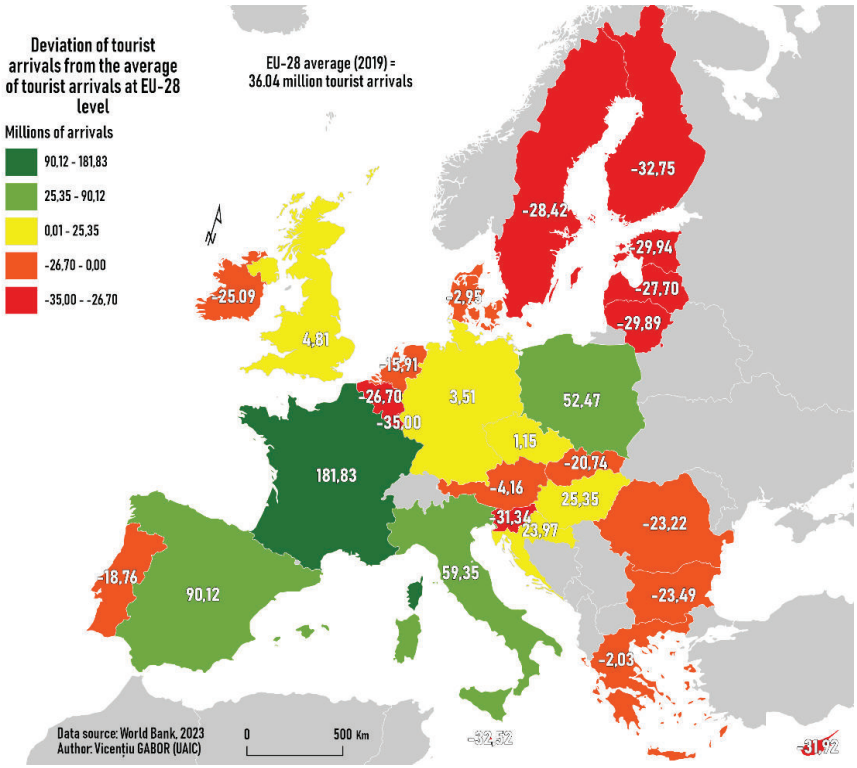
***Data Source**: World Bank 2023*

Poland's position at the top of this ranking is surprising and serves as a model for other less-developed tourism states within the European Union. Once a modest player in the European and international tourism market, Poland has gradually become more visible in the tourism sector. The country has implemented a series of sustainable tourism development policies, especially after overcoming the economic crisis (2008-2012), which significantly impacted the tourism sector between 2009 and 2010.

Within the European Union (EU-28) in 2019, the average number of tourist arrivals was 36 million. The countries whose figures exceeded the EU average were as follows: France, with a deviation of over 182 million from the EU average; Spain +90 million; Italy +59 million; and Poland +52 million (Figure 2).

Deviation of tourist arrivals from the European Union (EU-28) average of tourist arrivals

Figure 2



***Data source**: World Bank 2023*

Below the European Union average, there were countries with lower tourist flows: Luxembourg -35 million, Finland -33 million, Malta -33 million, and Cyprus with -32 million. Romania recorded a deviation of -23 million tourist arrivals compared to the European Union (EU-28) average (Figure 2).

In terms of tourist density, an indicator that measures the tourist intensity within a nation, Romania recorded in 2019 a ratio of 0.6 tourists per capita, compared to Croatia, where the value amounts to 14.7 tourists per capita. Thus, the tourist population present on the territory of the country over a year exceeds 15 times the total population of Croatia (4 million). This calculation indicates that a comprehensive analysis of the tourism phenomenon is insufficient when considering tourist arrivals and overnight stays indicators.

An example is that of Malta, an island nation with an area of only 316 km², which recorded 3.5 million tourist arrivals in 2019. This may seem

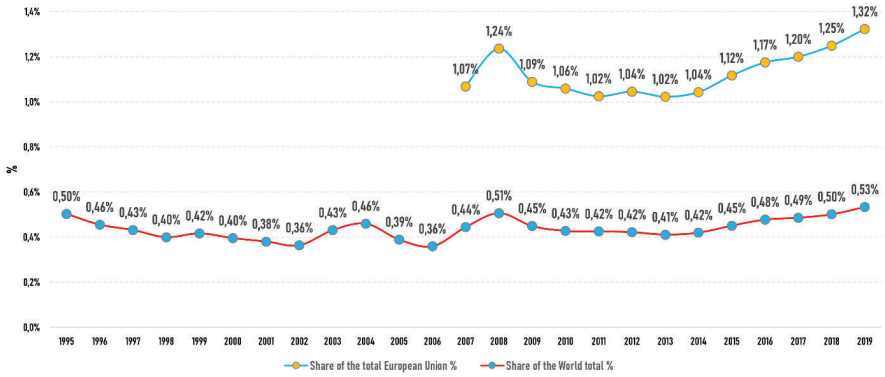
relatively low compared to the European average of 36 million tourist arrivals in 2019 (Figure 1). However, when viewed about the country's population, the tourist density rises to approximately 7 tourists per capita. This suggests that the tourism economy should not be solely measured from the perspective of absolute statistical values, such as the tourist arrival indicator, for instance.

Returning to the statistics of tourist density in Romania, the statistical data indicate that Romania has not yet fully realized its potential in harnessing the tourism sector, and there are still significant tourism capacities that can sustain much larger tourist flows than those presently experienced.

Romania's position is very modest among the countries where tourism plays a vital role in the national economy and the international tourism sector. In 2019, before the Covid-19 pandemic, Romania recorded approximately 13 million tourist arrivals, ranking 16th among the nations within the European Union. The volume of tourist arrivals represented a share of 1.32% in this economic sector at the European level and 0.53% in the international tourism market, also representing the highest values achieved by Romania to date (Figure 3).

The share of tourist arrivals from Romania out of the total tourist arrivals at the European and global levels

Figure 3



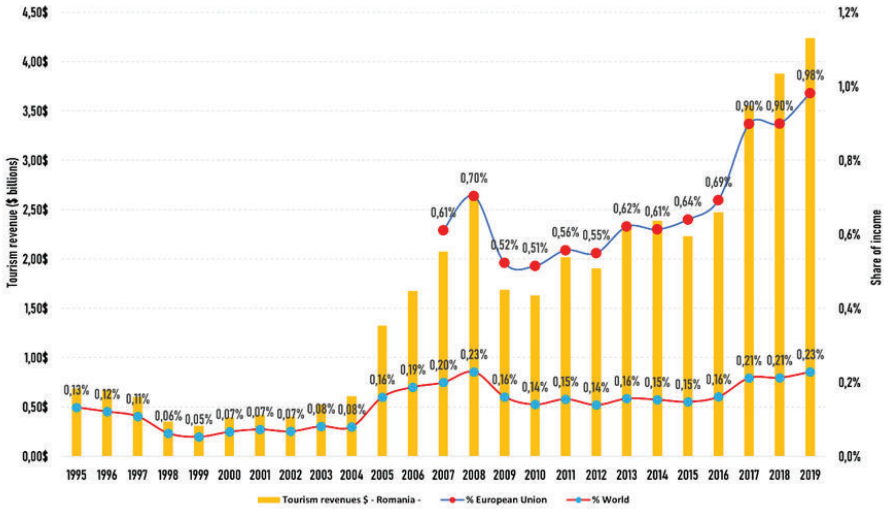
***Data source**: World Bank 2023*

Concerning the financial importance of the tourism sector in Romania, data from the World Bank showed that Romania generated revenues of 4.24 billion dollars in 2019, representing the highest revenues ever recorded according to available statistics (1995-2019). The value of 4.24 billion dollars represents 0.98% of the revenues generated by the tourism sector within the European Union and 0.23% of the global revenues (Figure 4). For the current

situation, there is not enough data available for an efficient comparison with 2019, but overall, based on existing indicators, the revenues from this sector have significantly decreased, and the Romanian tourism market has contracted, especially during the onset of the COVID-19 pandemic.

Evolution of tourism revenues in Romania between 1995 and 2019

Figure 4



***Data source**: World Bank 2023*

According to the World Travel and Tourism Council (WTTC), the contribution of tourism to Romania's Gross Domestic Product (GDP) in 2019 amounted to 6%, a value that includes travel. Excluding travel, the tourism sector's share in the Gross Domestic Product was only 2.98%, according to data provided by the National Institute of Statistics for the year 2019.

These moderate share values indicate that the tourism sector is essential for the Romanian economy but less vital than other European economies, such as Croatia, Greece, Albania, etc. Inevitable crises can lead to vulnerability for nations whose economies significantly rely on this economic sector. During times of crisis, regardless of their nature, the tourism sector is the first economic victim due to the specific nature of this industry, easily influenced by economic and social factors, as the ongoing fluctuations between anxiety and financial well-being present in a given temporal context shape it.

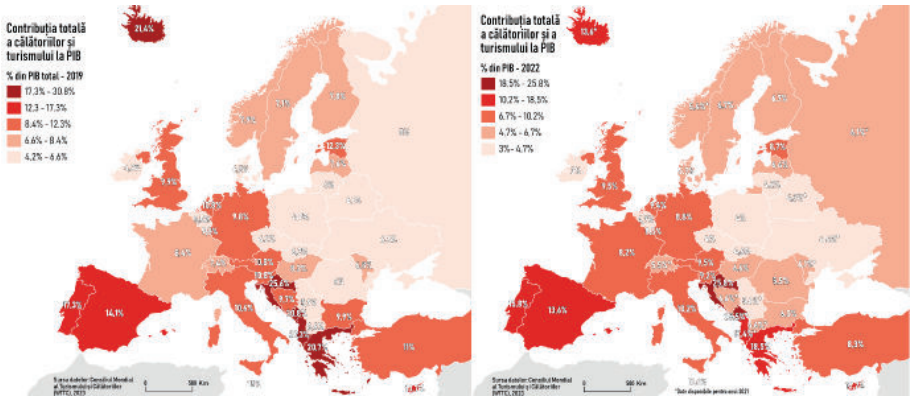
In 2019, several European nations had economies highly dependent on the tourism sector: Montenegro – 30.8% of the Gross Domestic Product, Croatia

– 25.6%, Iceland – 21.4%, Greece – 20.7%, and Albania – 20.3%. Despite potential vulnerabilities, tourism has been and still is a driver of economic development in these countries, even though, for a short period, the economic engine of tourism stalled due to COVID-19 lockdown regulations (Figure 5).

Contribution of tourism and travel to the national Gross Domestic Product - 2019/2022

Figure 5

(%)



***Data source**: World Travel and Tourism Council, 2023*

Ireland (4.2%), Poland (4.8%), and Russia (5%) were at the opposite end of the scale, indicating that statistical data should always be interpreted with caution. A lower proportion of tourism in GDP does not necessarily imply underdevelopment of this economic sector; decreased proportions can indicate greater diversity in other economic sectors.

Taking into account the situation in Poland, which ranked fourth in the European Union in terms of the number of tourist arrivals in 2019, it can be observed that the tourism sector does not represent vital importance to the national economy, significantly since these proportions are increasingly constrained by other economic sectors, such as the Information and Communications Technology (ICT) industry, which is on the rise.

In 2022, tourism continued to play an essential role in the economies of European states, but with a diminished role compared to the pre-COVID-19 pandemic period (before March 2020). Croatia, a nation whose share of the tourism sector in GDP has seen an increase, managed to achieve a contribution to GDP of 25.8%, with this percentage also including travel.

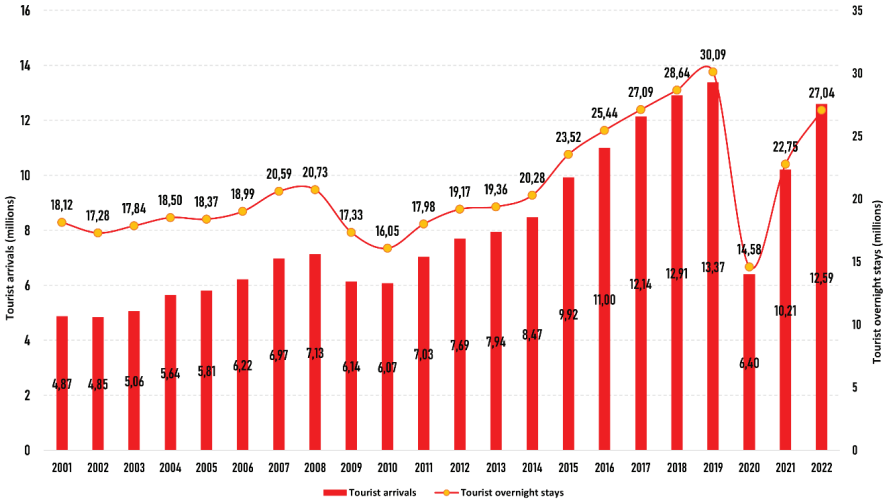
Romania's tourism sector contribution to GDP in 2022 was 5.5%, representing a half-percent decrease compared to 2019, according to data provided by WTTC (Figure 5).

4.2. Regional Disparities in the Romanian Tourism

Figure 6 shows an upward trend in tourist arrivals and overnight stays in Romania from 2001 to 2008. The economic crisis led to a decline in tourist activity in 2009 and 2010, but starting from 2011, the trend in tourist arrivals and overnight stays has been on the rise, reaching its peak in 2019. With the onset of the COVID-19 pandemic, there was a sharp decrease in tourist arrivals and overnight stays in Romania.

Evolution of tourist arrivals and overnight stays in Romania between 2001-2022

Figure 6



***Data source**: NIS 2023*

There are a number of territorial disparities in terms of tourist attractiveness across Romania. The number of tourist arrivals is not evenly distributed across the entire country. In 2019, the majority of tourist arrivals were recorded in the following locations: Bucharest (2 million tourist arrivals), Brașov (681,244 arrivals), Constanța (618,755), Cluj (488,742), and Sibiu (415,836). These five locations combined accounted for 16.48% of tourist flows in Romania. The intensity of these flows is a consequence of the natural and human potential present in these geographical areas (Figure 7).

The geographical areas encompassing Bucharest, Brașov, Constanța, and their surrounding localities represent archetypes of niche tourism, while simultaneously being the main tourist hubs in Romania, accounting for 36.1% of tourist flows in the country.

The city of Bucharest also boasts the highest number of international passenger air connections and serves as the primary gateway for tourists entering Romania. The Brașov region has recently established itself as one of the most important brands embedded in both the national and European collective consciousness, considered a representation of Romania's mountain tourism. Likewise, Constanța, with its Black Sea resorts, is regarded as an established hallmark of Romania's coastal tourism.

One of the notable trends in 2019 was the significant increase in the number of tourists who chose to visit Romania, setting a record for both Romanians and foreigners: out of 13 million registrations, 2.6 million were foreigners, according to data provided by NIS. This growth was the result of efforts to promote domestic tourist destinations and develop tourist infrastructure.

The COVID-19 pandemic had a major impact on Romanian tourism, leading to a drastic decrease in the number of tourists in 2020. This decline was driven by the pandemic-related restrictions that limited the movement of people and tourist activities.

During the period 2020-2021, domestic tourism experienced significant growth, driven by the legislative and financial constraints on international travel imposed due to pandemic management. This circumstance temporarily encouraged travel within the country. Romanians were compelled to spend their vacations within the country, leading to an increased demand for domestic tourist destinations and even the development of lesser-known tourist areas compared to traditionally established ones.

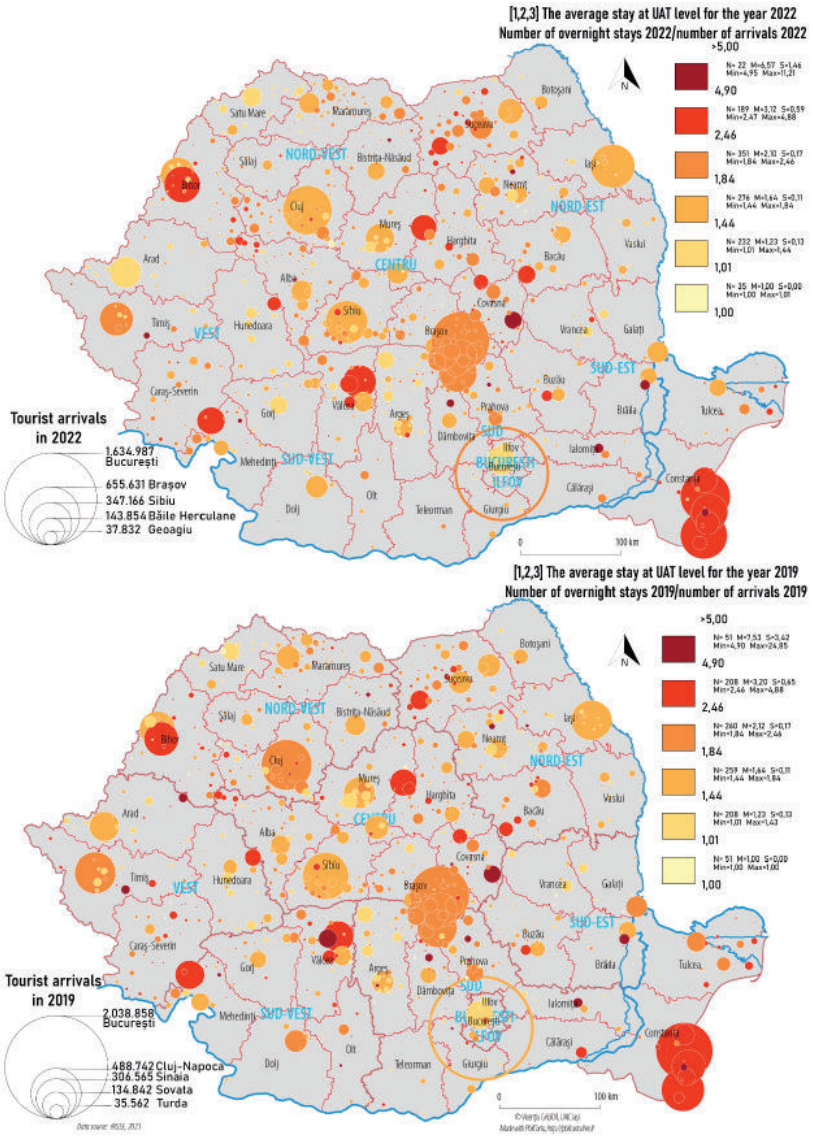
In the same time, rural and adventure tourism saw high demand, primarily due to the increased interest in nature-based vacations. Romanians sought relaxation and outdoor experiences in the rural and mountainous regions of the country (Figure 7). 2022 has brought about several changes in the structure of tourist arrivals, despite the fact that tourism in Romania has demonstrated a degree of resilience in the face of the pandemic. Many of Romania's localities have not fully recovered from the decline caused by the pandemic. In contrast, other localities have experienced growth compared to the pre-pandemic period.

