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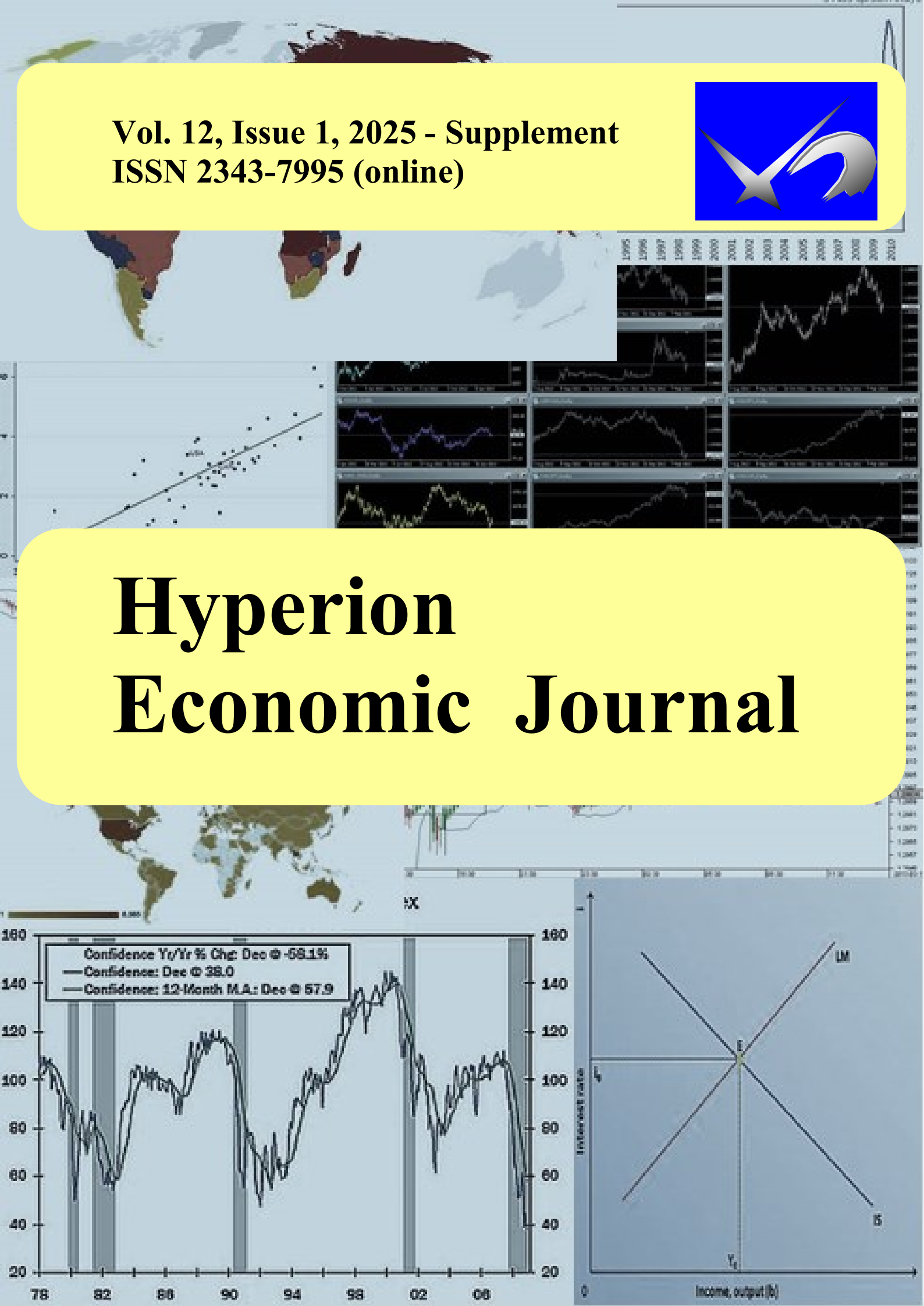

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CONTENTS

RESILIENCE OF ELDER PERSONS' ECONOMIC SECURITY IN CONDITIONS OF GLOBALISATION IN THE REPUBLIC OF MOLDOVA

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ABSTRACT: *The processes of globalisation in the modern world lead to changes in the economic, social and cultural fields of Moldovan society. In this article, the globalisation processes are understood as internationalisation of economic, socio-cultural and scientific-technical relations between countries, as well as liberalisation and free movement of capital, labour force, goods and services, information. In the context of globalisation challenges, the comparative analysis of situation the elder persons in the Republic of Moldova and in the European Union, as well as its impact on the formation of national socio-economic policies on the economic security of elder persons was carried out. The principal purpose of the research is to evaluate the possibility of prolonging economic activity and training, to increase the living standards and incomes, ensuring equality and inclusion of elder persons in all spheres of state socio-economic policies. The research is based on statistical data of the main indicators on the structure of usual residence population by main age groups and in the gender aspect, life expectancy, ageing rate and demographic burden, as well as indicators characterising employment and income of elder persons. The research applied integrated and systemic approaches, as well as such methods as analysis and synthesis, statistical, dynamic, graphical, positive and normative analysis, functional analysis. The results of research shown that population ageing is an important factor that should be taken into account both to ensure stable socio-economic development and to increase the resilience of economic security and living standards of the country's ageing population, which should be considered as a possible potential to fill the shortage in national labour market. In order to increase the resilience of economic security of the elderly, recommendations of perfection the state socio-economic policies, considering the elderly as equal participants in the process of social development and taking into account the satisfaction of their diverse requirements, were elaborated. The article was developed within the framework of the institutional project "Demographic transition in the Republic of Moldova: particularities, socioeconomic implications and consolidation of demographic resilience (2024-2027)".*