In terms of the number of tourist arrivals, Satu Mare county has recorded the highest increase in 2022 compared to 2019 (+23.22%), followed by Covasna county (17.11%), Alba county (+12.86%), Suceava county

(+11.95%), and Iași county (11.56%). Nationwide, the number of arrivals decreased by 6.25% in 2022 compared to 2019.

Geographical distribution of tourist arrivals and average stay at locality level

Figure 7



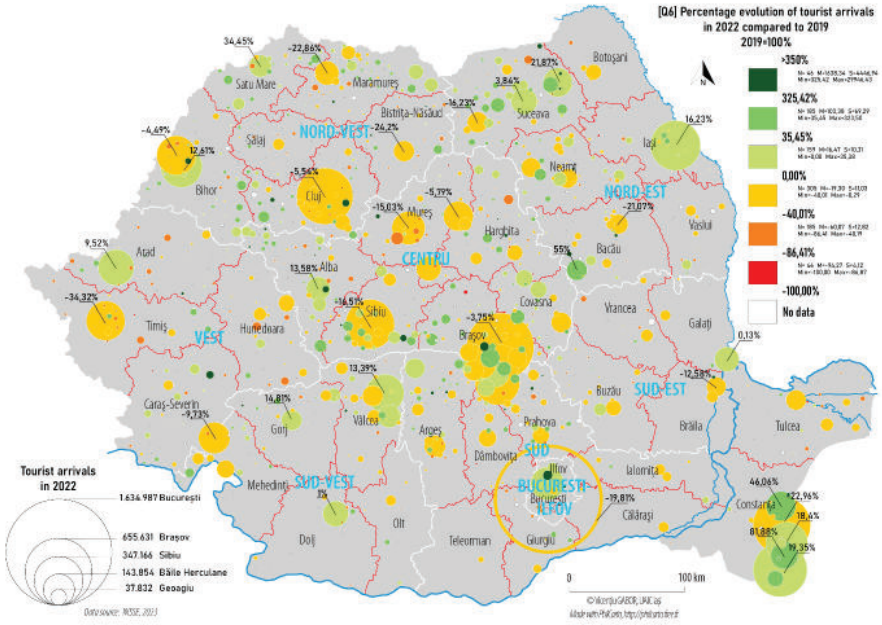
***Data source**: NIS 2023*

Among the localities that registered increases in the number of tourist arrivals in 2022 compared to 2019, notable mentions include: Limanu (85.8%), Costinești (81.7%), Slănic Moldova (55%), Satu Mare (34.45%), and Suceava (21.87%). Among Romania's major cities, Iași municipality (16.23%) and Arad (9.52%) demonstrated a high degree of recovery in the tourism sector, with a new trend of increasing arrivals observed in these localities.

The other major cities are still facing declines in arrivals, with the most significant decrease recorded in Bucharest area, -19.8%, representing an absolute loss of 403,871 tourist arrivals (Figure 8).

Evolution of tourist arrivals between 2019-2022

Figure 8



***Data source**: NIS 2023*

Another noteworthy aspect, in terms of developments, is the revitalization of the tourism sector on the Romanian coast, with all coastal resorts experiencing increases in arrivals, except for the Constanța municipality (-22.96%).

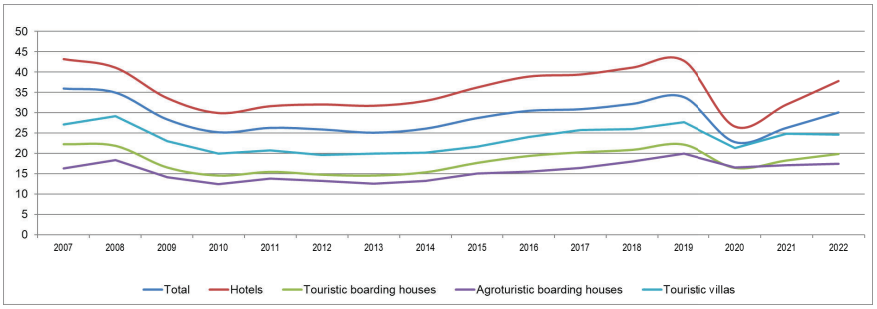
In Romania, the average length of stay decreased in 2022 compared to 2019, from 2.25 days to 2.15 days. More significant declines were observed in the counties of Olt (from 2.77 days to 1.95 days), Călărași (from 2.44 days to 1.81 days), and Vâlcea (from 3.6 days to 2.88 days).

In 2022, the highest average length of stay values were recorded in Ialomița county (3.9 days), Covasna (3.59 days), and Constanța (3.27 days). Resilient high values of the average stay duration are represented by localities with spa resort status, where tourists tend to spend more days compared to the national average: Bălțătești (average stay of 9 days), Sângeorz-Băi (8 days), Pucioasa (7 days), Amara (7 days), Covasna (6 days), etc.

An important indicator in analyzing the evolution of tourism activity is the net utilization index of accommodation capacity.

The evolution of the index of net using the tourist accommodation capacity in the period 2007-2022

Graph 1



Data source: *NIS, 2023*

According to the above graph, the net utilization index of accommodation capacity for total tourist accommodation establishments peaked in 2007 (36%) and a minimum in 2020 (22.8%). In 2022, the index value is 29.1%, lower than the value in 2019 (33.9%). Regarding types of tourist accommodation establishments, the highest net utilization indices of accommodation places were recorded for hotels.

Tourist accommodation structures in Romania represent another essential element of the country's tourism and economic sector, significantly impacting regional development and employment.

Classification of establishments of touristic reception with functions of tourists accommodation (excluding apartments and rooms for rent)

Table 1

Establishments of touristic reception	Anul 2019	Anul 2022
Agroturistic boarding houses	2800	3484
Touristic boarding houses	1669	1696
Hotels	1625	1629
Touristic villas	709	758
Bungalows	557	493
Hostels	323	313
Touristic chalets	222	220
Motels	219	207
Other accommodation establishments	278	320
TOTAL	**8402**	**9120**

Data source: *NIS 2023*

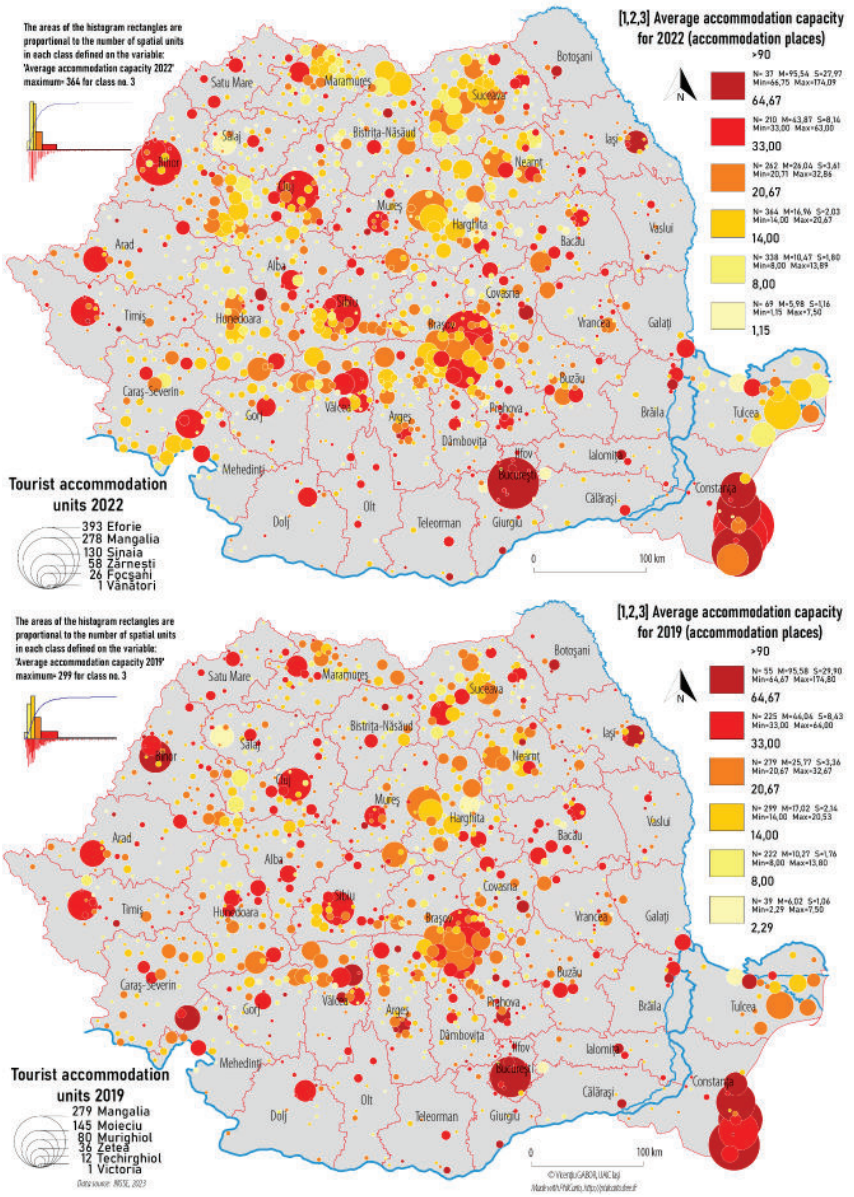
From the table above, we can observe that by the end of July 2022, the number of tourist accommodation units (excluding apartments and rented rooms) in Romania was 9,120, representing an increase of 8.5% compared to 2019. The most significant growth is in the segment of agrotourism guesthouses, which increased from 2,800 units in 2019 to 3,484 tourist accommodation units by the end of July 2022.

Of the tourist accommodation structures with accommodation functions, 27.5% were in mountain resorts, 16.3% in the Bucharest area and county residence cities (excluding Tulcea), 8.6% in coastal resorts (excluding Constanța), 7.1% in spa resorts, 4.7% in the Danube Delta (including Tulcea), and 35.8% were in other localities and tourist routes.

Tourist accommodation structures significantly impact local economies by providing employment opportunities. These units require staff for administration, cleaning, kitchen, maintenance, and other services, thus contributing to local workforce employment. This role as an employer is vital in rural or economically less developed areas.

Geographical distribution of accommodation units and average accommodation capacity at locality level

Figure 9



***Data source**: NIS, 2023*

In total, the accommodation capacity of establishments (excluding apartments and rented rooms) in Romania amounted to 356,562 accommodation places in 2019 and 367,386 in 2022, representing a growth of 3.0% compared to the situation in 2019. These values encompass various units, from hotels with thousands of rooms to smaller guesthouses and campgrounds.

The distribution of these accommodation places varies according to geographical areas and the specific requirements of tourists. For example, mountainous areas may have a higher density of cabins and guesthouses, while the Black Sea coast has a significant concentration of hotels and tourist complexes (Figure 9).

The tourist accommodation structures in Romania, distributed across the entire country, represent not only facilities for tourists but also an essential economic engine. Their diverse accommodation capacity, coupled with their role as local employers, contributes to regional development and improving the quality of life in local communities. A detailed study of these aspects can provide valuable information for the planning and further development of the tourism industry in Romania.

4.3. A Comparative Analysis of Tourism in Iași county versus Cluj county in the Post-Pandemic Period[1]

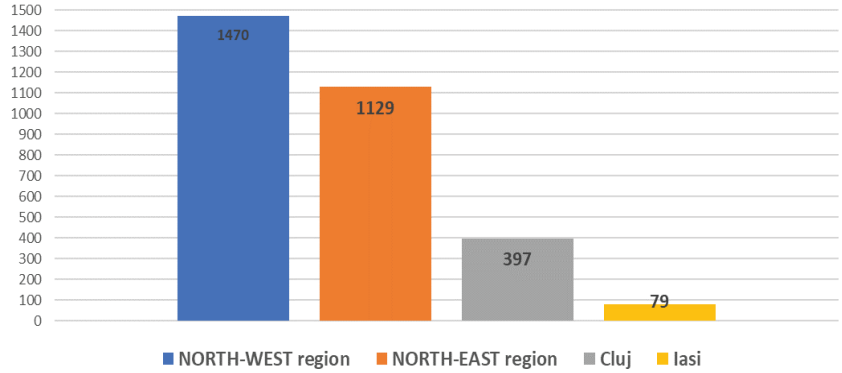
One primary indicator that describes the level of tourism development in an administrative-territorial unit (region, county, locality) pertains to the accommodation infrastructure for tourists (tourist accommodation structures), which includes buildings or facilities (hotels, hostels, motels, guesthouses, inns, tourist villas, etc.) that provide permanent or seasonal accommodation, restaurant, recreational, and other services.

According to NIS data, in 2020, there were 9,120 tourist accommodation structures nationwide, with 397 in Cluj county and 79 in Iași county. In practical terms, by the end of 2022, Cluj had five times more tourist accommodation structures than Iași.

1. This section represents the revised and expanded form of an article that was written by Ciprian Iftimoaei, the Deputy Executive Director of the Iasi County Statistical Directorate, in the context of his work as a member of the Technical Group for the elaboration of the Tourism Marketing Strategy for Iasi County. The article was published in the daily newspaper *Ziarul de Iași* on July 10, 2023: https://www.ziaruldeiasi.ro/stiri/iasi-versus-cluj-o-comparatie-privind-sectorul-turismului--357446.html

Comparison of Cluj *versus* Iași regarding establishments of touristic reception

Figure 10

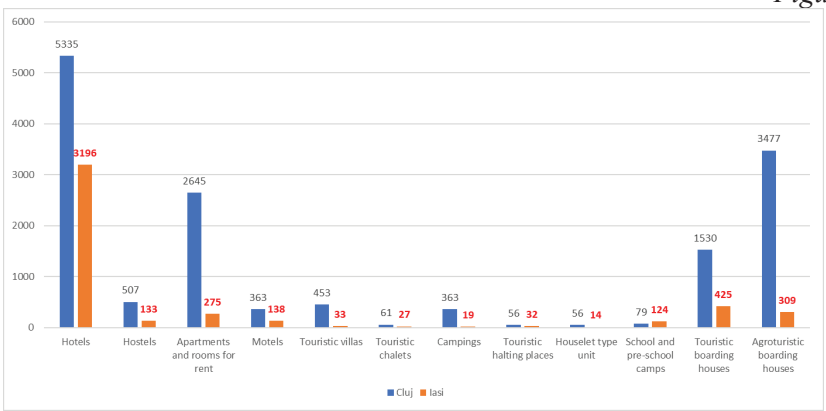


Data source: *NIS*

At the end of 2022, the tourist accommodation structures in Iași county provided a total of 4,149 places (of which 2,930 were in hotels), while Cluj county offered a total of 9,340 units (of which 5,515 were in hotels). It is observed that the Transylvanian county provides more than twice as many accommodation places as the Moldovan county. Most of accommodation places are in hotels (over 50% in both counties), followed by agrotourism guesthouses, tourist guesthouses, and motels.

Comparison of Cluj *versus* Iași based on existing touristic accommodation capacity

Figure 11



Data source: *NIS*

The second analyzed indicator is the number of arrivals in tourist accommodation structures. The arrival of a tourist in a tourist accommodation structure with accommodation functions is recorded when a person is registered in the register of that structure to be accommodated for one or more nights. In each tourist unit with accommodation functions, a single arrival per tourist is considered, regardless of the number of overnight stays resulting from their uninterrupted stay.

In Iași County, in April 2023, compared to the corresponding month of the previous year, arrivals in tourist accommodation structures with accommodation functions recorded an increase of 10.8%. As for Cluj County, in April 2023, compared to April 2022, arrivals in tourist accommodation structures increased by 23.9%.

Arrivals and overnight staying – comparison Iași *versus* Cluj

Table 2

Statistical indicator	IAȘI			CLUJ		
	April 2023 -number-	April 2022 -number-	April 2023 compared to April 2022 - % -	April 2023 -number-	April 2022 -number-	April 2023 compared to April 2022 - % -
ARRIVALS	31371	28304	10,8	52142	42098	23,9
OVERNIGHT STAYING	51424	50076	2,7	95974	72771	31,9

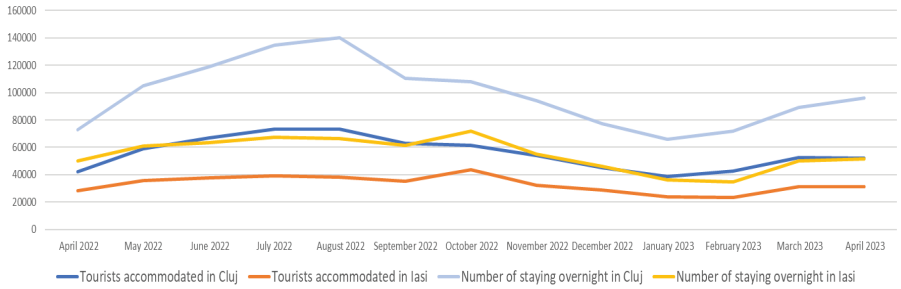
Data source: *NIS*

The third indicator used in the comparative analysis is the number of overnight stays in tourist accommodation structures. An overnight stay represents a 24-hour, starting from the hotelier hour, during which a person is registered in the records of the tourist accommodation structure and benefits from accommodation for the rate associated with the occupied space.

In the tourist accommodation structures in Iași county, in April 2023, there were 51,424 overnight stays, which is 2.7% higher than in April 2022 (50,076 overnight stays). The overnight stays recorded in the tourist accommodation structures in Cluj county, in April 2023, totaled 95,974 overnight stays, marking a 31.9% increase compared to the overnight stays in April 2022 (42,098 overnight stays). Based on the data presented so far, it is evident that Cluj county surpasses Iași in terms of both the dynamics of the number of arrivals and overnight stays in tourist accommodation structures in April 2023 compared to the same month in 2022.