Keywords: *ageing population, employment, income, economic security, state policies, demographic ageing, standard of living.*

JEL Classification: *J14, J21, J26, J31, I38*

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1. INTRODUCTION

In the scientific literature the interrelation of globalization, its challenges and risks for national socio-economic development is a problem of many discussions. Moreover, the vulnerability of the European model of social economy as a consequence of the process of global negative demographic trend of population ageing, which is a threat to the economic security of the country due to the growing burden of elderly human capital and causes the need to form new approaches to the models of socio-economic policies adequate to the current challenges and peculiarities of national development of the country in the context of ensuring the economic security of its elder population. In the scientific literature, the mechanism of the relationship between globalisation processes and social policy was reflected in the works of Scharpf F. [Scharpf F., 2000, 190–228], Pierson P. [Pierson P., 1994], Deacon B. [Deacon B., 2007], Rodrik D. [Rodrik D., 1998, 997–1032], Habermas J. [Habermas J., 2002].

Globalization results in radical changes in social life, as a consequence of the process of formation of a single economic space and a single market, which are functioning on the basis of unified norms, rules and international standards, as well as the emergence of new opportunities in the field of access of the population to the market of health services from other countries [Bert de Belder, 2005], which contributed to the increase in life expectancy, the possibility of distance higher education, the development of cultural ties and other spheres of public life. At the same time, along with positive effects, as a consequence of the given process, there are problems and risks of social nature, which are directly related to the standard of living and quality of life of the population. In the above-mentioned context, the use of the potential and advantages of globalization becomes one of the necessary conditions for the development of new socio-economic policies adequate to ensure the economic and social security of human resources independently from age and gender, which are based on respect for human rights and dignity and democratically governed in the context of the opportunities associated with liberalization, international movement of labour force flows, capital, goods and services, the formation of a single information space, etc. At the same time, social issues are importance that are directly related to ensuring a decent standard of living and quality of life, social responsibility and protection, especially for those categories who are most socially vulnerable and at risk of losing their means of subsistence средств существования, i.e., mainly the population of pre- and pension age.

As a rule, the influence of the globalization process on ongoing national social policies is carried out through international organizations (United Nations and its specialized organizations (European Commission, World Health Organization, UNICEF, UNFPA), IMF, International Labour Organization, Organization for Security and Co-operation in Europe, United Nations Development Programme, European Training Foundation and others) through the adoption and promotion of international legislative acts (e.g., the Universal Declaration of Human Rights (1948), the European Social Charter (1961 and 1996), ILO conventions, jointly adopted Declarations, etc.). The legislation, socio-economic development strategies, programs and concrete measures in the field of economic security of elder population in the Republic of Moldova are based on the principles promoted by the UN on human rights, equality and social cohesion, exclusion of any form of discrimination based on age, nationality and gender. As a member of the United Nations Economic Commission for Europe (UNICE), in 2002, the Republic of Moldova joined the Madrid International Plan of Action on Ageing (MIPAA), which provides policies and measures for the integration of demographic ageing into national policies, and also the country developed a Regional Strategy for the implementation of the Madrid International Plan of Action on Ageing. The adoption of the above-mentioned document was a response to the challenges of the globalization process, including the reduction in the number of working places as a result of changes in production and social infrastructure,

declining employment rate and growth of unemployment, increasing migration processes and income differentiation, which, in turn, is a source of growing social risks, polarization and tension against the background of demographic ageing of the population. In these conditions, an important task of the state is *to ensure the economic security of elder people*, which implies a set of measures to protect their interests in economic and financial aspects, including income (pension and other social benefits, income from continuation of labour activity, from savings and other sources), as well as increasing the level of financial literacy and skills of self-management of finances in order to avoid various types of fraud. Economic security also implies maintaining the solvency of elder population and the security of his employment.

In order to evaluate the economic security of elder population, it is necessary to consider another aspect, namely, which category of population enters into the above or from what age the population will be considered "elderly", i.e., the existence of a legal framework in the given field. With the growth of the share of the population aged 60 and over in the world, international human rights law is also constantly in the process of development. Thus, according to the data of the UN Department of Economic and Social Affairs in 1990 the number of population 60 years and over was 9.2%, then in 2050 according to forecasts it will increase to 21.1% of the world's population, or about two billion people [Eurasian Juridical Portal].