Dynamics of arrivals and overnight staying:comparison Cluj *versus* Iași

Figure 12



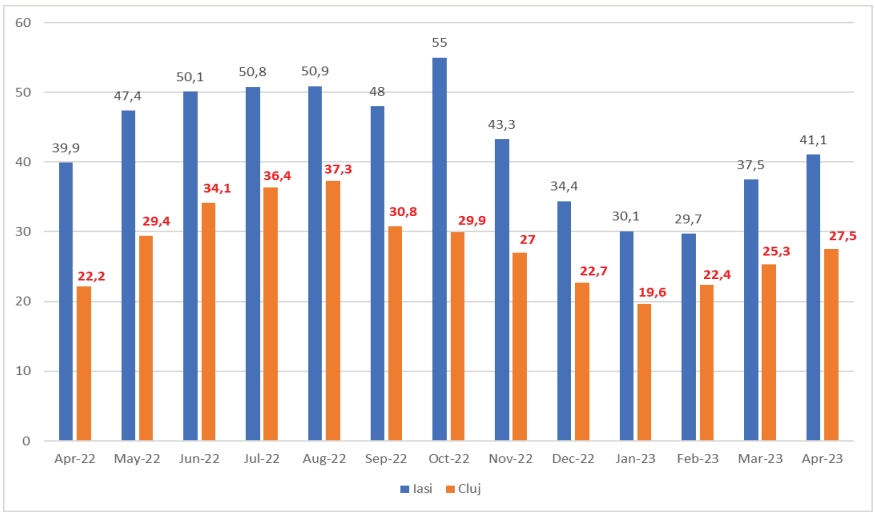
Data source: *NIS*

The fourth statistical indicator we analyze is the net utilization index of operational accommodation capacity, which is calculated by dividing the number of overnight stays by the operational accommodation capacity for a specific period. In April 2023, the net utilization index of accommodation places in Iași county was 41.1% for total tourist accommodation structures, which was 1.2 percentage points higher compared to April 2022. In Cluj county, the net utilization index of accommodation places in April 2023 was 27.5%, marking an increase of 5.3 percentage points compared to April 2022.

Although Iași county has a weaker accommodation capacity compared to Cluj, its net utilization index is better, with a peak recorded in October of each year when Iași celebrates its city's holidays and the feast of St. Paraskeva (Raiu, 2021). In October 2022, the net utilization index of tourist accommodation capacity in Iași county reached 55%. In Cluj county, the highest value of the net utilization index of accommodation capacity was recorded in August 2022, at 37.3%.

Index of net using the touristic accommodation capacity: comparison Cluj *versus* Iași

Figure 13



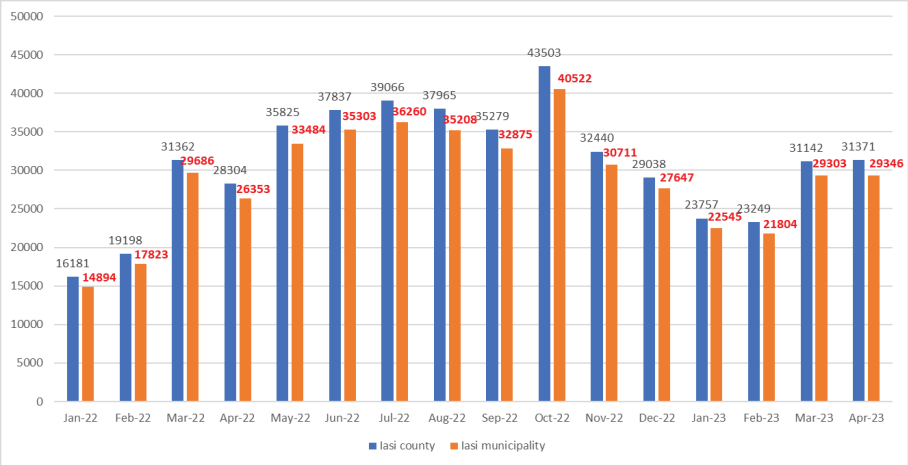
Data source: *NIS*

During the period from January 1 to April 30, 2023, arrivals recorded in the tourist accommodation structures in Iași county amounted to 109,519 persons, showing a 15.2% increase compared to the same period in 2022. Romanian tourists' arrivals in tourist accommodation structures with accommodation functions represented 84.1% of the total number of arrivals during the mentioned period, while foreign tourists accounted for 15.9%.

The overnight stays recorded in tourist accommodation structures totaled 172,501, marking a 7.0% increase compared to the same period in 2022. In Iași county, the average length of stay was 1.58 days (1.56 days for domestic tourists and 1.67 days for international tourists).

Arrivals in the accommodation units of Iaşi county by comparison with those in the Municipality of Iaşi, in the period January 2022-April 2023

Figure 14

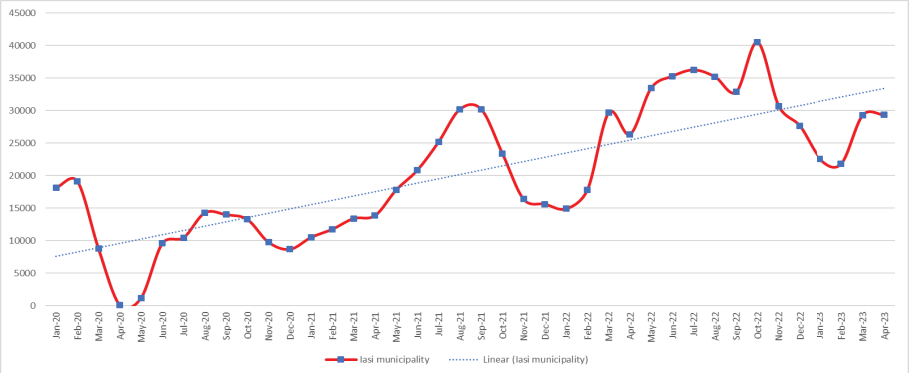


Data source: *NIS*

Tourism in Iași county is concentrated to a 90% extent in the county's seat, the city of Iași, with a peak in arrivals and overnight stays in tourist accommodation structures recorded in the month of October each year, coinciding with the celebrations of Iași and the pilgrimage to the relics of St. Paraskeva due to the high degree of religiosity of Romanians. The majority of cultural, religious, and historical tourist attractions are concentrated in the city of Iași. Representative landmarks include the Palace of Culture, surrounded by the Palas commercial complex, historical cathedrals and monasteries, and universities.

The evolution of the number of tourist arrivals in the Municipality of Iaşi in the period January 2020-April 2023.

Figure 15



Data source: *NIS*

Regarding the recovery of the tourism industry after the COVID-19 pandemic, Mihai Bulai (2023), the Vice Dean of the Faculty of Geography and Geology at Alexandru Ioan Cuza University in Iași, considers that Iași is the only major city (with over 250,000 inhabitants) that recorded a surplus of 23,000 tourists in 2022 compared to the pre-pandemic year 2019, surpassing the challenging period caused by the pandemic crisis. All other major cities had deficits in 2022 compared to 2019: Timișoara (-116,000 tourists), Cluj-Napoca (-86,000 tourists), Constanța (-35,000 tourists), Brașov (-35,000 tourists), Bucharest (-400,000 tourists). Professor Mihai Bulai explains the repositioning of Iași in the national tourism hierarchy in 2022 through the launch of tourism development projects such as the Tourism Strategy of the City of Iași, the expansion of the Information and Communication Technology (ICT) industries, the permanentization of events such as the local products fair, the artisans fair, the organization of youth music festivals, and the hosting of events like" Iași - Youth Capital 2019-2020" and" Iași - City Break Destination of the Year 2022", among others.

In an analysis article based on NIS data published in Ziarul de Iași, Cristina Petrache (2023) points out the following:" While at the level of significant cities, Iași was the only one that had a positive balance in 2022 compared to 2019 [...], at the county level, it ranked third, after Constanța and Suceava. In fact, out of 42 counties (including Bucharest), only 12 had more tourists last year than in the year before the pandemic, 2019, and four of these counties were from the North-East Development Region: Suceava (2nd place), Iași (3rd place), Bacău (10th place), and Neamț (12th place)."

In Cluj County, 186,048 tourists were accommodated between January 1 and April 30, 2023. Compared to the same period in 2022, the number of tourists arriving in Cluj County increased by 34.7%. The overnight stays recorded in the tourist units in Cluj County during the reference period totalled 172,501, an increase of 7.0% compared to the same period in 2022. The average length of stay for tourists in Cluj County was 1.58 days (1.56 days for domestic tourists and 1.67 days for international tourists).

Cluj County, particularly its capital, is a tourist attraction due to its historical, cultural, academic, and multicultural significance. It creates a distinct ”sense of place” that predominantly appeals to open-minded youth seeking diversity, modernity, and progress. It is worth noting that in 1581, the Jesuit College of Báthoryan was founded, the first institution of higher education on the territory of present-day Romania. This tradition, spanning centuries, has led to Cluj-Napoca’s status as the most prominent university city, hosting approximately 100,000 students annually in universities that offer Romanian, Hungarian, German, English, and French programs. The ”Babeș Bolyai University” is the highest-ranked university in the country. In contrast to the pilgrimage of the feast of St. Parascheva (Raiu, Mina Raiu, 2022), the UNTOLD festival serves as a sort of modern post-secular pilgrimage for young people from all over the world, drawn by the magic of electronic music and artists who perform at the impressive Cluj Arena stadium.

Both counties and counties’ residences have high tourism potential. Still, it is underutilized, reflected in the dynamics of the net utilization index of tourist accommodation capacity and in the relatively low average length of stay of tourists. In Cluj County, more international tourists arrive (about ~20%) compared to Iași (~16%). Both counties are insufficiently promoted from a tourism perspective and rely on short-term tourism, city breaks, weekends, business trips, and participation in academic, cultural, and artistic events.

Tourism in Iași County is primarily for weekends, business, academic, cultural, and religious exchanges (Raiu, 2022). The average stay in tourist accommodation structures in Iași County is 1.63 days for Romanian tourists and 1.70 days for foreign tourists. Due to the lack of highways connecting Iași to western Romania and Europe and the Republic of Moldova and Ukraine, the central transportation hub is Iași Airport, which has become increasingly busy until the inauguration of the new terminal.

By developing road, railway, and airport infrastructure, Iași county could easily catch up with Transylvania, including through better marketing of the tourist potential in the metropolitan area of the county seat and certain specific tourist destinations within the county. In my opinion, one of the objectives of the Tourism Marketing Strategy for Iași County should be

transitioning from weekend tourism to at least seasonal tourism and, in the long term, to tourism based on relatively permanent destinations, attractions, and events.

5. CONCLUSIONS

International comparisons based on official statistics show Romania occupies a relatively marginal position in the global or European tourism industry. Before the outbreak of the COVID-19 pandemic, Romanian tourism reached a turning point, recording the highest share of GDP (2.98%) from 2008 to 2019. The lowest share of tourism's contribution to Romania's GDP was recorded in 2010 (1.81%) when the world was shaken by the global economic crisis (2008-2012). From the analysis of these crises, a somewhat positive fact emerges, namely that the decrease in the contribution of tourism to GDP affects the national economy less compared to countries where development depends to a large extent on this sector.

In 2019, before the COVID-19 pandemic, Romania recorded approximately 13 million tourist arrivals, ranking 16th among the European Union nations. World Bank data showed that our country generated revenues of $4.24 billion in 2019, representing the highest revenues recorded up to that point. Financial data analysis confirms that 2019 was the best year for Romanian tourism.

During 2020-2021, domestic tourism saw a significant increase, driven by legislative and financial constraints on international travel imposed due to pandemic management. Residents were forced to spend their vacations within the country, leading to increased demand for domestic tourist destinations and even the development of lesser-known tourist areas compared to traditionally popular ones. During this period, we also witnessed a revival of rural and adventure tourism, driven by an increased interest among resident tourists for vacations in nature. During the pandemic, more and more domestic tourists flocked to forests, lakes, mountains, and those secluded or less frequented coastal areas compared to the pre-pandemic period.

Currently, Romanian tourism faces the following structural problems: (1) a low share of foreign tourists visiting Romania compared to resident tourists; (2) a low number of overnight stays in tourist accommodation structures, resulting in low revenues; (3) non-competitive quality of services and tourist products provided by businesses operating in this field; (4) insufficiently promoted tourist attractions at the national and international levels; (5) a lack of an efficient mechanism for cooperation among relevant stakeholders (central and local public authorities, HORECA businesses,

destination management experts) in shaping public policies in the field of tourism.

NIS data shows that 2022 marks a recovery of tourism in Romania. Currently, efforts are being made in the Romanian tourism market to develop this economic sector, including the launch of the National Strategy of Romania for Tourism Development, which will guide the directions of action for 2023-2035.

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The Effect of Health Care Renunciation of Pregnant Women on their New-Borns' Health

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ABSTRACT

The paper aims to assess the effect of health care renunciation by pregnant women for financial reasons on the health status of their new-borns. A sample of 512 women who gave birth at "Cuza-Voda" Maternity in Iasi was surveyed. The following methodological approach was used to reach the objectives of the study: assessment of the degree to which pregnant women renounce health care; identification of factors influencing health care renunciation; estimation of the effects of the determinant factors on health care abandonment by pregnant women; assessment of the health status of new-borns; estimation of the effect of health care abandonment by pregnant women on the health of their new-borns. The following statistical methods were applied: Student test, Chi-Square test of independence, binary logistic regression, and nomogram. The results of this study highlighted that socio-demographic factors, psychological factors,

and at-risk behaviour factors have significant influence on health care renunciation by pregnant women. Moreover, the new-borns' health is significantly influenced by the health care renunciation by the mothers during their pregnancy period.

Keywords: *vulnerable population, healthcare access, pregnancy, inequalities, unmet need of health care*

JEL Classification: *I14, J13, P36*

1. INTRODUCTION

Pregnant women are one of the most vulnerable populations. Previous studies concerning pregnant women have been focused primarily on two dimensions. One dimension comprised the analysis of the effect of at-risk behaviour (smoking, alcohol drinking, unbalanced diet) on the health of mothers and their new-borns. A second dimension included the analysis of the determinants of healthcare renunciation by pregnant women (Ancelot, Bonnal and Depret, 2017).

This study aims to assess the effect of health care renunciation by pregnant women on the health status of their new-borns. The descriptive statistics was used to assess the degree to which pregnant women renounce health care and measure the health status of the new-borns. The association analysis and Chi-square test were used to identify the determinants of health care renunciation by pregnant women. The logit models were used to estimate the effect of the influence factors on health care renunciation by pregnant women and to estimate the influence of health care renunciation on the health of the new-borns. The nomogram was used to provide a graphical presentation of the influence factors on health care renunciation.

The case study was conducted on a sample of pregnant women from Romania. The infant mortality demographics in Romania places this country first in the European Union, with infant mortality of 7.8 (number per 1,000 live births) in 2015, a figure which is more than double compared to the EU average, instead of being on a decreasing trend of the last years in other countries. Moreover, fertility in Romania was on a decreasing trend after 1990, the economic situation and the health insurance system failing to provide proper conditions for supporting and stimulating the health care of pregnant women (Jaba et al., 2013). Moreover, migration of women in their fertile age has become more intense.

The paper is divided into five sections. After the Introduction, the literature review section overviews recent studies on healthcare renunciation, in general, and looks specifically into the case of pregnant women and their effect on the health of the new-borns. The third section describes the

sample, the variables, and the methods. The fourth section presents the main results in terms of quantification of the new-borns' health by putting forward an indicator for their health status; the influence of determining factors on health care renunciation by pregnant women; and the influence of health care renunciation by mothers on their new-borns' health. The fifth section contains the main conclusions of the study.

This study is based on the research project PRaSoP (*Precarity, Healthcare Renunciation and Perinatality: A French-Romanian comparison*) that implied the collaboration of researchers from the Alexandru Ioan Cuza University of Iaşi, Romania and the University of Poitiers, France.

2. LITERATURE REVIEW AND RESEARCH HYPOTHESES ON HEALTHCARE RENUNCIATION

Over the last years, there has been a growing interest for the study of healthcare renunciation for financial reasons.

Healthcare renunciation is influenced by the cumulating effect of different dimensions of precarity. Healthcare is correlated with different characteristics: positive correlation with the fact of being women, education level, social support; and negative correlation with income, age, good health status and health insurance coverage (Després et al., 2011; Dourgnon et al., 2011; Litaker and Love, 2005; Mollborn et al., 2005; Wu, 2005; Allin and Masseria, 2009; Allin et al., 2010). Other studies looking at Switzerland (Guessous et al., 2014) and Canada (Thompson et al., 2014) have shown that women renounce dental healthcare for financial reasons more often than men.

In Eastern European countries, Sowa et al. (2013) observed that the poorest households, the unemployed, working-age cohorts, and women have generally more difficulties in accessing health care. The study of Atanasova et al. (2016) noted that treatment costs are the most common reason for forgoing medical care in Bulgaria. There were identified significant differences in access to health care services between urban and rural areas, as well as among income groups. Arora et al. (2016) showed that Rroma inhabitants in Central and Eastern European countries are two to three times more likely having reported over the previous 12 months having unmet health needs than non-Rroma living nearby.

For France, studies on healthcare renunciation showed the existence of two types of renunciation: the barrier renunciation and the refusal renunciation (Despres et al., 2011; Chauvin et al., 2012; Dourgnon et al., 2012; Despres, 2013). These two types of renunciation go along in situations of great precarity.

Chaupain-Guillot et al. (2014) identified for the French population during the 2004 – 2007 period that the main determinants for renouncing healthcare and dental care services include household income, age, health status, and marital status (especially for women).

After analysing the SHARE database for 16 European countries, Bouba-Olga and Vigé (2014) found that total healthcare renunciation is correlated with the following factors: negative correlation with age, education level, the fact of living in a couple, the number of children, the social network and the chronic illnesses; and positive correlation with being unemployed and staying at home.

Baggio et al. (2017) investigated the reasons for healthcare renunciation among young adults in higher education in France. The following characteristics are associated with higher level of healthcare renunciation: older, less educated students are more likely to renounce; markers of adulthood, not having enough money, bad health satisfaction, chronic illness, being depressed, and feeling isolated.

For Switzerland, Guessous et al. (2012) identified that forgoing healthcare for economic reasons is associated with the following socioeconomic factors: lower income, female gender, smoking status, lower job position, having dependent children, being divorced and single, paying a higher deductible, and receiving a premium subsidy.

Mielck et al. (2009) studied the association between forgoing care and household income in population aged 50 or above in five countries (France, Germany, Greece, Italy and Sweden). Low income groups report having foregone care more often than high income groups (except Italy), foregone care being more prevalent among women than men (except Germany). The prevalence of foregone care increases with the decrease of self-assessed health.

Studying healthcare renunciation for financial reasons by pregnant women, Ancelot and Depret (2013) reported that health care renunciation is multifactorial and is due to socio-economic, psycho-social, behavioural, as well as institutional and medical factors.

The literature discusses the issue of subjective versus objective renunciation. For instance, Allin et al. (2010) outlined the two dimensions of healthcare renunciation (objective and subjective): the declared renunciation and the effective consumption of healthcare. Moreover, Ancelot et al. (2017) compared the subjective (the claim of individuals that they have renounced healthcare) and the objective renunciation (effective resort of patients to healthcare services) and identified the major effect of socioeconomic factors on failing to seek treatment.

Dourgnon et al. (2011) argue that the need for healthcare is perceived differently by each individual. Self-assessed unmet needs have a negative causal effect on future health status, contributing to social health inequalities (Dourgnon et al., 2012).

However, studies on healthcare renunciation by pregnant women, as well as on its effect for their health and that of their new-borns are less frequent.

In France, recent studies on health status of pregnant women analysed the effect of precarity and poverty on the perinatal pathologies and prematurity (Lejeune, 2008). Gayral-Taminh et al. (2005) revealed that deprivation is an important perinatal medical risk factor. Deprivation is associated with more difficulties during pregnancy and in the perinatal period. Moreover, using data of French National Perinatal Survey, Ancelot et al. (2018) analysed for the first time the impact of health care renunciation by pregnant women on the health status of their new-borns.

A French-Romanian comparative study (Ancelot et al., 2020) emphasised the inequalities in the use of health care during pregnancy. The unmet need for health care during pregnancy is measured considering both the World Health Organization (less than four visits to a health specialist and two ultrasounds) and the French National Authority for Health (less than seven prenatal visits, no more than two ultrasounds) recommendations for pregnancy monitoring. For both countries, there was found a relationship between perinatal health care abandonment and social, informational, and psychological inequalities.

In the United States, Howell and Blondel (1994) identified a strong relationship between the socio-economic and cultural precarity and perinatal pathologies. Rustgi et al. (2009) stressed out that women have more problems than men in accessing needed care due to cost. Moreover, several studies looking at the United States provided some evidence that the extension of health insurance coverage Medicaid to higher income groups of women led to a decline in infant mortality (Howell, 2001).

In this study we measured the subjective health care renunciation by pregnant women. Considering the findings of previous studies on health care renunciation and its effect on new-borns health, the following hypotheses were formulated:

H_1: Health care renunciation by pregnant women hinges on the characteristics (socio-demographic, psychological, etc.) of this population.

H_2: Among the determining factors of health care renunciation by pregnant women, the following factors may be considered: education, income, marital status, psychological factors, and alcohol and cigarette consumption.

H_3: Health status of new-borns is influenced by the health care renunciation of their mothers during their pregnancy.

To verify the hypotheses of this research, the proper statistical methods have been applied to data collected through sample survey of pregnant women.

3. DATA AND METHODOLOGY

3.1. Sample and variables

Data were collected from a sample survey of pregnant women hospitalised at the "Cuza Vodă" Maternity in Iasi. The "Cuza-Vodă" Maternity is one of the most important maternities in Romania, being the main maternity in the North-East region of the country. From the list of women eligible to take part in the survey, we excluded the women whose health status prevented them from filling in the questionnaire within 72 hours after giving birth. The mothers who were in the hospital during the post-partum period refused to take part to the survey due to medical (bad general health status, tiredness, pain) or personal reasons.

The questionnaire was developed using the questionnaire used in the French National Perinatal Survey. The questions were grouped into three sections: (1) socio-demographic situation; (2) pregnancy and (3) birth and the new-borns. The questionnaire was pre-tested in a theoretical and practical framework. After pre-testing the questionnaire on 30 women during the post-partum period, we reconsidered the variants of answers for certain questions.

The questionnaire was completed by face-to-face survey. A total number of 513 questionnaires were completed, 512 of which were validated. The refusals were not associated with any social category or with mothers having specific demographic characteristics. The aim of the survey was presented to every woman, with the consent of the medical staff.

The variable reflecting the subjective renunciation of health care services during pregnancy matches to the following question: *During pregnancy, have you been constraint to renounce consultations, medical investigations, or dental treatments due to financial reasons?* The question had two possible answers: *Yes* (1) and *No* (0).

To assess the new-borns' health status (*NBHS*), we suggested a variable based on the characteristics used by the World Health Organization (*WHO*) for defining the health status of the new-borns. These characteristics include the Apgar score, birth weight, and the gestational age (Apgar, 1953; Casey et al., 2001; Whitfield et al., 2007). The new variable *NBHS* is derived from these three characteristics. Therefore, if only one of the new-borns' health status characteristics has values corresponding to a good health of the new born, then

the overall *NBHS* is considered to be good; while if two or more of the new-borns' health characteristics have values that indicate precarious health, then overall *NBHS* is considered to be poor. The new variable describing the *NBHS* is a dummy variable: poor health (1) and good health (0).

3.2. Methods

To measure the effect of health care renunciation by pregnant women on the health status of the new-borns, we applied the following approach of statistical analysis. To study the relationship between health care renunciation due to financial reasons and the socio-demographic, psychological and behavioural characteristics of pregnant women, the following tests were applied: (1) the Chi square test – to analyse the association between two categorical variables; (2) the Student test for independent samples – to test the differences in the means of the two populations for numerical variables.

To assess the effects of determinant factors on health care renunciation by pregnant women and to estimate the effect of health care renunciation on the *NBHS,* the binary logistic regression model was estimated.

We estimated a logit equation, which is a linear function modelling the logarithm of probability of having response *Y = 1* (*Precarious health*) to the predetermined baseline category *Y = 0* (*Good health*).

The dependent variable is the logarithm of odds (*logit*) or the odds. Therefore, the logit equation can be written as eqn. [1] or [2] (Agresti, 2002; Andrei and Bourbonnais, 2017):

$$\ln Odds = \ln\left(\frac{P(Y=1 \mid X)}{P(Y=0 \mid X)}\right) = \beta_0 + \beta_1 X_1 + ... + \beta_k X_k \quad [1]$$

$$Odds = \left(\frac{P(Y=1 \mid X)}{P(Y=0 \mid X)}\right) = e^{\beta_0 + \beta_1 X_1 + ... + \beta_k X_k}, \quad [2]$$

where: Y – is the binary dependent variable; $X = (X_1, X_2, ..., Xk)$ – is a set of explanatory variables which may be continuous or categorical or both; β_k – are the logit coefficients that express the amount to which the logit changes with one unit change in X_k, e^{β} are the exponential function of regression's coefficient that expresses the amount to which the odds changes (odds ratio - OR).

To assess the quality of the logistic regression model, the likelihood ratio test was estimated, while to validate the accuracy of the model, we estimated the area under the ROC (Receiver Operating Characteristic) curve,

namely AUC (Area under Curve) (Kleinbaum and Klein, 2010; Hosmer and Lemeshow, 2000).

The results of the binary logistic model were graphically shown using the nomogram (Yang, 2013; Lionte et al., 2017). The nomogram is an exploratory data analysis method that can be applied as user-friendly graphic interface for the visualisation of a complex model equation (Kattan and Marasco, 2010; Zhang and Kattan, 2017). The importance of a variable in the model is positively correlated with the dimension of the line corresponding to that specific variable. The Kattan-style nomograms were generated in STATA software using the *nomolog* program for the binary logistic models (Zlotnik and Abraira, 2015).

4. **RESULTS AND DISCUSSIONS**

4.1. The association between the socio-demographic characteristics of pregnant women and the renunciation of health care services

At the sample level, 25.59% of pregnant women gave up health care. There are different types of factors that explain women's behaviour related to health care, among which, the most important are socio-demographic, psychological and at risk-behaviour factors.

The social and demographic characteristics of pregnant women in relation to health care renunciation are described in Table 1. The results show that more than a quarter of the pregnant women in the sample from the North-Eastern region of Romania (25.59%) gave up examinations, medical exams or dental care for financial reasons, while 74.41% of pregnant women in the sample did not.

We analysed the association between the following socio-demographic characteristics and health care renunciation: age, education, place of residence, marital status, employee status, monthly revenue and medical coverage at the beginning of pregnancy.

For all socio-demographic characteristics, the values of the chi square test are statistically significant. Therefore, the socio-demographic profile of the two groups of pregnant women who gave up health care and who did not is statistically different.

Considering age, we may note that by applying the independent samples T Test, the Student statistics is significant. The women who renounced health care are on average aged (26.09), which is statistically smaller than the average age of women who did not (28.87 years).

There is a significant association between the marital status and health care renouncement, only 16.10% married women gave up health care services

during their pregnancy due to financial reasons, while 53% of unmarried women also renounced health care. Women from rural areas dropped health care services due to financial reasons to a higher extent than women from urban areas. Moreover, less educated women (no education, or no primary and secondary education) renounced to a greater extent health care services than those with higher education.

The relationship between socio-demographic characteristics and health care renunciation by pregnant women

Table 1

Social and demographic characteristics of pregnant women	Total	Health care renunciation		Test Statistic
		No	Yes	
No. of observations (%)	512 (100%)	381 (74.41%)	131 (25.59%)	$t = -11{,}004$; ***
Age; Mean ± Std. Dev.	28.16 ± 6.43	28.87 ± 5.97	26.09 ± 7.25	$t = 3.947$; ***
Education level; N (%)				
Primary education	29 (5.66%)	8 (27.6%)	21 (72.4%)	$\chi^2 = 123.110$; ***
Lower secondary	135 (26.37%)	68 (50.4%)	67 (49.6%)	
Upper secondary	150 (29.3%)	115 (76.7%)	35 (23.3%)	
Short-cycle tertiary	16 (3.13%)	15 (93.8%)	1 (6.3%)	
Bachelor / master / doctoral degree	182 (35.55%)	175 (96.2%)	7 (3.8%)	
Place of residence; N (%)				
Urban	272 (53.12%)	238 (87.5%)	34 (12.5%)	$\chi^2 = 52.189$; ***
Rural	240 (46.88%)	143 (59.6%)	97 (40.4%)	
Marital status; N (%)				
Unmarried	132 (25.78%)	62 (47.0%)	70 (53.0%)	$\chi^2 = 70.357$; ***
Married	380 (74.22%)	319 (83.9%)	61 (16.1%)	
Employee status, at the end of pregnancy; N (%)				
Employed	254 (49.9%)	136 (53.5%)	118 (46.5%)	$\chi^2 = 116.638$; ***
Unemployed	255 (50.1%)	243 (95.3%)	12 (4.7%)	
Monthly household income; N (%)				
Less than 800 RON	139 (27.15%)	54 (38.8%)	85 (61.2%)	$\chi^2 = 149.156$; ***
800 – 1.600 RON	114 (22.27%)	84 (73.7%)	30 (26.3%)	
1.600 – 3.200 RON	142 (27.73%)	134 (94.4%)	8 (5.6%)	
3.200 RON and over	86 (16.80%)	85 (98.8%)	1 (1.2%)	
Variable income	31 (6.05%)	24 (77.4%)	7 (22.6%)	
Health insurance coverage; N (%)				
Public health insurance	362 (70.84%)	309 (85.4%)	53 (14.6%)	$\chi^2 = 78.728$; ***
Private health insurance	37 (7.24%)	27 (73.0%)	10 (27.0%)	
Without health insurance	112 (21.92%)	44 (39.3%)	68 (60.7%)	

Note: *** for P < 0.001; ** for P < 0.01: * for P < 0.05.

(Source: Own calculations in IBM SPSS 22.0)

Out of pregnant women with health insurance coverage (either public or private), only 14.6% renounced health care for financial reasons, while the percentage is higher (52.3%) in case of women with no health insurance coverage.

4.2. The association between psychological characteristics of pregnant women and the renunciation of health care services

During pregnancy, more than half of pregnant women (51.76% of women) were well- surrounded by those close to them, while 42.97% of women received some protection (Table 2). The percentage of women who had little or no support during pregnancy was 5.27%. There is a significant relationship between the protection that pregnant women received from their family during their pregnancy and health care renunciation: 70.4% of pregnant women who received either little or none protection from their family gave up consultations, medical examinations or dental care due to financial reasons.

Most women were happy with the timing of pregnancy (73.19% of women). Also, 7.83% of women would have preferred getting pregnant earlier. However, 11.15% of women would have wished getting pregnant later, and 7.83% of women would have chosen not getting pregnant at all. Moreover, the state of mind when finding out about pregnancy influenced the decision of women to renounce health care: 62.5% of women who would have preferred not getting pregnant renounced health care for financial reasons. Plus, 38.60% of women who would have preferred getting pregnant later renounced health care for financial reasons.

Women having a good psychological mood during pregnancy prevail (79.49% of women), while only 13.09% of women had a fair mood. The percentage of women having a bad mood amounted to 7.42%. Among pregnant women having a good psychological mood during their pregnancy, only 22.1% renounced health care. A higher percentage of women who renounced health care was observed among those with a fair (43.3%) or bad psychological mood (31.6%).

The relationship between psychological characteristics and health care renunciation by pregnant women

Table 2

Psychological characteristics of pregnant women	Total	Health care renunciation		Test Statistic
		No	Yes	
Protection received during the pregnancy from the close persons; N (%)				
Substantial	265 (51.76%)	230 (86.8%)	35 (13.2%)	$\chi^2 = 60.009$; ***
Some	220 (42.97%)	143 (65.0%)	77 (35.0%)	
Little or none	27 (5.27%)	8 (29.6%)	19 (70.4%)	
Abortion on request during previous pregnancies; N (%)				
No	428 (83.92%)	327 (76.4%)	101 (23.6%)	$\chi^2 = 5.017$; *
Yes	82 (16.08%)	53 (64.6%)	29 (35.4%)	
State of mind when finding out about current pregnancy; N (%)				
Happiness for it happening now	374 (73.19%)	294 (78.6%)	80 (21.4%)	$\chi^2 = 42.202$; ***
I wished it had happened earlier	40 (7.83%)	36 (90.0%)	4 (10.0%)	
I wished it had happened later	57 (11.15%)	35 (61.4%)	22 (38.6%)	
I wished I had not been pregnant	40 (7.83%)	15 (37.5%)	25 (62.5%)	
General psychological mood during current pregnancy; N (%)				
Good	407 (79.49%)	317 (77.9%)	90 (22.1%)	$\chi^2 = 14.317$; **
Fair	67 (13.09%)	38 (56.7%)	29 (43.3%)	
Bad	38 (7.42%)	26 (68.4%)	12 (31.6%)	
No. of children prior to current pregnancy; Mean ± Std. Dev.				$t = -4.742$; ***
	0.96 ± 1.427	0.74 ± 1.091	1.61 ± 1.990	

Note: *** for P < 0.001; ** for P < 0.01: * for P < 0.05.

(Source: Own calculations in IBM SPSS 22.0)

There is a significant difference in the level of health care renunciation due to the number of children prior to pregnancy. The women who renounced health care have a statistically significant higher number of children compared to women who did not. Moreover, a higher percentage of women who renounced health care was noted among the women who had an abortion on request (either using surgery or medication).

4.3. The association between the behaviour at risk of pregnant women and the renunciation of health care services

Smoking behaviour has been associated with health care renunciation by pregnant women (Table 3). More women who had declared having been smoking during the 3rd trimester of pregnancy renounced health care due to financial reasons compared to non-smoking women.

Most women did not have any alcoholic beverages during their pregnancy. However, 10.74% of pregnant women drank alcohol once a month or less, and 3.91% of women had alcohol twice a month or more often. We may observe that a higher preference for alcohol consumption during pregnancy is associated with health care renunciation.

The relationship between at-risk behavioural characteristics and health care renunciation by pregnant women

Table 3

At-risk behaviour characteristics of pregnant women	Total	Health care renunciation		Test statistic
		No	Yes	
Cigarette smoking during the 3rd trimester of current pregnancy; N (%)				
No smoking	460 (89,84%)	356 (77.4%)	104 (22.6%)	$\chi^2 = 21.116$; ***
1 – 9 cigarettes	40 (7,81%)	19 (47.5%)	21 (52.5%)	
10 cigarettes and more	12 (2,34%)	6 (50.0%)	6 (50.0%)	
Alcohol consumption during current pregnancy; N (%)				
Never	437 (85,35%)	336 (76.9%)	101 (23.1%)	$\chi^2 = 12.812$; **
Once a month or less	55 (10,74%)	36 (65.5%)	19 (34.5%)	
Twice a month or more	20 (3,91%)	9 (45.0%)	11 (55.0%)	
Pregnancy reporting period				
the 1st trimester	393 (76.76%)	328 (83.5%)	65 (16.5%)	
the 2nd trimester	72 (14.06%)	36 (50.0%)	36 (50.0%)	$\chi^2 = 81.383$; ***
the 3rd trimester	26 (5.08%)	13 (50.0%)	13 (50.0%)	
No reporting	21 (4.10%)	4 (19.0%)	17 (81.0%)	

Note: *** for P < 0.001; ** for P < 0.01: * for P < 0.05.

(Source: Own calculations in IBM SPSS 22.0)

The women not having reported their pregnancy at a medical unit, or having delayed to do so were more disposed to health care renunciation compared to women having reported their pregnancy early on. Therefore, 81% of women having reported their pregnancy stated having renounced health care services.

4.4. The analysis of the effect of the socio-demographic, psychological and behavioural characteristics on health renunciation by pregnant women

To explain healthcare renunciation in relation to three groups of factors (socio-demographics, psychological and behavioural), we have estimated three logistic regression models. In the models, the explanatory variables are represented by the characteristics that were associated significantly with health care renunciation.

The results of logistic regression models concerning the effect of pregnant women characteristics on healthcare renunciation are shown in Table 4. From the set of pregnant women's characteristics under observation, only the statistically significant influences have been kept in the model, and then reported.

For employed pregnant women, the odds of renouncing health care are smaller, 67.7% compared to the unemployed women.