In response to the challenges of demographic ageing of population, especially since the end of the 20th century, norms and instruments to protect the rights of elder persons in framework of international law were elaborated. However, at present, there is no universal document that contains the main characteristics of "elder person" as an object of international law and clearly defined his rights. The given fact is the reason for the existence of different approaches and systems of protection of elder persons in different countries. However, in order to study the realization of the rights of elder persons in practice and their protection, it is necessary to define the concept of the category "elder person" or to define the age at which the population is included in this category. International documents, the terminology on the given issue also varies. Thus, the Committee on Economic, Social and Cultural Rights (CESCR) considers the most acceptable to use the term "elder persons", which has already been used in General Assembly resolutions 47/5 (Declaration on Ageing) and 48/98 (Implementation of the International Plan of Action on Ageing). The age marker of 60 years is used in UN documents. In particular, it can be noted that the first international document, which devoted to elder population is the Vienna International Plan of Action on Ageing, adopted at the World Assembly on Ageing in 1982, in which it was established that the given category includes a person who has reached 60 years and over. Currently, the main international document on the rights of elder people is the Madrid International Plan of Action on Ageing (2002), which was adopted at the Second World Assembly on Ageing and also recognizes that 60 years of age is the beginning of old age. The beginning of elder age from 60 years is recognized and used by UN statistics and the World Health Organization (WHO). However, WHO, in the global summary for the World Health Day 2012, noted that in a number of its studies due to various reasons can be considered such age groups of the population as 50 years and over, 65 years and over and 80 years and over, as the age limits largely depend on life expectancy in a concrete country. Considering the problems of economic security, it is also necessary to note the position of the International Labour Organization (ILO), which suggests that the beginning of the age of elder person is the adopted standard of retirement age in most countries or the age of 65 years. Thus, for example, section number five of ILO Convention No. 102 "On Minimum Standards of Social Security" provides for men and women, who have reached the age of 65 years or a higher age limit established by the state, the old-age benefits. Eurostat, or the statistical office of the European Union classifies "elder persons" as those who are age limit 65 years and over.

Consequently, there is no uniformity in the use of international law and instruments for the protection of the rights of elder persons due to the different socio-economic and cultural features of the development of different countries, and that's why each country has different approaches to the observance of rights and policies in relation to the category "elder persons". At the same time, the adoption of an international conventions, which will establish a single age of old age, will eliminate negative consequences in the application of different approaches to the realization of the rights and protection of elder people, ensuring equal opportunities and high standards of quality of life for the given category of the population. In this context, it should be noted that the European system of human rights protection identifies elder people as vulnerable category of population, including in the Recommendation of the Parliamentary Assembly of the Council of Europe on the rights to health care and social security, as well as in the Recommendation of the Parliamentary Assembly of the Council of Europe on combating discrimination against elder people in labour market, and the Madrid International Plan of Action on Ageing (MIPAA) singles out groups of elder people, especially those living alone, as having multiple vulnerabilities, including those who experience multiple discrimination. Knowledge of legal norms (right to social security and protection, right to health, right to work, right to participate in public life, freedom from violence and abuse, etc.) and observance for the rights of elder people will allow for the practical implementation of the UN Convention "society for all ages". In the Republic of Moldova, the implementation of the MIPAA is carrying out, the Regional Action Plan for the implementation of the principle of active ageing was adopted, as well as the Program for Active and Healthy Ageing for 2023-2027 [Decision of the Government of the Republic of Moldova, 2023], which is ensured the realization of the obligations assumed by the Republic of Moldova as a result of its joining to the Madrid International Plan of Action on Ageing (MIPAA), also in connection with the declaration by the UN General Assembly of the Period from 2021-2030 as the Decade of Healthy Ageing and the necessity to adapt policies to the requirements of the country's elderly population. The above-mentioned Program also corresponds to aims and objectives of the National Strategy for Regional Development of the Republic of Moldova for 2022-2028 in conditions of the impact of demographic ageing in the regions of the country, the National Development Strategy "European Moldova 2030" and other sectoral normative documents in the field of health, education, development of the national statistical system and others. The Program provides a complex and cross-sectoral approach to ageing issues, which contributes to achieving the aims of reducing poverty and improving the quality of life of elder persons, ensuring healthy live and promoting well-being, expanding and adapting lifelong learning services for elder persons, developing their digital skills for social inclusion, creating a labour market open to elder persons that will contribute to increase the participation and use of the potential of elder persons in labour market, expanding the dialogue between generation, reducing cases of discrimination and stereotypical attitudes towards elder persons, as well as ensuring the participation of elder persons in decision-making processes, that apply to them, and decline the number of elder persons exposed to various forms of violence and discrimination.

This article presents the results of a research on the economic security ensuring of elder people in the Republic of Moldova. In particular, it assesses the economic activity and the possibility of its continuation, taking into account the learning process, living standards and income. Research is based on statistical data about of number of the population with usual residence, life expectancy, ageing rate and demographic burden, indicators on employment and income of elder people.

2. PURPOSE OF RESEARCH AND DATA

In the context of the above-mentioned research, the authors understand *ensuring the economic security of elder people* as the exclusion of internal and external influences or risks related to financial or resource provision that affect the protection of the interests of an individual or household of elder people, i.e. interests are understood here as a set of requirements, the satisfaction of which is reliable and sustainable for the well-being and development of elder people.

3. RESULTS AND DISCUSSIONS

In the Republic of Moldova, the age limit for elder population is 60 years and over. The dynamics of elder population is presented представлена in Table 1.