The effects of socio-demographic, psychological and behaviour characteristics on health care renunciation by pregnant women

Table 4

Variables	B	Odds-ratio	P value
Model for socio-demographic characteristics			
Constant	1.350	3.858	0.000
Employee status (*Unemployed*)			
Employed	-1.128	0.324	0.007
Marital status (*Not married)*			
Married	-0.911	0.402	0.001
Household monthly income (*less than 800 RON*)	-	-	0.000
800 – 1.600 RON	-0.838	0.432	0.007
1.600 – 3.200 RON	-2.081	0.125	0.000
3.200 RON and more	-3.497	0.030	0.001
variable income	-1.351	0.259	0.007
Health insurance coverage (*Without health insurance)*			0.015
Public health insurance	-0.594	0.552	0.056
Private health insurance	-1.205	0.300	0.007
No. of observations = 508	Pseudo r^2 = 0.346		
LR chi2 *(9) = 198.55; Prob = 0.0000	AUC = 0.8755		
Model for psychological characteristics			
Constant	-2.265	0.104	0.000
Protection received from close persons (*Substantial*)	-	-	0.000
Fair	1.094	2.986	0.000
None	2.413	11.173	0.000
No. of children prior to current pregnancy	0.299	1.348	0.000
Psychological state when finding out of this pregnancy (*I was happy that it has happened right now*)	-	-	0.004
I wished it had happened earlier	-0.639	0.528	0.256
I wished it had happened later	0.817	2.264	0.012
I wished I wasn't pregnant	0.955	2.598	0.016
No. of observations = 507	Pseudo r^2 = 0.1637		
LR chi2 *(6) = 94.48; Prob = 0.000	AUC = 0.7643		
Model for behaviour characteristics			
Constant	1.202	3.326	0.034
Cigarette smoking during the 3rd trimester of pregnancy (*None*)	-	-	0.008
between 1 and 9 cigarettes	1.116	3.053	0.003
10 cigarettes and more	0.691	1.995	0.325
Alcohol consumption (*Never*)	-	-	0.027
Once a month or less	0.573	1.774	0.088
Twice a month or more	1.136	3.115	0.028
Pregnancy reporting period (*No declaration*)			0.000
1st trimester	-3.032	0.048	0.000
2nd trimester	-1.485	0.227	0.016
3rd trimester	-1.750	0.174	0.013
No. of observations = 512	Pseudo r^2 = 0.1559		
LR chi2 (7) = 90.77; Prob = 0.0000	AUC = 0.7385		

Note: The category in brackets denotes the control group (reference category) in the logit regression model.
(Source: Own calculations in STATA 13.0)

Pregnant women who do not have any health insurance are more likely to renounce health care services than the insured women in public or private system. In addition, the renunciation of health care of married women is less than 60% compared to that of unmarried women. Moreover, an increase in the monthly income of the household leads to a decrease in the renunciation of healthcare.

Among the psycho-social factors, the following three have a significant effect on health care renunciation: the protection received by the mother during her pregnancy from close people, number of children before current pregnancy, and the psychological state when finding out about pregnancy. Health care renunciation becomes more important as pregnant women are less protected by those close to them. Higher number of children before current pregnancy, greater the risk of renouncing health care services. More pregnant women are happy about current pregnancy, less they renounce health care.

Risky behaviours have a significant effect on health care renunciation. Health care renunciation is greater for women who smoked in the third trimester of their pregnancy than for women who did not smoke at all. Pregnant women who had alcohol during their pregnancy are more likely to renounce health care services.

The importance of effects of explanatory variables for health renunciation is graphically represented using the nomogram.

The results obtained in the binary logistic models are presented graphically through the nomograms that allow us to highlight the importance of the variables in the model. The nomograms highlight the factors with the highest influence on healthcare renunciation.

Among the socio-demographic factors, the main influence on health care renouncement of pregnant women corresponds to household income (Figure 1).

Figure 1. The nomogram of health care renunciation in relation to socio-demographic characteristics of pregnant women

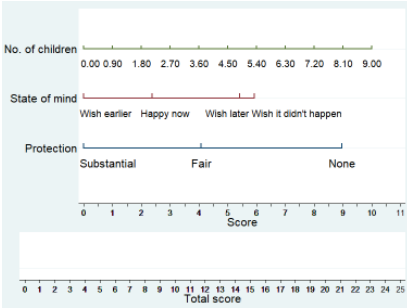

Figure 2. The nomogram of health care renunciation in relation to psychological characteristics of pregnant women

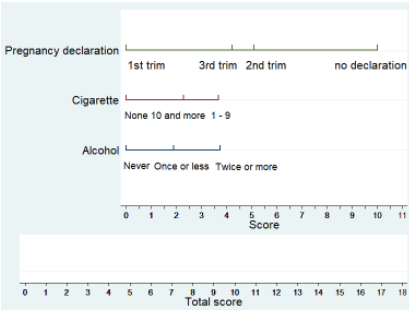

Figure 3. The nomogram of health care renunciation in relation to risk behaviour characteristics of pregnant women

Among the psychological factors, all three factors represented graphically have almost the same importance (Figure 2). Among the risk behaviour factors, the most important factor is the time span until pregnancy reporting (Figure 3).

4.5. Analysis of the effect of health care renunciation on NBHS

Finally, we have estimated the effect of health care renunciation on *NBHS* based on the following characteristics of the new-born: *Apgar score, Birth weight, Gestational age*. The composite variable defining the new-born health status is presented in Table 5 together with the variables used to create it. For the sample of new-borns, it may be noticed that the new-borns having a precarious health condition represent 12.1% of the studied population.

Definition of the health status of the new-borns

Table 5

New-born's health variables	Precarious health (1)	n (%)	Good health (0)	n (%)
Apgar score	Less than or equal to 7	53 (10.3%)	Greater than 7	460 (89.7%)
Birth weight	Less than or equal to 2500g	62 (12.1%)	More than 2500g	451 (87.9%)
Gestational age	Less than or equal to 37 weeks	120 (23.4%)	More than 37 weeks	393 (76.6%)
New-born health status (NBHS)	Two or more of the above are true	62 (12.1%)	One of the above is true	451 (87.9%)

To analyse the influence of pregnant women's healthcare renunciation on the *NBHS*, the logistic regression model was estimated. The dependent variable is *NBHS* (1 – *Precarious health*, 0 – *Good health*). Together with *Health care renunciation*, the other independent variables measuring the risk factors of *NBHS* are *Presentation of the fetus* and *Risk of premature birth* (Table 6).

Using the binary logistic regression, we have identified a significant effect of health care renunciation by pregnant women on their new-borns' health status. The likelihood of having a precarious health is higher for the new-borns whose mothers have renounced health care services during pregnancy. The effect of health care renunciation by pregnant women on *NBHS* is significant across the three estimated models.

The results of logistic regression for *NBHS*

Table 6

	M1		M2		M3	
Variables	**B**	**OR**	**B**	**OR**	**B**	**OR**
Constant	-1.070	0.343***	-1.229	0.293***	-1.600	0.202***
Health care renunciation (*No*)						
Yes	0.447	1.564**	0.470	1.600**	0.553	1.738**
Fetus presentation (*Cranial*)						
Pelvic			0.867	2.379**	0.626	1.870*
Other			2.096	8.131***	2.169	8.748***
Risk of premature birth (*No*)						
Yes, needed hospitalization					1.472	4.357***
Yes, underwent outpatient treatment					1.298	3.663***
					No. of obs. = 487	
					LR chi2 (7) = 57.63	
					Prob = 0.0000	
					Pseudo r^2 = 0.0999	
					AUC = 0.6803	

Note: The category in brackets is the control group (reference category) in the logit regression model; The symbols *, ** and *** show the statistical significance of regression coefficient with a risk of 0.1, 0.05 and 0.01, respectively.

(Source: Own calculations in STATA13.0)

The *NBHS* is also significantly influenced by fetus presentation and the risk of premature birth. A new-born is more likely to have a precarious health if the presentation of the fetus is not cranial. Furthermore, precarious health of new-borns is more likely to occur if there is a risk of premature birth and especially if pregnant women need hospitalization.

5. CONCLUSIONS

This study aimed to assess the degree of health care renunciation among pregnant women and its effect on the health of the new-borns. The case study was conducted on a sample of pregnant women from Romania.

To develop the profile of pregnant women who renounced health care due to financial reasons, we applied the association analysis and test statistics to identify and assess the determinants of health care renunciation by pregnant women. For measuring the effects of the determinant factors on the health care renunciation of pregnant women, the binary logistic regression was applied together with the nomogram.

The main results show that health care renunciation by pregnant women is associated with the socio-demographic characteristics of women. Unmarried women renounce health care more than married women. Higher is

the level of education and the monthly income, less pregnant women renounce health care. Women in rural areas renounce more health care due to financial reasons than those in urban areas.

Health care renunciation by pregnant women has also been found to be associated with the psycho-social characteristics of women. More pregnant women are surrounded by their loved ones, less they give up on care. More feelings vis-à-vis the current pregnancy are positive, less women renounce health care. Women who felt psychologically bad or somewhat bad during their pregnancy renounced health care more than those who felt psychologically well.

Cigarette smoking and alcohol consumption are health-risk behaviours associated with the health care renunciation by pregnant women.

In conclusion, the first two research hypotheses have been verified and are consistent with the results of previous studies (Ancelot et al., 2018).

Moreover, this study has outlined the importance of health care renunciation as a risk factor for the health condition of the new-borns. The results stress out that the health of the new-borns is significantly influenced by the health care renunciation by mothers during their pregnancy period. Consequently, the third research hypothesis has been validated.

Although this study adopted a subjective measure of health care renunciation (the information offered by a qualitative question), our findings are consistent with the results reported by other studies which adopted an objective definition of the unmet need for health care of pregnant women based on WHO or other national entities recommendations (Ancelot et al., 2020).

This research relied on data collected regarding pregnant women from the Moldova region of Romania. In a future study, we could extend the research area that would include all regions of the country and carry out a national survey of the representative maternity hospitals. This goal could be achieved through a research project comprising both academic and health professionals.

The findings of this research are important both at societal and individual level. In order to reduce the effects of health-care renunciation by pregnant women on the health of the new-borns, the Romanian health care system should offer affordable and high-quality health care services starting with the period of early pregnancy. Moreover, vulnerable families should be helped by supporting pregnant women get access to health care services if we want to reduce social health inequalities.

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The impact of Romania's accession to the EU on foreign trade with agri-food products

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ABSTRACT

In this paper we make an analysis of Romania's foreign trade with agri-food products between 2000 and 2020, dividing this period in two subperiods relative to the year of EU accession: pre-accession (2000-2006) and post-accession (2007-2020) periods. We identified the main effects of EU accession on the foreign trade with agri-food products emphasizing that this event has been beneficial for Romania, as since 2007 there has been a significant increase in exports for most categories of agri-food products. After the accession to the EU, we noted a specialization of the country's exports for several categories of agri-food products. Most exports consist of products with a low degree of processing, which have a low added value. Although, at least after 2007, these product categories recorded considerable surpluses, they were still insufficient to offset the accumulated deficits in most categories of agri-food products. Another important aspect in the activity of foreign trade with agri-food products that we analyzed was the competitiveness. Using the combined values of the TBI and LFI indicators, we obtained that the most competitive product categories are Cereals, Live Animals and Seeds. Romania's accession to the EU has allowed the creation of favorable conditions for ensuring the competitiveness of several product categories, both on the European market, but also on the markets in Asia and Africa.

Keywords: *foreign trade; agri-food products; EU accession; concentration of exports and imports*

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INTRODUCTION

Romania's foreign trade with agri-food products has undergone important changes with the political changes at the end of 1989 and the transition from a centralized economy to a market economy. The country's accession to the EU on 1 January 2007 gave a new impetus to trade with agri-food products. The effects of accession were manifested, both in the increase of exports and imports, and in important changes in the structure of exports and imports, at the level of agri-food categories and economic areas. These are also immediate effects that have been experienced by all Eastern European countries that have joined the EU (Svobodová 2014, Smutka, 2016). In Romania, as in the case of the other countries in the Eastern part of the continent that have joined the EU, the large increase of exports of agri-food products due to natural access to a large free market was accompanied by a massive increase of imports of agri-food products and implicitly an increase of the trade deficit with agri-food products (Gheorghe et al., 2018, Bojnec and Ferto, 2009).

Romania's accession to the single market also made it possible to access European funds for the modernization of agricultural production and, consequently, for the increase of export capacity. During the pre-accession period, Romanian agriculture benefited from European funds for restructuring the vegetable and animal agricultural production, so that, with the accession to the EU, Romania considerably increased its productions and implicitly exports of cereal products, the most competitive agri-food category in the country's exports. However, in a relatively short period of time, Romania did not have the capacity to overcome the problems in agriculture in order to increase both the agricultural production and the processing capacity of the raw material in the country (Albu et al., 2018).

The variation of the volume of imports, exports and trade balance with agri-food products in Romania is largely dependent on domestic demand and developments in agricultural production and the ability to capitalize the natural potential of each country (Rusali, 2019). The EU ascension led to an increase of the exported agri-food goods for Romania (Andrei et al. 2022a) with a competitive advantage on few products (Andrei et al. 2022b).

Under the conditions of the global economy, the goods that are the subject of international trade are the result of the interaction between economic operators from different countries. Only a small part of the exports of goods from a country is the exclusive result of the production of economic agents from a country, the largest are the result of the interaction between local and foreign economic agents (Zaman and Simion, 2020). Therefore,

it is very important for each country to join the global value chain with as many local economic agents as possible to participate as much as possible in creating the added value of exported products (Zaman et al., 2018). The current philosophy of developing the global economy does not help an economic zone to impose economic restrictions to protect its own products as it will lead to economic losses and cost increases (Xi, 2021). The rest of the paper is organized as follows. In the next section with present the data sources used in our analysis and the main indicators. Then, we discuss some general aspects regarding Romania's foreign trade with agri-food products and we present the most important characteristics of the structure of imports and exports of agri-food products. The paper continues with a section dedicated to a comparative index analysis and in the last section we present the conclusion of our study.

DATA AND METHODS

The article aims to identify characteristics of foreign trade with agri-food products for Romania during 2000-2020 period. We used data on exports and imports of Romanian agri-food products for each year aggregated at the level of product categories and by economic areas (Europe, EU-28, Asia, Africa and America). We considered 24 product categories according to the statistics nomenclature defined by the European Communities (European Communities, 1987) identified by Combined Nomenclature (CN) codes. Our analysis is based on data on foreign trade with agri-food products calculated by the National Institute of Statistics in Romania. The annual values of exports and imports of agri-food products are expressed in Euro. We used annual data to evaluate exports and imports of product categories during the pre-accession (2000-2006) and post-accession (2007-2020) periods.

The article aims to identify: the effects of Romania's accession to the European Union starting with January 1st, 2007 on the volume of exports and imports of agri-food products by categories of agri-food products; the changes in the structure of exports and imports by product category and economic area over time; those categories of agri-food products that define the specifics of Romania's exports; those categories of products that provide Romania with a comparative advantage in certain economic areas; to what extent Romania's domestic market for those categories of agri-food products important in population consumption depends on imports, most of the imports being from EU countries.

To achieve these objectives, we computed various indicators starting from the primary data. We denote by X_i^j the export from category i, $i = 1, \dots, n$

of the agri-food product to the economic area j, $j = 1, \dots, m$ and by M_i^j the import from category of agri-food i, $i = 1, \dots, n$ to the economic area j, $j = 1, \dots, m$. The categories of agri-food products were classified in a number of classes, and their number is denoted by p. We define the following weights for the exports:

- the share of the export volume of the product categories from a class in the economic zone in the total export of the product categories from the class: $P_1(X) = \frac{\sum_{i=1}^{p} x_i^j}{\sum_{j=1}^{m}\sum_{i=1}^{p} x_i^j}$;
- the share of the volume of exports in the economic area in total export: $P_2(X) = \frac{\sum_{i=1}^{n} x_i^j}{\sum_{j=1}^{m}\sum_{i=1}^{n} x_i^j}$;
- the share of exports of the categories of products in the class in the economic zone in the total exports in the economic zone: $P_3(X) = \frac{\sum_{i=1}^{p} x_i^j}{\sum_{i=1}^{n} x_i^j}$;

The weights for imports are defined in a similar way, if we replace X by the letter M in the above relations.

We compute three indicators using export and import data, which have a certain level of aggregation: the balance calculated as the difference between exports and imports $(\Delta = X - M)$, the total trade as the sum between exports and imports $TT = X + M$ and foreign trade coverage ratio indicator calculated as the ratio between exports and imports $FTCR = \frac{X}{M} \cdot 100$. These indicators are calculated for each year of a longer period, as is the case in this paper, in the pre-accession period (2000 - 2006) or in the post-accession period (2007 - 2020).

We assessed the extent to which categories of products subject to Romania's trade with European or EU-28 countries have comparative advantages and the extent to which there are significant changes in foreign trade with agri-food products after EU accession relative to the comparative advantages. In this respect, we computed the Lafay Index (LFI) indicator (Lafay, 1992) for the 24 product categories for the pre-accession and post-accession period:

$$LFI(i,j) = 100 \cdot \left(\frac{\Delta(i,j)}{TT(i,j)} - \frac{\sum_{i=1}^{n} \Delta(i,j)}{\sum_{i=1}^{n} TT(i,j)} \right) \frac{TT(i,j)}{\sum_{i=1}^{n} TT(i,j)} \quad (1)$$

For both periods we evaluated the extent to which Romania specializes in the export or import of certain categories of products. To this end, the Trade Balance Index (Lafay, 1992) is calculated for each of the two periods:

$$TBI(i,j) = \frac{\Delta(i,j)}{TT(i,j)} \quad (2)$$

Depending on the sign of the indicator we will assess whether the country is "net-exporter" or "net-importer": if $TBI(i,j) > 0$, then the country is "net-exporter" for product category j; if $TBI(i,j) < 0$, then the country is a "net-importer".

Another important objective of this study was to establish to what extent Romania's exports / imports from an economic zone have a certain degree of concentration of exports / imports of agri-food products by categories. Thus, we computed the Herfindahl index (Hirschman, 1964) at the level of economic zones for a year or a period:

$$H_t = \sum_{i=1}^{n} y_{it}^2 \quad (3)$$

where, y_i represents the share of export / import from the category of goods to this economic zone in the exports / imports of Romania. The values of this indicator show to what extent a certain category of products is dominant in exports to a certain market or to what extent imports of products from a country have a higher degree of concentration around certain categories of products.

GENERAL ASPECTS REGARDING ROMANIA'S FOREIGN TRADE WITH AGRI-FOOD PRODUCTS

During the 2000 – 2020 period, important changes took place in the exports and imports of Romanian agri-food products. The study did not use statistical data to characterize foreign trade for agri-food products from 1990 to 1999 as during this period we recorded large variations in both the volume of exports and imports of agri-food products and are not useful in assessing the effects of Romania's accession to the EU starting with January 1, 2007. The main problem in Romanian agriculture in the first ten years of the transition was the restoration of private property, which was severely affected during the socialist economy (Andrei et al., 2011).