Table 1. Key indicators characterizing the process of demographic ageing of the population, Republic of Moldova (at the beginning of the year)

	2020	2021	2022	2023	2024[1]
Average number of usual residence population, persons	2643675	2626588	2565030	2 492 278	2 423 287
60-64 years	193 305	198 151	197 578	194 732	189 578
65-69 years	163 671	161 417	159 797	163 318	168 853
70-74 years	93 468	111 352	122 616	132 973	135 948
75 years and over	123 854	116 152	109 978	108 970	116 305
Ageing rate, %	21.7	22.4	23.0	24.1	25.2
Urban	20.6	21.0	21.2	21.9	22.7
Rural	22.5	23.3	24.3	25.7	27.1
Males	18.3	18.8	19.4	20.4	21.5
Females	24.9	25.6	26.3	27.3	28.4
Dependency Index (Dependency ratio), national level*	69.3	68.1	69.7	69.8	72.0
Dependency Index, international level**	49.0	49.6	50.6	52.0	53.5
Average age of population, years	39.3	39.6	39.9	40.3	-
Males	37.4	37.6	37.9	38.4	-
Females	41.0	41.3	41.7	42.1	-

Note: *Number of population of non-working age (0-15 years, 57/62 years and over) per 100 people of working age (16-56/61 years).

**65 years and over per 100 people of working age (16-64 years).

[1] Preliminary data NBS for 2024 are presented.

Since 01.01.2019 the pension age increased and amounted to 63 years for males and 58 years for females; since 01.01.2021 the pension age increased for female to 59 years; since 01.01.2023 the pension age for female increased to 60 years.

Source: NBS, www.statistica.md

In the Republic of Moldova, at the beginning of 2024, elderly population constituted 25.2% of the total population with usual residence, of which the majority or 60.2% were females, and every third person (31.0%) belonged to the age category within the limits of 60-

64 years and moreover, 9.8% of the above-mentioned elder population exceeded the age of 80 years. Analysis of statistical data on the main age groups revealed the tendency of growth of elder population in the age group 70-74 years or from 16.3% (at the beginning of 2020) to 22.3%(at the beginning of 2024), while the share of other age groups of the above-mentioned category of the population is decreasing. It should be noted that the ageing process in the country became irreversible, as compared to the beginning of 2020, the ageing rate increased by 3.5 p.p. and its level is quite high. In this aspect, it should be noted that elder population has a female face - the ageing rate of females is higher than for males (the difference is 6.9 p.p.), the ratio between males aged 60 and over and females as of 1 January 2024 was 66.1 males per 100 females. In the territorial aspect, as of 1 January 2024 the share of elder population aged 60/63 years and over was 26% in the Northern and Southern zones, 24% in the Central zone and ATU Gagauzia and 18% in mun. Chisinau.

The process of demographic ageing increases the demographic burden indicators, the growth trend of which is reflected in Table 1. In conditions of population decline, the given process leads to a reduction in the number of economically active and, as a consequence, employed population, including the labour force imbalance and its deficit. The above-mentioned situation in labour market is also one of the factors of impossibility to ensure and maintain the economic and social security of the elderly population of the country, including taking into account the age and gender component of the given category of the population.

Analysis the elder population (aged 60 years and over), its structure and gender component revealed that life expectancy increased, including by 0.4 years for males and 0.9 years for females (2019-2023). As a consequence of this factor, there was also an increase in the gap of the average life expectancy in males and females from 4.2 years (in 2019) to 4.7 years (in 2023) in favour of females. Thus, according to data assessments for 2023, a 60-year-old female will live another 20.4 years, while the average life expectancy of a 60-year-old male will be only 15.7 years [NBS RM, 2024]/ (Table 2.).

Table 2. Dynamics of life expectancy at birth and upon reaching elder age
(number of years)

	2019	**2020**	**2021**	**2022**	**2023**
Life expectancy at birth –total, RM including:	70.9	69.9	69.0	71.4	71.9
Males	66.8	66.0	65.1	67.1	67.5
Females	75.2	73.9	72.9	75.7	76.4
Life expectancy at age on average in the country and by gender:					
60 years	17.6	16.6	15.6	17.5	18.2
Males	15.3	14.2	13.4	15.0	15.7
Females	19.5	18.6	17.4	19.6	20.4
65 years	14.3	13.4	12.4	14.1	14.8
Males	12.5	11.4	10.7	12.1	12.7
Females	15.7	14.9	13.8	15.7	16.4
70 years	11.3	10.5	9.6	11.0	11.7
Males	10.0	9.0	8.3	9.6	10.3
Females	12.2	11.5	10.5	12.0	12.6
75 years	8.4	7.9	7.1	8.2	8.9
Males	7.5	6.9	6.2	7.2	8.1
Females	8.9	8.4	7.7	8.8	9.4

	2019	2020	2021	2022	2023
80 years	6.1	5.7	5.1	5.8	6.3
Males	5.7	5.2	4.7	5.3	5.8
Females	6.3	5.9	5.4	6.0	6.5
85 years	4.1	3.7	3.2	3.7	4.2
Males	4.0	3.6	3.0	3.5	4.2
Females	4.1	3.7	3.3	3.8	4.2

Source: NBS, www.statistica.md

The analysis of life expectancy in the gender aspect allows to conclude that in 2023 there was an increase in the difference of this indicator between males and females by 0.3 years compared to 2022, taking into account the difference in the age-specific mortality rates of males and females.

It should also be noted that life expectancy for both males and females decrease with increasing age, with higher life expectancy for females, but the gap in this indicator decreases with increasing age.

According to the data of the study by the National Bureau of Statistics of household budgets, in 2023, 42.7% of households had at least one household member aged 60 and over, including 79.7% of households consisting only of elder people. Depending on the place of residence, 67.8% of households consisting of elder people live in rural and only 32.2% in urban. Moreover, it should be noted that 68.9% of households consisted of one person and only 30.7% of households consisted of 2 persons.

Taking into account the above, *ensuring the economic security of the elderly* is one of the main priority tasks of the long-term socio-economic development of an ageing society. In this context, attention will be focused on the possibility of continuing economic activity and improving their financial situation due to this factor, and, ultimately, their standard of living.

Table 3. Dynamics of structure of economically active and employed elder population, Republic of Moldova, 2020-2024

Indicators / Age group	Number, thousand persons					Share of age group in total number, %				
	2020	2021	2022	2023	2024	2020	2021	2022	2023	2024
Economically active population, 15 years and over										
Total, thousand persons	**867.3**	**871.6**	**890.0**	**929.5**	**889.1**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
55-64 years	160.9	164.9	168.6	176.3	172.2	18.5	18.9	18.9	19.0	19.4
65 years and over	25.0	20.6	22.7	29.3	27.9	2.9	2.4	2.6	3.2	3.1
Employed population, total, thousand persons	**834.2**	**843.4**	**862.3**	**886.9**	**853.9**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
55-64 years	156.2	160.4	164.5	170.0	167.2	18.7	19.0	19.1	19.2	19.6
65 years and over	24.9	20.6	22.6	29.1	27.7	3.0	2.4	2.6	3.3	3.2
	Economic activity rate, %					Employment rate, %				
Total, RM, %	40.3	41.1	41.8	45.1	44.5	38.8	39.8	40.5	43.1	42.7
55-64 years	41.7	43.8	45.2	48.9	49.3	40.5	42.6	44.1	47.1	47.9

Indicators / Age group	Number, thousand persons					Share of age group in total number, %				
	2020	**2021**	**2022**	**2023**	**2024**	**2020**	**2021**	**2022**	**2023**	**2024**
Males	50.1	51.8	53.4	57.1	54.2	48.1	50.0	51.8	54.7	52.4
Females	34.2	36.6	38.3	42.1	45.2	33.7	36.0	37.6	40.9	44.1
Urban	44.3	48.2	47.8	49.9	55.7	42.5	46.6	46.6	48.1	53.8
Rural	40.3	41.5	44.0	48.3	45.7	39.4	40.5	42.9	46.6	44.5
65 years and over	6.6	5.3	5.8	7.3	6.6	6.5	5.3	5.7	7.2	6.6
Males	8.5	6.9	7.7	10.3	9.9	8.4	6.9	7.7	10.3	9.8
Females	5.4	4.3	4.5	5.3	4.6	5.4	4.3	4.4	5.2	4.6
Urban	9.2	7.7	7.7	9.0	8.9	9.2	7.7	7.6	8.9	8.8
Rural	5.0	4.0	4.8	6.2	5.1	4.9	4.0	4.8	6.2	5.1
	Number of pensioners in labour market, persons					Share of pensioners in labour market, (including the share of females/males in total number of employed pensioners) %				
Total, persons	175656	172516	169529	171019	174885	23.4	23.7	24.0	23.5	24.1
Females	98697	96656	93843	92418	92 996	56.2	57.2	55.4	54.0	53.2
Males	76959	75860	75686	78601	81 889	43.8	42.8	44.6	46.0	46.8
Economically inactive population, thousand persons	**1283.6**	**1248.9**	**1240.1**	**1129.9**	**1110.2**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
55-64 years	225.0	212.1	204.4	184.5	176.8	17.5	17.0	16.5	16.3	15.9
65 years and over	356.4	366.3	370.9	374.1	392.9	27.8	29.3	29.9	33.1	35.4
Category of economic non-employment - pensioner, number and share in the economically inactive population, thousand persons/%	580.1	583.5	580.1	562.7	477.8	45.2	46.7	46.8	49.8	43.0

Source: elaborated by the authors on the basis of NBS data and authors' calculations

Analysis of data on the structure of the economically active and employed population for the last five years shows the tendency of growth in their number and share in both the economically active and employed population, which exceeds 22% in 2024. In framework of economic activity and employment rate of elder population, the corresponding coefficients for the age categories 55-64 years and 65 years and over exceed the national average, including in 2024, respectively, for the category 55-64 years by 4.8 p.p. for economic activity and by 5.2 p.p. for employment rate. It should also be noted that both economic activity rate and employment rate in the age categories 55-64 years and 65 years and over are approximately 8-9% higher for males than for females. The share of pensioners in labour market in the analyzed period was 24%, including the share of employed females is predominant and on average 8 p.p. higher than the share of males employed in labour market in the total number of employed

pensioners. The category of economic unemployment - pensioner, number. Share of pensioners as a category of economic unemployment in the structure of economically inactive population registered a decreasing tendency and in 2024 amounted 43.0% or decreased by 6 p.p. in comparison with the previous year.