The data presented in Table 1 and in Figures 1 and 2 allow the identification of some characteristics of the foreign trade with agri-food products.

Firstly, we point out that during this period, exports and imports of agri-food products increased a lot, the average annual export rates being 15.9%, and imports rates 11.5%. Even under these conditions when the average annual growth rate of exports was higher than the growth rate of imports, Romania accumulated, except for two years, trade deficits in foreign trade with agri-food products between 2000 and 2020. In 2007, the year when Romania joined the EU, we registered the highest annual growth rates of exports and imports of agri-food products, being 31.4% for exports, respectively 37.7% for imports. We also registered the largest deficit in the trade balance with agri-food products, being equal to 2.22 billion euros. A large deficit, but not exceeding the value recorded in 2007, was also registered in the next two years. During this period, in only two years there was a surplus in the trade balance with agri-food products, but as we will see in the analysis, this was due to the accumulation of very large productions for cereals (CN code 10). The average value of agri-food exports in the pre-accession period was only 3.4 billion euros, rising to 4.8 billion euros in the post-accession period. The average annual value of imports in the pre-accession period was 4.4 billion euros, rising in the post-accession period to 5.7 billion euros.

Secondly, it should be noted that, through the predominant export of products with a low degree of processing and the massive import of a wide variety of processed agri-food products, Romania has managed to cover its imports of agri-food products through exports for only two years, 2013 and 2014. To assess the extent to which imports were covered by exports, we calculated the Foreign Trade Coverage Ratio (FTCR) as the ratio between exports and imports of agri-food products. The results obtained for each year in the analyzed period show an improvement of the imbalance between exports and imports of agri-food products only for certain subperiods. Evaluating this aspect, we must emphasize that, in the pre-accession period, Romania had a reduced capacity to ensure the imports of agri-food products through the exports of this category of products. Until 2007, the FTCR indicator did not exceed 40% with the lowest value of 32.4% reached in 2003. During the post-accession period, as a result of the dramatic increase in exports of certain product categories, the value of the FTCR indicator has considerably improved for the products belonging to the product categories identified by CN codes 10, 12 and 24. However, in the post-accession period, two subperiods with different evolutions were identified. Thus, in the period 2008 - 2014 the FTCR indicator appreciated relatively continuously reaching values higher than 100% in 2013 and 2014, which is equivalent to the fact that exports were higher than imports. Since 2015, FTCR values have been lower than 100 and have decreased each year. Given that the value of the indicator in 2015 was

97.7%, and in the period 2015-2020 the average annual rate of exports was 3.4%, and the average annual rate of imports was 8.1%, in 2020 the FTCR indicator was 78.3% (see Table 1).

The third aspect considered in the assessment of the characteristics of foreign trade with agri-food products starts from the sign and actual values of the normalized foreign trade balance (NTB), an indicator calculated as the ratio between balance and total trade (export plus import). During the period 2000 - 2020, this indicator registered positive values only in 2013 and 2014, these being two years when Romania registered large cereal productions, thus ensuring a large volume of exports for products included in this category. The positive aspect is related to the fact that until 2015 the value of this indicator has improved, but since 2016 there is a depreciation, largely due to the growth of the imports of agri-food products with a much higher average annual rate relative to that of the exports.

The fourth aspect to be emphasized is the positive effect of Romania's accession to the EU on the volume of exports of certain categories of agri-food products, both in EU countries and in other economic areas. In 2007, compared to 2006, Romania's exports of agri-food products increased by almost 32%, but at the same time imports increased by 38%. Equally, EU accession has brought significant changes in the economic areas structure of exports and imports. Thus, the major change after accession occurred in the territorial structure of imports, the share of products imported from European countries, especially from EU Member States significantly increasing since 2007. If in the pre-accession period the share of goods imported from European countries was 65.7%, it increased to 89.2% in the post-accession period. On the other hand, the share of goods exported to the European space decreased from 83.6% in the pre-accession period to only 74.9% in the post-accession period. In the period after accession, the share of Romanian products exported to Asian countries increased significantly. In 2020, a share of 22.1% of agricultural goods exported by Romania were to Asian countries (Table 2). Although during the post-accession period the volume of exports of agri-food products increased by an annual average rate of 14% and imports by only 7.3%, the accumulated imbalances between exports and imports of most categories of agri-food products have not been reduced.

Data on foreign trade with agri-food products

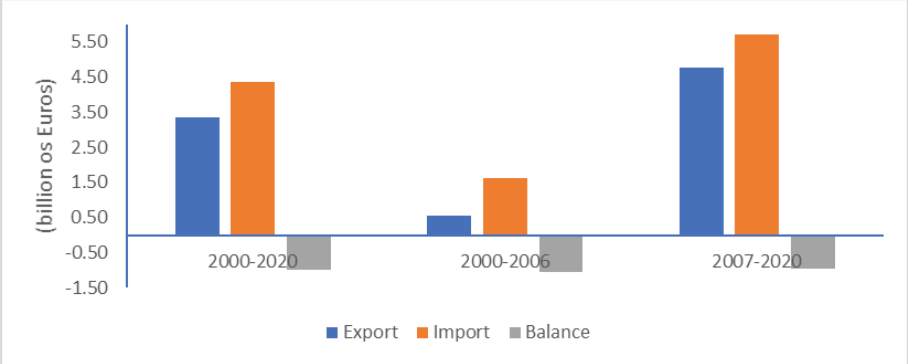
Table 1

Year	Export	Import	Balance	NTB	FTCR	Chain index of export flows	Chain index of import flows
2000	0.37	1.02	-0.65	-46.80	36.20	-	-
2001	0.48	1.35	-0.87	-47.20	35.80	131.70	133.10
2002	0.46	1.25	-0.79	-46.00	37.00	95.20	92.20
2003	0.50	1.54	-1.04	-51.00	32.40	108.10	123.30
2004	0.59	1.71	-1.13	-49.00	34.30	118.00	111.60
2005	0.67	2.02	-1.35	-50.00	33.30	114.60	118.00
2006	0.85	2.42	-1.57	-47.90	35.20	126.80	119.90
2007	1.12	3.34	-2.22	-49.70	33.60	131.40	137.70
2008	2.17	4.35	-2.18	-33.50	49.80	192.90	130.20
2009	2.24	3.82	-1.58	-26.10	58.70	103.60	88.00
2010	3.11	3.92	-0.81	-11.50	79.40	138.80	102.50
2011	4.02	4.45	-0.42	-5.00	90.40	129.20	113.40
2012	4.04	4.80	-0.75	-8.50	84.30	100.60	107.90
2013	5.28	4.95	0.33	3.20	106.70	130.70	103.30
2014	5.58	5.12	0.46	4.30	108.90	105.50	103.40
2015	5.92	6.06	-0.14	-1.10	97.70	106.10	118.20
2016	6.17	6.79	-0.62	-4.80	90.90	104.2	112.10
2017	6.41	7.42	-1.02	-7.40	86.30	103.80	109.30
2018	6.50	7.64	-1.13	-8.00	85.20	101.50	102.90
2019	7.19	8.43	-1.25	-8.0	85.20	110.50	110.40
2020	6.99	8.93	-1.94	-12.20	78.30	97.30	105.90

Data source: authors' calculations using primary data from NSI Romania, 2021

Annual average indicators (export, import and balance)

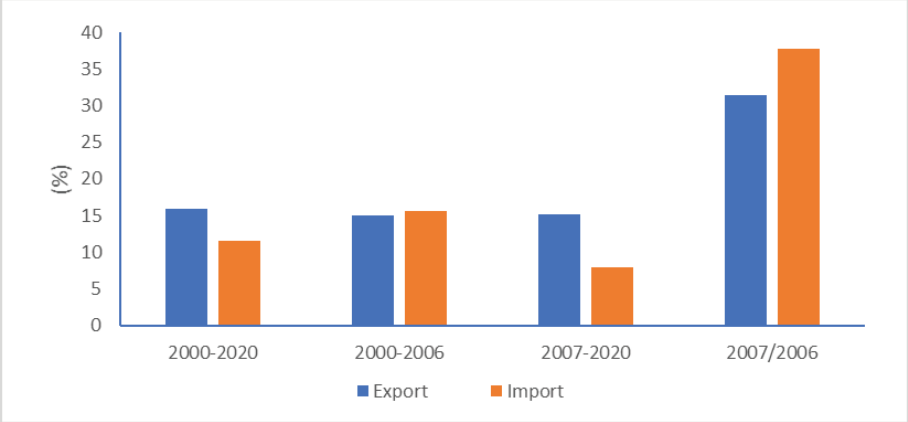
Figure 1



Data source: authors' calculations using primary data from NSI Romania, 2021

Cumulative average rate for exports and imports for various periods

Figure 2



Data source: authors' calculations using primary data from NSI Romania, 2021

Structure of exports and imports by economic areas (%)

Table 2

	Europe		Asia		Africa		America	
	Export	Import	Export	Import	Export	Import	Export	Import
2000	78.56	64.29	13.27	8.59	6.78	2.76	1.13	22.50
2001	78.82	64.86	12.24	6.45	7.85	2.59	0.84	25.29
2002	82.62	67.12	11.38	5.92	4.55	2.01	1.22	24.35
2003	86.86	70.43	9.31	6.77	2.12	1.53	1.49	20.81
2004	87.79	62.93	7.59	6.37	3.10	2.06	1.17	27.85
2005	89.22	63.60	6.50	6.44	3.01	2.01	0.93	27.00
2006	84.77	65.84	10.17	7.03	3.74	1.79	0.84	24.85
2007	88.95	82.13	7.80	4.51	2.14	1.08	0.75	12.00
2008	79.34	85.04	13.96	4.14	5.50	0.76	0.39	10.01
2009	84.95	85.78	10.89	3.76	3.05	1.42	0.35	8.96
2010	82.81	86.90	13.91	3.83	2.65	1.85	0.33	7.39
2011	82.78	84.88	13.19	3.59	3.78	1.27	0.19	10.23
2012	78.78	85.25	12.44	3.19	8.39	2.67	0.27	8.87
2013	67.86	86.69	17.77	3.11	13.76	1.53	0.56	8.65
2014	71.05	88.22	13.97	2.62	14.19	2.11	0.66	6.78
2015	74.24	88.43	14.42	2.65	10.56	2.10	0.60	6.80
2016	69.02	91.47	17.57	2.17	12.48	1.50	0.51	4.84
2017	75.74	91.37	13.19	2.02	10.18	1.13	0.33	5.48
2018	77.45	92.18	13.69	1.90	8.18	0.68	0.40	5.23
2019	73.97	93.05	15.81	1.75	9.34	0.81	0.41	4.36
2020	70.06	93.33	22.07	1.56	7.24	0.80	0.63	4.31
2000-2020	75.47	86.11	14.95	3.20	8.80	1.44	0.49	9.10
2000-2006	83.61	65.67	10.55	6.86	4.52	2.13	1.01	24.52
2007-2020	74.94	89.19	15.24	2.64	9.08	1.34	0.46	6.78

Data source: authors' calculations using primary data from NSI Romania, 2021

Foreign trade coverage ratio (FTCR) was computed for each year from the period 2000 - 2020 and separately for the pre-accession period (in this case between 2000 - 2006) and post-accession (2007 - 2020) globally, but also for each economic zone (Europe, Asia, Africa and America). The results presented in Table 3 show that for the trade with European countries the coverage of imports through exports was low in the pre-accession period, the value of the indicator was more than 50% in any year of the period. With Romania's accession to the EU, the value of the indicator ameliorated until 2014 but starting with 2015 up to 2020, the values of the indicator are on a decreasing trajectory. During the post-accession period, Romania accumulated a deficit of over 21.3 billion euros from trade with agri-food products with European countries, which is equivalent to an average annual deficit of over 1.5 billion euros. The second economic area where Romania exports agri-food products is Asia. During the pre-accession period, due to a low volume of exports, the value of the indicator was low, so that only in 2006 the indicator registered a value higher than 50%. After 2007, the volume of exports to Asian countries increased significantly, so that FTCR values increased significantly year by year, reaching over 1100% in 2020 when Romania registered a trade surplus from the trade with Asian countries of over 1.4 billion euros. During the post-accession period, Romania recorded a surplus of over 8 billion euros in the trade relations with agri-food products with Asian countries. With the accession to the EU, Romania's exports to African countries also increased, the value of the FTCR after 2007 far exceeded the 100% threshold (Table 3). Due to low imports of agri-food products from African countries, Romania recorded a surplus of almost 5 billion euros in the post-accession period, which represents an average annual surplus of over 360 million euros. The countries of American continent have a small share, both in exports and imports of agri-food products. In the post-accession period due to a low volume of exports to American countries and average annual imports of almost 400 million euros, Romania recorded a deficit of over 5.1 billion euros. The results presented above show us a major impact of Romania's accession to the EU in relation to the structure and efficiency of trade in agri-food products by economic areas (Gheorghe et al., 2018).

Coverage of exports by imports

Table 3

Year	Europe	Asia	Africa	America
2000	44.3	55.9	89.0	1.8
2001	43.5	68.0	108.6	1.2
2002	45.5	71.0	83.8	1.9
2003	40.0	44.6	44.9	2.3
2004	47.8	40.8	51.6	1.4
2005	46.7	33.6	50.0	1.1
2006	45.4	51.0	73.9	1.2
2007	36.4	58.2	66.7	2.1
2008	46.5	168.0	358.8	1.9
2009	58.1	169.8	126.0	2.3
2010	75.7	288.6	113.8	3.6
2011	88.2	332.3	269.4	1.6
2012	78.0	328.6	265.4	2.5
2013	83.5	610.2	959.5	6.9
2014	87.5	579.3	731.0	10.6
2015	82.3	533.2	493.2	8.6
2016	68.7	736.3	755.7	9.5
2017	71.6	564.5	781.3	5.3
2018	71.3	610.5	1015.0	6.6
2019	67.9	770.3	978.5	8.1
2020	58.6	1103.6	702.1	11.3
1999-2020	67.7	361.3	472.0	4.2
1999-2006	46.3	55.8	77.1	1.5
2007-2020	70.1	480.7	566.7	5.7

Data source: authors' calculations using primary data from NSI Romania, 2021

CHARACTERISTICS OF THE STRUCTURE OF IMPORTS AND EXPORTS OF AGRI-FOOD PRODUCTS

With the accession to the EU, Romania has considerably increased its value of exports and imports of agri-food products, both for total and by categories of agri-food products. For three product categories Cereals (CN code 10), Oil seeds and oleaginous fruits (CN code 12) and Tobacco and manufactured tobacco substitutes (CN Code 24) export increases were quite exceptional. The three categories are added Live Animals category (CN code 1) which has accumulated significant trade surpluses throughout the post-communist period. After the accession to the EU, Romania has increased and diversified its imports of agri-food products to satisfy, to a large extent, the consumption needs of the population.

Using the Herfindahl index, we assessed: (i) whether the degree of specialization of exports and imports of agri-food products by product category has changed over time; (ii) the extent to which there are significant differences between exports and imports of agri-food products, considering their degree of concentration by product category. The assessment of the

specialization of imports and exports was made based on annual data and also for cumulative data at the level of pre-accession and post-accession periods. The results obtained for the two periods for exports and imports of agri-food products, for the whole foreign trade but also for each economic areas are presented in Table 4. At the global level of economic trade there is a much higher level of specialization in exports of goods relative to that of imports. Moreover, specialization of the exports is much more pronounced in the post-accession period, and the concentration of imports has decreased significantly in the post-accession period.

Herfindahl index values determined for economic areas

Table 4

	Export		Import	
Economic area	pre-accession	post-accession	pre-accession	post-accession
World	1111	1630	771	565
Europe	1064	1236	730	587
Asia	2347	2866	1050	831
Africa	3835	6748	2313	2134
America	2439	1174	1584	1936

Data source: authors' calculations using primary data from NSI Romania, 2021

We noted a specialization of Romania for the foreign trade with agri-food products in the export of three categories of products for both periods, pre-accession and post-accession. In the pre-accession period (2000 - 2006) products from three product categories held half of the value of the export of agri-food products: Live animals had 23.1%, Oil seeds and oleaginous fruits around 14% and Cereals 12.7%. In the post-accession period, the three product categories held over 55% of the value of exports for the period 2007-2020: Cereals (32.6%), Oil seeds and oleaginous fruits (16.6%) and Live animals (6.3%). Also, during this period, Tobacco and manufactured tobacco substitutes (CN code 24) were added to the three product categories, holding 13.2%. Thus, four categories of products are essential for Romania's exports, two of which (CN code 10 and CN code 12) depend to a large extent on climatic conditions.

The results presented in Table 4 show an increase of the specialization of Romania's exports after the accession to the EU for the economic areas that have an important cumulative share in exports: Europe, Asia and Africa. In the pre-accession period, 37% of exports of agri-food products to the European market consisted of products belonging to two product categories: Live animals with 23.3% and Oil seeds and oleaginous fruits with 13.9%. During

the post-accession period, the specialization level of Romania's exports on the European market increased, two categories of products ensuring the accumulation of 40% of the volume of exports on this market: Cereals with 20.3% and Oil seeds and oleaginous fruits with 20.4%. The degree of specialization of exports is much higher for exports to the Asian market. In the pre-accession period, no less than three categories of products accounted for 77% of Romania's exports on this market: Cereals accounted for 30.9%, Live animals had a contribution of 26.2% and Oil seeds and oleaginous fruits of 20.5%. During the post-accession period, the high contribution of 82.5% of the three categories of products in the exports of agricultural goods on this market was maintained, only that the share of Cereals increased to 64%, Live animals decreased to 11.3% and Oil seeds and oleaginous fruits decreased to 7.3%. Even if the exports of agri-food goods to African countries have a small share in Romania's exports of agri-food products (8.8% for the period 2000 - 2020; 4.5% during the pre-accession period and 9.1% during the post-accession period) we still noted the specialization in the products belonging to two categories of products, both in the pre-accession and in the post-accession period: in the pre-accession period Live Animals represented 19.9% of Romania's exports on this market and Cereals 57.6%; in the post-accession period, the share of Cereals increased to over 81.4%, and Live Animals had almost 10%.