Employment of elder people in the age categories of 55-64 years and 65 years and over by main types of economic activity is presented in Table 4.

Table 4. Characteristics of employed elder population by main types of economic activity, Republic of Moldova, 2020-2024

Indicators / Age group	Number, thousand persons					Share of age group in total number of employed population in economic activity, %				
	2020	**2021**	**2022**	**2023**	**2024**	**2020**	**2021**	**2022**	**2023**	**2024**
Employed population, total, thousand persons	**834.2**	**843.4**	**862.3**	**886.9**	**853.9**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
55-64 years	156.2	160.4	164.5	170.0	167.2	18.7	19.0	19.1	19.2	**19.6**
65 years and over	24.9	20.6	22.6	29.1	27.7	3.0	2.4	2.6	3.3	3.2
Agriculture, forestry and fisheries	**175.9**	**181.2**	**179.3**	**185.3**	**154.6**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
55-64 years	44.1	42.4	43.7	44.7	36.8	25.1	23.4	24.4	24.1	**23.8**
65 years and over	7.3	6.4	7.7	8.8	7.1	4.1	3.5	4.3	4.7	4.6
Industry	**121.4**	**121.6**	**127.6**	**127.8**	**114.8**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
55-64 years	18.8	20.5	21.6	21.6	22.8	15.5	16.9	16.9	16.9	**19.9**
65 years and over	2.5	1.4	1.7	2.0	1.6	2.1	1.1	1.3	1.6	1.4
Constructions	**60.4**	**65.1**	**66.5**	**63.3**	**64.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
55-64 years	7.9	8.8	8.8	8.8	8.3	13.1	13.5	13.5	13.9	13.0
65 years and over	0.5	0.4	0.7	0.8	0.6	0.8	0.6	1.1	1.3	0.9
Wholesale and retail trade; accommodation and public catering activities	**148.4**	**147.5**	**152.7**	**156.9**	**150.2**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
55-64 years	17.8	19.6	19.9	22.5	21.2	12.0	13.3	13.0	14.3	14.1
65 years and over	2.5	2.1	2.6	3.2	3.7	1.7	1.4	1.7	2.0	2.5
Transport and storage, Information and communication	**61.5**	**60.2**	**63.8**	**63.2**	**64.9**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
55-64 years	11.1	10.9	9.5	9.8	9.8	18.0	18.1	14.9	15.5	15.1
65 years and over	1.7	1.2	1.0	1.3	1.8	2.8	2.0	1.6	2.1	2.8

Indicators / Age group	Number, thousand persons					Share of age group in total number of employed population in economic activity, %				
	2020	**2021**	**2022**	**2023**	**2024**	**2020**	**2021**	**2022**	**2023**	**2024**
Public administration, Education, Health and social assistance	**193.1**	**193.5**	**197.4**	**203.5**	**211.1**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
55-64 years	45.8	49.0	50.2	48.2	49.8	23.7	25.3	25.4	23.7	**23.6**
65 years and over	8.1	6.8	6.1	9.4	9.0	4.2	3.5	3.1	4.6	4.3
Other service activities	**73.5**	**74.3**	**75.1**	**86.9**	**94.5**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
55-64 years	10.8	9.2	10.8	14.4	18.5	14.7	12.4	14.4	16.6	**19.6**
65 years and over	2.4	2.3	2.8	3.5	3.8	3.3	3.1	3.7	4.0	4.0

Source: elaborated by the authors on the basis of NBS data and authors' calculations

The main share of employed elder population in the 55-64 age category is registered in agriculture, forestry and fisheries (23.8% of employed in the given types of activities), as well as in public administration, education, health and social assistance (23.6%), where the main share of those aged 65 and over (4.6% and 4.3%, respectively in 2023 and 2024). The above tendency has been practically maintained throughout the last five years. The process of labour force ageing is visible in industry and other types of activity, in which the share of employed labour force in the 55-64 age category in 2024 was almost 20%. In other types of economic activities, the share of employed elder population is 15% or less, it is due to the necessity of presence the good health in conditions of increased physical activity and psychological state of a person.

Increased economic activity of elder people and their involvement in labour activity is not an indicator of improved their well-being. Labour activity is an important form of social activity and in this context retirement for elder people is the loss of social ties and work as the principal source of their income and, as a consequence, the basis of their financial well-being and security. That is why, when considering the problem of economic security of elder population, it is necessary to evaluate the preservation of solvency and the possibility of planning monetary flows for the perspective in conditions of unequal socio-economic development of the country, increasing social and property differentiation, the risk of poverty and other internal and external factors. The pension system plays an important role in ensuring economic and, in particular, financial security. Pension payments enable elder people to satisfy the basic needs and ensure their self-sufficiency, including the possibility to withstand the risks of vulnerability. Table 5. presents the evolution of average monthly wages per worker, disposable monetary income and pensions for the period 2020-2024 in the context of inflation and poverty risk.

Table 5. Dynamics of average monthly wages, disposable income and pensions, RM, 2020-2024

	2020	**2021**	**2022**	**2023**	**2024**
Average pension (at the end of the year), MDL	**2 104.5**	**2 578.5**	**3 156.4**	**3 676.7**	**3 975.2**

	2020	**2021**	**2022**	**2023**	**2024**
Pension growth Index, % to the previous year	110.7	122.5	122.4	116.5	108.1
Real growth Index, % to the previous year	106.6	116.6	95.1	102.7	103.2
Replacement ratio (Average pension/wages), %	*26.0*	*28.3*	*30.0*	*29.8*	*28.2*
Average old-age pension (at the end of the year), MDL	**2 067.56**	**2 595.3**	**3 164.9**	**3 683.6**	**3 983.8**
Age pension growth Index, % to the previous year	112.2	125.5	121.9	116.4	108.1
Real growth Index, % to the previous year	108.1	119.4	94.7	102.6	103.2
Replacement rate (old-age pension/wages), %	*25.5*	*28.5*	*30.1*	*29.8*	*28.3*
Average pension for work insurance period (at the end of the year), MDL	1 006.5	1 118.4	1 438.8	1 675.9	1 788.8
Pension growth Index for work insurance period, in % to the previous year	104.1	111.1	128.6	116.5	106.7
Average pension amount in case of early pensions (at the end of the year), MDL	2 855.1	2 959.6	3 344.4	3 711.4	3 920.5
Growth Index of early pensions, % to the previous year	92.8	103.7	113.0	111.0	105.6
Disposable income of one member of a pensioner household, MDL	**2 640.3**	**2 943.9**	**3 688.0**	**4 174.4**	**4 407.9**
Including by sources of income:	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
- wages	12.6	13.3	13.1	11.7	12.9
- income from individual agricultural activity	9.7	9.1	9.1	7.8	7.0
- income from individual non-agricultural activity	1.5	2.4	1.5	1.6	1.5
- income from property	**0.0**	**0.0**	**0.1**	**0.0**	**0.0**
Social benefits, total	62.4	62.5	68.3	69.9	68.5
- Pensions	53.4	54.6	60.7	64.6	64.5
- Child benefits	0.3	0.3	0.4	0.4	0.1
- Social assistance	0.7	0.7	0.2	0.2	0.1
Other income	13.8	12.8	8.0	8.9	10.1
- including remittances of labour workers abroad	9.8	9.2	5.7	6.3	6.4
Average monthly wage of one employee in the country (Gross), MDL	**8 107.5**	**9 115.9**	**10 529.1**	**12 354.7**	**14 096.7**
- budget sector	7313.8	7786.6	8844.6	10451.0	11961.8
- real sector	8402.7	9595.0	11126.6	13015.6	14829.2
Index of growth of average monthly wages, % to the previous year	110.2	112.4	115.5	117.3	114.1

	2020	2021	2022	2023	2024
Real growth Index of average monthly wage, % to the previous year	106.2	106.9	89.7	103.4	109.0
Consumer Price Index (CPI), %	**103.8**	**105.1**	**128.7**	**113.4**	**104.7**
Absolute poverty threshold, MDL	**2 174.1**	**2 285.2**	**2 942.0**	**3 336.8**	**3 493.3**
Absolute poverty rate, %	**26.8**	**24.5**	**31.1**	**31.6**	**33.6**
- including if the main source of income of the head of the household is a pension	39.5	38.2	45.8	46.1	48.5
- age of the head of the household, 60-64 years	28.5	26.6	34.2	35.6	37.0
- age of the head of the household, 65 years and over	41.1	39.7	48.1	47.7	47.5
Extreme poverty threshold, MDL	**1 753.4**	**1 843.0**	**2 372.7**	**2 691.2**	**2 817.1**
Extreme poverty rate, %	**10.8**	**9.5**	**13.5**	**13.8**	**15.4**
-including by age group 60 years and over	15.0	13.4	19.7	19.7	19.4

Source: elaborated by the authors on the basis of NBS data and authors' calculations

Analysis of the incomes of the elderly allows to conclude about the low level of economic security and, as a consequence, about existence of poverty risk in conditions of inflationary processes. Thus, there are a tendency of growth both the absolute poverty rate during the last five years (in 2024 by 6.8 p.p. compared to 2020) and the extreme poverty rate (by 4.4 p.p. in the category of 60 years and over compared to 2020). In 2024 the difference between the absolute poverty threshold (3493.3 MDL) and the average monthly pension in the country (3975.2 MDL) is 12.1% (481.9 MDL), and the extreme poverty threshold (2817.1 MDL) is 29.1% (or 1158.1 MDL), i.e. elder people practically exist on the brink of poverty. Moreover, if the age of the household head is 65 years and over, the absolute poverty rate increases to 47.5%, and if the pension is the principal source of income for the elderly, this indicator has exceeded 40% over the last 3 years and in 2024 will amount to 48.5%. This indicator has exceeded 40% for the last 3 years and in 2024 will be 48.5%.

Due to the small amount of pensions, including both the national average and age pensions, the ratio between the amount of pensions and the average monthly wages of one employee is slightly higher than 28% and decreased by 1.5 p.p. compared to the previous year. Due to the difficult economic and financial situation of pensioners, the share of pensions in 2024 increased to 64.5% compared to 53.5% in 2020, or by 11.0 p.p., the share of wages as one of the sources of their replenishment in the structure of disposable income is 12%. At the same time, the share of state social assistance at the level of 0.1% is so minuscule that it does not provide real support for improving the lives of elder population. In the given context, it can be noted that remittances of labour migrants abroad (6.4%) provide more financial support. Table 6. presents the structure of disposable monetary income and expenses of pensioners by age groups 60-64 years and 65 years and over, depending on the place of residence, urban and rural.