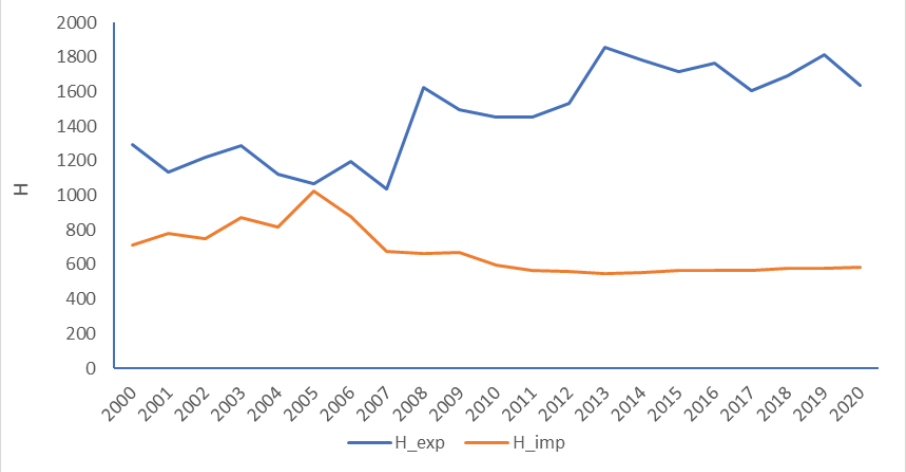
In order to assess to what extent there are significant differences from one year to another between the values of the Herfindahl index, we computed the annual values of this indicator based on the exports and imports of Romanian agri-food products and the results are shown in Figure 3. In the pre-accession period, there is a slow decrease, from one year to another, of the values of the Herfindahl index in the case of agri-food exports, the minimum value being reached in 2007. During this period of time the Cereals category did not exceed 20% of the total volume of exports of agri-food products in any year. The value of the indicator was relatively high for exports, due, in large part, to the high share of products in the Live Animals category.

On the other hand, in the post-accession period, due to the increase of the share of Cereals products in agri-food exports, the values of the Herfindahl index are on an increasing trajectory, with some variations of the indicator from one year to another. The highest annual increases of the Herfindahl index were registered in 2008, 2013 and 2019. An analysis of the annual growth rates of exports of Cereals will show that these are the years when high annual growth rates are recorded for exports of this category of products: in 2008 exports increased 4.2 times compared to the previous year, in 2013 the annual growth rate was 48% and in 2019 the annual growth rate was 20%. Equally,

a significant reduction of the Herfindahl index in 2017 and 2020 is doubled by significant negative annual rates for Cereals exports: in 2017 the rate was -5.7%, and in 2020 it was -17.3%. These results show once again the high degree of specialization of Romania for the export of cereals in the post-accession period. In fact, the products in this category, represent more than 32% of the total value of Romania's exports of agri-food products in the entire period 2007 - 2020, while in the pre-accession period their share was only 13.4% of the total volume of exports of agri-food products.

Herfindahl index for exports and imports

Figure 3



Data source: authors' calculations using primary data from NSI Romania, 2021

The concentration of imports of agri-food goods is much lower if we compare it to the degree of concentration recorded for exports of agri-food goods. We identified three periods in the dynamics of this indicator: (i) the period 2000-2005 shows a significant increase in the degree of concentration of imports; (ii) during the period 2005-2009 there is a sharp decrease in the degree of concentration, given that the volume of goods imported by Romania has increased significantly; (iii) after 2010 we observed a stability of the Herfindahl index series.

The data presented in tables 5 and 6 provide us with important information on the characteristics of Romania's trade in terms of the economic areas where it exported goods and the economic areas from which agri-food products are imported from Romania. The evaluation of the structure of exports and imports for each category of products by economic zones during the two

periods allowed us to identify some changes in the flow of agri-food goods from the foreign trade as a result of Romania's accession to the EU. Exports show a decrease in the share of goods delivered to the European market by 9.8 pp and an increase of 5.5 pp in the share of goods that were oriented to Asian market and by 4.9 pp in those delivered to African countries. On the other hand, the share of goods imported from European countries increased significantly, from 65.5% in the pre-accession period to 89.2% in the post-accession period. For 15 out of 24 product categories, more than 90% of the volume of imports is exclusively from European countries, which shows, on the one hand, a high degree of integration in the European market of agri-food products, but on the other hand a large dependence of the satisfaction of the internal consumption of the population on the European market.

With Romania's accession to the EU, important categories of agri-food products show an increase in the share of their exports to Asian countries and a decrease in the share of exports to EU countries. Exports to the European market of products in the Live Animals category decreased from 85.3% in the pre-accession period to 58.8% in the post-accession period. In contrast, their share increased from 11.1% to 27.2% for the Asian market. For Cereals, the share of the European market decreased from 57.1% to 46.8%, while the share held by the Asian market for this product, increased from 23.7% to 30%. On the other hand, together with the increase of Romania's exports of Tobacco products after the accession to the EU, the share of exports on the European market also increased from 78% to 93.1%.

Structure of the exports by economic areas

Table 5

	pre-accession						post-accession					
CN codes	Europe	EU-27	Asia	Africa	America	The rest	Europe	EU-27	Asia	Africa	America	The rest
01	85.30	82.10	11.06	3.62	0.00	0.02	58.81	52.60	27.16	14.03	0.00	0.00
02	97.19	98.38	0.95	0.59	1.15	0.12	92.08	90.31	6.95	0.67	0.26	0.05
03	96.84	92.02	0.37	0.04	2.08	0.67	94.34	82.90	5.58	0.00	0.04	0.03
04	87.42	85.94	4.09	0.65	7.12	0.72	94.65	91.36	3.51	0.19	1.62	0.04
05	97.25	92.16	2.74	0.00	0.01	0.00	97.26	92.61	2.37	0.15	0.22	0.00
06	97.08	92.77	2.80	0.08	0.04	0.00	98.05	85.19	0.67	0.08	1.19	0.00
07	99.42	93.97	0.39	0.01	0.15	0.03	93.51	89.82	6.38	0.05	0.05	0.00
08	91.23	69.53	7.45	0.16	1.07	0.09	93.96	83.19	3.59	0.33	2.10	0.02
09	57.48	38.43	26.37	11.67	1.17	3.31	91.14	81.28	5.68	1.91	0.91	0.36
10	57.11	46.00	23.72	19.08	0.02	0.07	46.75	36.58	29.95	22.72	0.31	0.26
11	92.70	44.09	1.61	5.38	0.22	0.10	87.47	68.92	5.95	6.24	0.33	0.00
12	83.20	67.45	14.14	2.63	0.03	0.00	91.81	78.66	6.64	1.21	0.32	0.01
13	93.76	44.64	1.65	0.00	4.60	0.00	80.52	93.15	9.44	7.49	2.39	0.16
14	95.41	95.28	0.00	0.00	4.59	0.00	99.72	98.77	0.13	0.05	0.09	0.02
15	91.17	54.30	5.78	2.78	0.26	0.02	87.79	81.07	3.17	8.59	0.21	0.24
16	96.16	90.84	0.62	0.02	2.98	0.21	98.75	95.73	0.83	0.07	0.32	0.03
17	96.39	80.76	1.29	0.21	0.19	1.92	92.63	95.27	6.59	0.54	0.11	0.13
18	93.02	63.75	1.26	0.00	0.61	5.11	88.46	78.86	7.58	1.18	1.54	1.24
19	90.39	81.75	4.10	4.47	0.93	0.12	91.51	80.80	4.22	1.38	2.45	0.44
20	95.62	91.73	2.10	0.03	0.94	1.31	97.36	91.33	1.46	0.07	0.96	0.14
21	93.92	90.20	1.63	0.22	3.74	0.49	92.91	81.19	3.97	0.43	0.93	1.76
22	85.22	55.99	5.55	0.12	7.52	1.59	91.04	78.97	4.17	0.10	2.69	2.00
23	91.78	68.42	6.23	1.90	0.09	0.00	76.38	61.86	19.57	3.51	0.33	0.20
24	78.04	76.30	13.91	2.73	0.32	5.00	93.10	90.28	6.22	0.12	0.11	0.45
Total	84.68	73.62	9.73	4.20	1.06	0.33	74.94	66.46	15.24	9.08	0.46	0.29

Data source: authors' calculations using primary data from NSI Romania, 2021

If we analyze the structure of imports by product categories and by economic areas, we noted an increase of the number of product categories for which imports are mainly from European countries. Thus, if during the pre-accession period the share of goods imported from the European area for only 6 product categories represented more than 90% of the total volume of imports, their number increased to 15 in the post-accession period. This result confirms that population demand is largely met by imports from European countries and most EU Member States.

Structure of the imports by economic areas

Table 6

	pre-accession						post-accession					
CN codes	Europe	EU-27	Asia	Africa	America	The rest	Europe	EU-27	Asia	Africa	America	The rest
01	99.56	98.89	0.05	0.00	0.31	0.08	99.96	98.80	0.03	0.00	0.01	0.00
02	65.97	65.49	0.55	0.00	33.34	0.13	98.64	96.50	0.01	0.00	1.30	0.04
03	70.09	26.42	9.44	1.60	17.88	1.00	87.96	79.95	6.54	2.07	3.37	0.06
04	97.88	84.12	0.29	0.00	0.79	1.03	99.76	97.19	0.20	0.00	0.04	0.01
05	36.79	37.94	39.29	0.02	20.67	3.23	66.33	62.90	30.58	0.10	2.82	0.16
06	98.36	86.53	1.20	0.12	0.30	0.01	99.01	96.76	0.61	0.08	0.31	0.00
07	76.94	52.08	18.10	3.77	0.86	0.34	94.06	73.50	2.84	2.81	0.28	0.00
08	54.35	30.86	4.09	1.87	39.61	0.07	91.13	75.33	2.52	1.25	5.09	0.01
09	42.63	42.27	33.84	9.36	13.96	0.20	79.19	78.47	8.98	4.30	7.46	0.08
10	65.58	47.68	4.04	10.47	19.90	0.01	96.92	94.62	0.68	0.38	2.02	0.00
11	99.04	96.14	0.34	0.00	0.57	0.04	99.79	97.83	0.06	0.11	0.02	0.02
12	48.33	35.52	11.99	0.68	38.85	0.15	81.97	62.11	2.89	0.27	14.85	0.01
13	73.83	73.54	11.07	0.44	14.66	0.00	82.47	79.51	16.02	0.01	1.49	0.01
14	86.82	83.20	9.24	0.24	3.67	0.04	94.04	90.40	5.70	0.12	0.13	0.02
15	76.19	58.66	23.09	0.00	0.69	0.03	90.84	80.29	8.49	0.24	0.43	0.01
16	61.25	59.87	34.95	0.92	2.87	0.01	90.81	89.56	6.12	1.08	1.93	0.06
17	24.93	19.86	1.19	0.02	73.76	0.10	64.43	51.61	0.83	11.07	23.34	0.33
18	93.76	83.46	4.09	1.80	0.19	0.16	99.77	95.27	0.16	0.05	0.01	0.01
19	98.74	91.41	0.68	0.02	0.50	0.06	99.65	87.70	0.31	0.01	0.03	0.00
20	75.17	57.92	19.01	0.76	4.96	0.11	93.11	82.29	4.72	1.74	0.42	0.01
21	76.51	71.83	9.29	1.47	12.62	0.11	88.74	84.51	5.55	0.41	5.24	0.05
22	87.39	66.95	0.13	0.04	9.30	3.14	95.13	89.71	0.85	0.05	3.80	0.16
23	67.95	70.64	0.39	0.41	31.23	0.03	62.08	60.33	0.33	0.06	37.53	0.00
24	59.13	43.24	2.67	3.23	30.36	4.61	72.55	61.76	4.93	4.48	17.92	0.12
Total	65.50	55.43	6.74	2.04	24.93	0.79	89.19	81.94	2.64	1.34	6.78	0.05

Data source: authors' calculations using primary data from NSI Romania, 2021

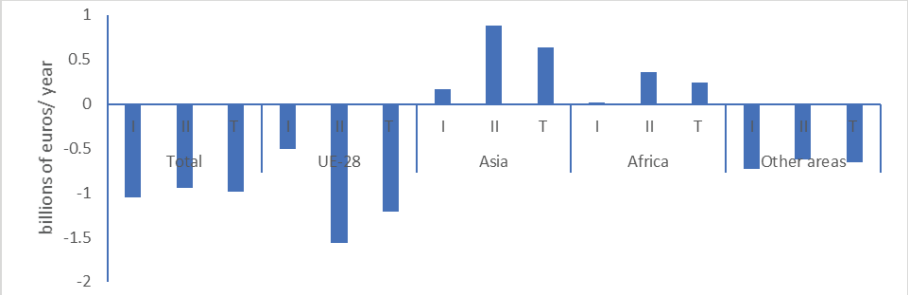
COMPARATIVE ADVANTAGE INDEX ANALYSIS

The results presented above show an increase, both in the volume of exports, but especially in the imports of agri-food products, and also the fact that Romania has a small number of product categories with trade surpluses. Moreover, the products of these categories are agri-food raw materials that have a low added value. During the period 2000 - 2020, Romania registered an average deficit of 980 million euros. While the global differences between the two periods are not major (the average accumulated deficit in the pre-accession period was 1.05 billion euros and 948 million euros in the post-accession period), the differences are major when we compare the accumulated results for foreign trade by economic areas (see Figure 4). After accession, Romania has significantly increased its average annual deficit from half a billion euros, which was recorded in the pre-accession period, to over 1.56 billion euros in the post-accession period for the trade with agri-food products with EU-28 countries, and it recorded trade surpluses in both periods for the trade with

agri-food products with countries from Asia and Africa. Moreover, Romania's surpluses in relation to countries from these economic areas increased significantly in the post-accession period. For the trade with countries from other economic areas than the EU-28, Asia and Africa, Romania recorded substantial trade deficits, exceeding an annual average of half a billion euros in both periods.

Average annual balance of trade by economic areas in the pre-accession (I) and post-accession period (II)

Figure 4



Data source: authors' calculations using primary data from NSI Romania, 2021

Trade balance by product categories in the pre-accession and post-accession period

Table 7

	Total (billion euro)			UE-28 (billion euro)		
CN codes	Pre-accession	Post-accession	Total 00-20	Pre-accession	Post-accession	Total 00-20
01	0.66	2.22	2.87	0.50	0.21	0.71
02	-1.85	-6.41	-8.26	-1.20	-6.52	-7.73
03	-0.24	-1.77	-2.02	-0.10	-1.45	-1.56
04	-0.06	-3.00	-3.07	-0.06	-3.17	-3.23
05	-0.07	-0.36	-0.43	0.00	-0.13	-0.13
06	-0.10	-1.41	-1.51	-0.09	-1.37	-1.45
07	-0.04	-2.70	-2.74	0.08	-1.80	-1.72
08	-0.45	-4.68	-5.13	-0.05	-3.46	-3.51
09	-0.48	-2.36	-2.84	-0.20	-1.84	-2.04
10	-0.35	16.29	15.95	-0.17	2.95	2.77
11	-0.27	-1.22	-1.49	-0.27	-1.25	-1.52
12	0.21	7.04	7.26	0.25	6.21	6.46
13	-0.04	-0.29	-0.33	-0.03	-0.24	-0.27
14	0.01	0.00	0.01	0.01	0.01	0.01
15	-0.11	-0.14	-0.25	-0.08	-0.07	-0.15
16	-0.03	-0.34	-0.37	0.01	-0.20	-0.19
17	-0.92	-2.93	-3.85	-0.15	-1.27	-1.43
18	-0.20	-2.03	-2.23	-0.17	-2.04	-2.20
19	-0.20	-2.81	-3.00	-0.20	-2.62	-2.81
20	-0.33	-2.54	-2.87	-0.17	-2.07	-2.23
21	-0.69	-3.32	-4.01	-0.51	-2.97	-3.48
22	-0.11	-2.35	-2.46	-0.10	-2.36	-2.46
23	-0.44	-3.11	-3.55	-0.29	-1.90	-2.19
24	-1.29	4.96	3.67	-0.54	5.49	4.95
Total	-7.38	-13.27	-20.65	-3.52	-21.88	-25.39

Data source: authors' calculations using primary data from NSI Romania, 2021

During both periods, according to the data in Table 7, there were commercial surpluses for four product categories, these being also product categories that had an important contribution in Romania's exports. A fifth product category (CN code 14) cannot be mentioned in this category as it has an insignificant share in trade. With regard to these products, we note that: (i) Cereals (CN code 10) and Tobacco and tobacco substitutes (CN code 24) are two categories of products that have been positively affected by the accession process. These products registered significant trade surpluses only after Romania's accession to the EU, while in the pre-accession period Tobacco was the category of products with one of the largest deficits for each

year; (ii) after accession to the EU, the zonal contribution of the trade surplus recorded in the category of Live Animals products (CN code 01) has changed significantly.

Figures 5-8 shows the distribution of product categories in the two periods and by some economic areas in relation to the values recorded for two important indicators for characterizing the economic efficiency of foreign trade with agri-food products. This is the TBI (Trade Balance Index) which allows us to determine whether a country is "net-importer", when the value of the indicator is negative or is "net-exporter" when the value of the indicator is positive (Widodo, 2009) in relation with a product category. The second indicator is LFI (Lafay, 1992) which allows us to assess whether a country has a comparative advantage, if the value is positive (Zaghini, 2003) for a certain category of products. The results obtained and presented in Figures 5-8 allow the classification of the categories of agri-food products that are the object of the foreign trade activity in four classes.

Those product categories for which LFI (comparative advantage) and TBI (Trend Balance Index) have positive values were introduced into class A. In relation to Romania's trade with the European market, there are six categories of products that fall into this class in the pre-accession period (categories with CN codes 01, 05, 07, 12, 14 and 16), while in the post-accession period the number of these categories was reduced to five (CN codes 01, 10, 12, 14 and 24). At EU-28 level, except for product categories with CN code 05, we found the same list of product categories in both periods. Tables 8, 9 and 10 present statistics on the product categories that are included in this class. Based on these results, we formulate the following comments.

First, we emphasize that for both periods the categories of products included in this class have an important share in the exports of agri-food products of Romania: in the pre-accession period they represented 49.3% of the exports of agri-food products and in the post-accession period, the share of product categories in this class increased to 62.7%. The second observation is related to the fact that the share of exports of these categories of products to European countries after EU accession has decreased. In the pre-accession period, the share of these product categories exported to European countries in the total exports of these product categories represented 87.5%, and it decreased to 67.7% in the post-accession period. The same characteristic is highlighted for exports of agri-food products to EU-28 countries, where the share decreased from 77.8% to 58.7%. The third observation concerns the surplus recorded by the product categories in this class. During the pre-accession period, the six product categories mentioned above registered a surplus of 877 million euros (an annual average of 125.3 million euros) for the trade relationships

with European countries, while for the trade with agri-food products there was a deficit of over 4.08 billion euros (an annual average of 583.3 million euros). Regarding only the EU-28 countries, the results are relatively similar: the accumulated surplus from the trade with the six categories of products amounted to 858 billion euros (an annual average of 12.7 million euros), while the accumulated deficit was 3.5 billion euros for all the trade with agri-food products with this economic area (an annual average of 502.6 million euros). In the second period, the five product categories had a surplus of 17.6 billion euros (an annual average of 1.26 billion euros), while the trade balance with agri-food products recorded a deficit of over 21.3 billion euros (an annual average of 1.52 billion euros). The trade with EU-28 countries during this period maintained the same trend: the categories of products in this class recorded a surplus of over 14.86 billion euros (the annual average was 1.06 billion euros), given that trade with agri-food products with EU-28 countries recorded a deficit of 21.88 billion euros (the annual average was 1.56 billion euros). The fourth observation is related to the fact that Romania registered a surplus in the trade relationship with European countries, respectively EU-28, for both periods mostly for those agri-food products that are included in the category of agri-food raw materials (CN codes 01, 10, 12). In the post-accession period, the share of cereals in the export of agri-food products is over 32.5%. Moreover, during this period, three product categories (CN codes 01, 10 and 12) which contribute to a large extent to the surplus of the class consisting of the five products registered more than 55.5% of the total exports of agri-food products of Romania.

Characteristics of the first class of the category of products for the European and EU-28 pre-accession market

Table 8

Category of products (CN codes)	Europe			EU-28		
	Weight in the category		Balance (millions of euros)	Weight in the category		Balance (millions of euros)
	Export	Import		Export	Import	
01	85.30	99.56	526	82.10	97.93	501
05	97.25	36.74	3			
07	99.42	76.94	26	93.85	52.06	84
12	83.20	48.34	297	67.44	35.52	253
14	95.41	86.85	8	95.28	63.58	9
16	96.16	61.25	17	90.80	61.10	12

Data source: authors' calculations using primary data from NSI Romania, 2021

Characteristics of first class of the category of products in the European and EU-28 market in the post-accession period

Table 9

Category of products (CN codes)	Europe			EU-28		
	Weight in the category		Balance (millions of euros)	Weight in the category		Balance (millions of euros)
	Export	Import		Export	Import	
01	58.81	99.96	475	52.54	99.91	211
10	46.75	96.92	4893	36.58	92.05	2947
12	91.81	81.97	6867	78.66	62.26	6206
14	99.73	94.03	4	98.41	82.35	6
24	93.10	72.55	5405	90.86	65.09	5494

Data source: authors' calculations using primary data from NSI Romania, 2021

Share of export / import of product categories included in class A in exports / imports of agri-food products in the post-accession period

Table 10

Category of products (CN codes)	Total		Europe		EU-28	
	Export	Import	Export	Import	Export	Import
01	6.34	2.52	4.97	2.82	5.04	3.05
10	32.55	6.79	20.31	7.38	18.03	7.58
12	16.63	5.06	20.37	4.65	19.80	3.82
14	0.03	0.02	0.04	0.03	0.05	0.02
24	13.18	4.80	16.37	3.90	18.13	3.79
$P_3(X)$	68.73	19.19	62.70	18.78	61.06	18.27
$P_1(X)$			67.68	87.28	58.67	78.47
$P_2(X)$			74.94	89.19	66.04	82.43

Data source: authors' calculations using primary data from NSI Romania, 2021

In the second class (class B) we included the product categories for which LFI is positive (comparative advantage) and are "net-importer" (TBI is negative). Five categories of products are recorded in this class in the trade relationship with European countries in the pre-accession period (CN codes 04, 08, 10, 15 and 22), while in the post-accession period their number decreased to three (CN codes 05, 15 and 16). If we consider the trade with EU-28 countries, then we included six products in this class in the first period (CN codes 04, 05, 08, 10, 15 and 22) and only three product categories during the post-accession period (CN codes 05, 15 and 16). In the case of these product categories, based on the results presented in Table 11, we emphasize some relevant aspects related to foreign trade with European and EU-28 countries:

(i) the share of exports of class B product categories in countries from Europe / EU-28 significantly increased in the post-accession period compared to the pre-accession period. This change was registered even if in the post-accession period we no longer find Cereals (CN code 10), as it happened in the pre-accession period. The transition of this category of products from class B to class A was due to the very large increase of the exports of products of this category in the post-accession period; (ii) while the average annual exports of products from the categories included in this class to EU-28 countries increased 2.4 times in the post-accession period compared to pre-accession period, the imports increased 3.4 times; (iii) the average annual deficit of products in this class in the post-accession period was 66 million of euros, and it was reduced to 57 million euros in the post-accession period.

Characteristics of the product categories included in class B

Table 11

Economic area	Unit	Export		Import		Balance	
		I	II	I	II	I	II
Total	Billion euros	1.38	4.45	2.46	7.59	-1.08	-3.14
Europe	Billion euros	1.07	4.09	1.72	4.62	-0.66	-0.53
EU-28	Billion euros	0.80	3.89	1.27	4.29	-0.46	-0.40
Share in total							
Europe	%	77.48	91.90	70.10	60.81	60.70	16.80
EU-28	%	58.32	87.49	51.48	56.56	42.77	12.76

Data source: authors' calculations using primary data from NSI Romania, 2021

The third class (class C) includes those product categories for which LFI is negative and TBI is positive. In the case of Romania, from the trade exchanges with agri-food products with European countries or only with EU-28 countries, such product categories were not identified.

The fourth class (class D) includes those product categories with a comparative disadvantage (LFI is negative) and trade deficits (TBI is negative). From the trade relationships with European or EU-28 countries, most of the product categories are included in this category, both in the pre-accession and in the post-accession period. For the trade with European or EU-28 countries, 13 product categories were included in the pre-accession period in this class (CN codes 02, 03, 06, 09, 11, 13, 17-21, 23 and 24), and their number increased to 16 in the post-accession period (CN codes 02, 03, 04, 06, 07, 08, 09, 11, 13,17-23). In most cases they are products that are subjected to processing or require special storage conditions.

Characteristics of the product categories included in class D

Table 12

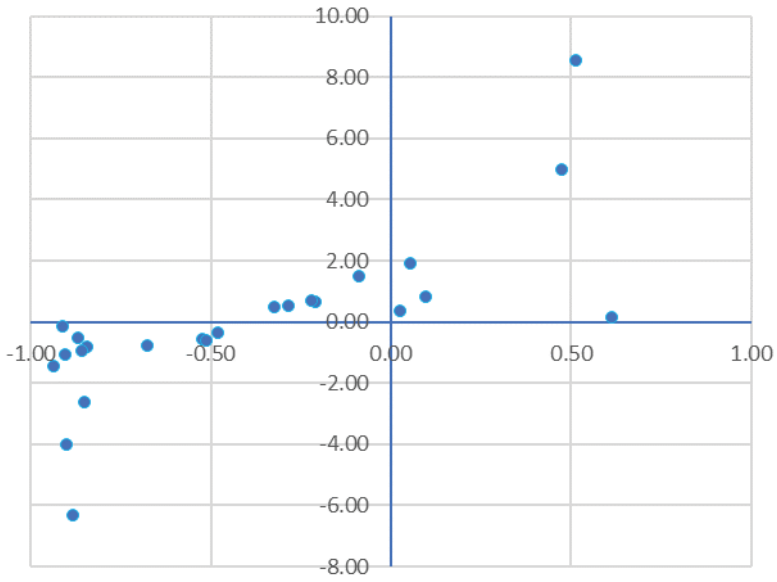
Economic area	Unit	Export		Import		Balance	
		I	II	I	II	I	II
Total	Billion euros	0.67	16.44	7.72	59.38	-7.04	-42.94
Europe	Billion euros	0.62	14.88	4.92	53.34	-4.30	-38.46
EU-28	Billion euros	0.53	13.27	4.44	49.61	-3.91	-36.34
Share in total							
Europe	%	91.47	90.51	63.78	89.84	61.13	89.58
EU-28	%	77.84	80.72	57.53	83.55	55.58	84.64

Data source: authors' calculations using primary data from NSI Romania, 2021

The data in Table 12 show that, during both periods, the product categories included in this class are mostly exported to European countries (91.5% in the first period, respectively 90.5% in the second period), and their share to total EU-28 countries exports increased significantly in the post-accession period compared to the pre-accession period (77.8% in the first period and 88.7% in the second period, respectively). On the other hand, in the pre-accession period the share of imports of these product categories in imports of these categories was much lower than in the case of exports: 63.8% if we consider imports from European countries, respectively 83.6%, if we refer only to EU-28 countries. After Romania's accession to the EU, the share of imports of these product categories increased significantly: 89.8% in the case of imports from European countries, respectively 83.6% in the case of EU-28 countries. Together with these increases, there was also a significant increase in deficits for these product categories after EU accession. If in the pre-accession period, the deficit was 4.3 billion euros for the trade with European countries (an average annual deficit of 615 million euros), and after accession it increased to 38.5 billion euros (the annual average deficit was 2.75 billion euros).

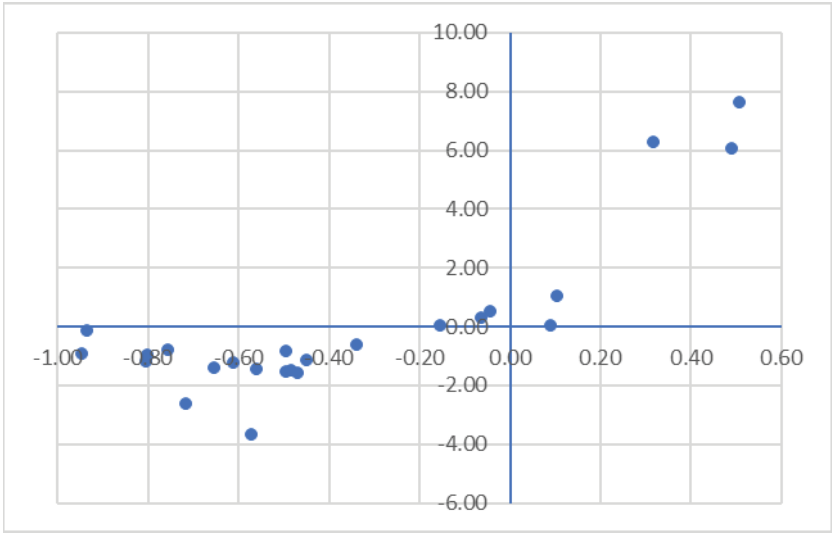
Modified product mapping scheme – Europe 2000-2006

Figure 5



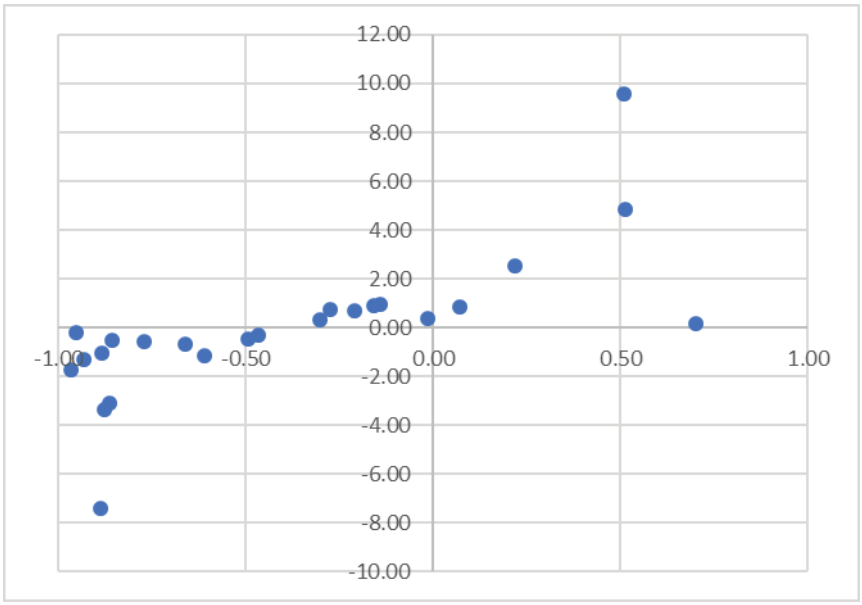
Modified product mapping scheme – Europe 2007-2020

Figure 6



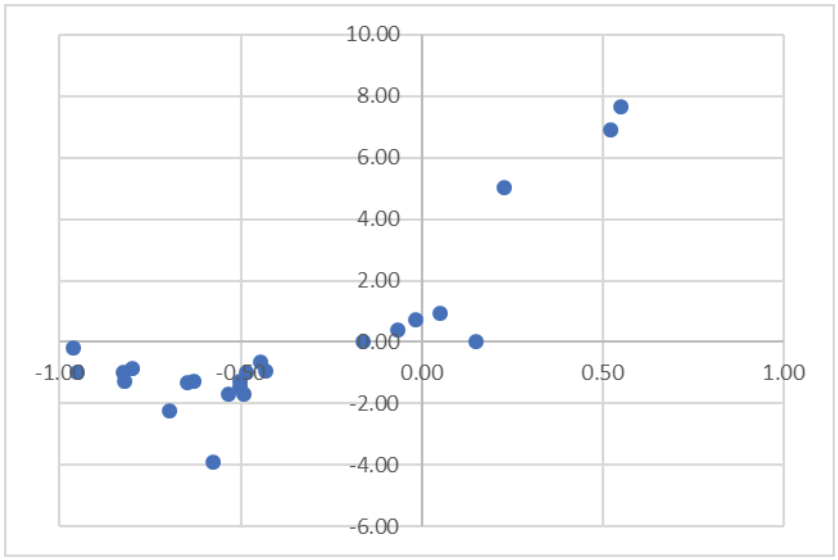
Modified product mapping scheme – EU 2000-2006

Figure 7



Modified product mapping scheme – EU 2007-2020

Figure 8



CONCLUSIONS

The results presented in this paper show that during 2000-2020 period, Romania significantly increased its exports and imports of agri-food products, while registering a significant increase in the degree of concentration of trade with European Union countries. The country's accession to the EU has been beneficial, as since 2007 there has been a significant increase in exports to most categories of agri-food products, both in the European area and to countries in other economic areas, especially Asia. On the other hand, with the accession to the EU, the dependence of the population's domestic consumption on imported agri-food products increased considerably, most of which have EU countries as their source of origin. The degree of concentration of exports by product categories is much higher than that of imports, this feature being much more evident after Romania's accession to the EU.

After the accession to the EU, a specialization of the country's exports was noted for several categories of agri-food products. Most exports consist of products with a low degree of processing, which have a low added value. Although, at least after 2007, these product categories recorded considerable surpluses, they were still insufficient to offset the accumulated deficits in most categories of agri-food products. Thus, Romania registered a surplus in the trade balance with agri-food products in only two years between 2000 and 2020. In these two years, 2013 and 2014, Romania registered completely exceptional productions for products included in the cereals category (CN code 10). In the following years, with the increase and diversification of imports of processed agricultural products, the increase in cereal production could not cancel the deficits recorded for most product categories, Romania registering chronic deficits for the trade with agri-food products.

Given that the export-import coverage ratio in 2000 was 36.3%, and in 2020 compared to 2000 exports increased 19 times and imports 8.8 times, the export-import coverage ratio indicator reached 78.3%. Considering this relatively positive evolution, if we refer only to the increases registered in certain categories of agri-food products, in 2020 Romania registered one of the highest annual deficits for the trade with agri-food products during the transition period, reaching 1.94 billion euro. Significant increases in exports and imports were recorded for all 24 product categories during the analyzed period, but the most important increases were recorded for the product categories which contributed each year to the reduction of the trade balance with agri-food products, but which appears to have been insufficient to close the imbalances between exports and imports of other important agri-food categories Romania's trade. If the exports from 2020 are compared to those

from 2000, then we will record an increase of over 60 times for cereals (CN code 10), over 23 times for seeds (CN code 12) and for tobacco (CN code 24) the increase was over 530 times. We emphasize that for two out of the three product categories (CN codes 10 and 24) there were significant trade deficits during the post-accession period, while during the same period these are the product categories with the largest contribution to reducing trade deficits in agri-food products.

If we aim to assess the degree of concentration of exports and imports of agri-food products during the period 2000-2020 we must emphasize two aspects. Firstly, both globally and for the economic areas that hold the most important share in exports and imports of agri-food products of Romania (Europe and EU-28) we noted a high degree of concentration of the exports compared with imports. At the level of the Asian and African economic zones, there is also a high degree of concentration of exports.

Given that globally, a deficit of almost 20.6 billion euros was accumulated between 2000 and 2020, we noted that from the trade with countries in Asia and Africa there were significant trade surpluses. Trade results with Asian countries are assessed by a share of exports to countries in this region equal to 10.6% of total exports of Romanian agri-food products and a low share of imports of only 2.9%. Therefore, a surplus of 7.67 billion euros was achieved. Romania registered significant commercial surpluses for three product categories: Cereals (CN code 10), Live Animals (CN code 01) and Seeds (CN code 12). A significant contribution to the realization of the trade surplus on this market was brought by products from the categories symbolized by 23 and 24 CN codes. Trade results in relation to African countries, are characterized by a share of exports in the total exports of Romania of 6.23%, and a share of the imports from this economic zone in the total imports of agri-food products of 1.30%. consequently, Romania registered a surplus of over 4.9 billion euros. The largest surpluses are from the trade with Cereals (CN code 10) and Live Animals (CN code 01).

An important aspect in the activity of foreign trade with agri-food products on a market is their competitiveness. Using the combined values of the TBI and LFI indicators, we obtained that the most competitive product categories are Cereals, Live Animals and Seeds. Romania's accession to the EU has allowed the creation of favorable conditions for ensuring the competitiveness of several product categories, both on the European market, but also on the markets in Asia and Africa. These are products belonging to the product categories: Cereals (CN code 10), Seeds (CN code 12), Live animals (CN code 01) and Tobacco (CN code 24). For most of the product categories, other than the four mentioned above, Romania is clearly importing

and not competitive on the European market. Domestic consumption of the population depends to a large extent on imports of agri-food products from other countries, mostly in Europe.

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