Table 6. Structure of disposable monetary income and expenses of pensioners, RM, 2024

	Households of pensioner (by socioeconomic status)			**Head of household, 60-64**			**Head of household, 65 and over**		
	RM*	Urban	Rural	RM*	Urb.	Rur.	RM*	Urb.	Rur.
Disposable income of one member of a pensioner household, MDL	**4407.9**	**5361.7**	**3957.2**	**5576.9**	**7110.3**	**4688.2**	**4594.5**	**5646.1**	**4017.9**
Including by sources of income:	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
- wages	*12.9*	*15.6*	*11.2*	*48.1*	*51.0*	*45.4*	*15.1*	*21.6*	*10.1*
- individual agricultural activity	7.0	0.6	11.1	6.4	0.4	11.7	6.1	0.7	10.2
- income from individual non-agricultural activity	1.5	1.22	1.7	4.0	5.3	2.8	1.2	0.9	1.4
- income from property	**0.0**	**0.0**	**0.1**	**0.1**	**0.2**	0.0	0.0	0.0	0.1
Social benefits, total	**68.5**	**70.6**	**67.1**	**32.8**	**33.5**	**32.3**	**70.3**	**68.5**	**71.7**
- pensions	*64.5*	*68.6*	*61.8*	*30.1*	*31.7*	*28.7*	*66.4*	*66.4*	*66.4*
- child benefits	0.1	-	0.1	0.0	-	0.1	0.1	-	0.2
- social assistance	0.1	-	0,1	0.1	0.2	0.0	0.0	0.0	-
Other income	**10.1**	**12.0**	**8.8**	**8.6**	**9.5**	**7.8**	**7.3**	**8.3**	**6.6**
- including remittances of labour migrants abroad	6.4	6.8	6.1	6.5	6.9	6.2	4.5	4.6	4.4
Consumer expenses of elder people, MDL	**3811.6**	**4404.4**	**3531.4**	**4369.9**	**5431.6**	**3754.7**	**3847.7**	**4489.6**	**3495.8**
Including by directions:	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Food and non-alcoholic beverages	47.8	44.5	49.7	44.4	40.1	48.0	48.3	45.6	50.3
Alcoholic beverages and tobacco products	1.4	1.6	1.3	1.9	2.0	1.9	1.3	1.4	1,3
Clothing, shoes	5.3	4.6	5.7	5.9	5.3	6.4	5.1	4.6	5.5
Payment for housing, water, electricity and gas	21.7	21.4	21.9	18.9	17.6	20.0	22.1	21.3	22.7
Purchase of furniture and housing maintenance	5.1	4.6	5.4	6.0	5.8	6.2	5.0	4.7	5.3
Health	6.1	8.7	4.6	5.6	7.9	3.6	6.0	8.2	4.5
Transportation expenses	3.0	3.5	2.8	4.9	5.1	4.7	3.0	3.4	2.6
Telecommunications	4.4	4.2	4.5	4.4	3.9	4.9	4.1	4.0	4.2

	Households of pensioner (by socioeconomic status)			Head of household, 60-64			Head of household, 65 and over		
	RM*	Urban	Rural	RM*	Urb.	Rur.	RM*	Urb.	Rur.
Entertainment (leisure) and culture	1.0	1.8	0.5	2.0	3.7	0.6	0.8	1.4	0.4
Education	0.2	0.2	0.2	0.6	1.1	0.1	0.2	0.3	0.1
Restaurants, hotels	0.6	1.5	0.1	1.6	3.2	0.2	0.7	1.7	0.1
Other products and services	3.4	3.5	3.3	3.9	4.3	3.5	3.2	3.4	3.1
Absolute poverty rate, %	**48.5**	-	-	**37.0**	-	-	**47.5**	-	-
* National average of Republic of Moldova									

Source: elaborated by the authors on the basis of NBS data and authors' calculations

The comparative analysis of the sources of income of elderly in 2024 highlighted that the share of *wages* is the main source and exceeds the share of *pensions* in the age category 60-64 in both urban and rural from 13 to 19 p.p., and in the age category 65 years and over, despite the fact that the main share in the income structure belongs to pensions (more than 66%), wages also remain one of the main additional sources of income formation. *Remittances* of labour migrants abroad the country are also the third in importance and share in income formation. At the same time, social state assistance is insignificant and practically don't impact on improving the well-being of elder people and their economic and financial security, which confirms the high rate of absolute poverty among pensioners (48.5%), especially in households with a head of household aged 65 and over (47.5%). Moreover, elder people need to work in order to improve their living standards and to cover necessary consumer expenses, including financial security, through their wages.

In the structure of consumer expenses food, non-alcoholic and alcoholic beverages, tobacco products are almost 50% of expenses, up to 22% of expenses are for housing, water, electricity and gas, on average 5 to 6% of expenses are used for shopping (clothes and shoes). It can also be noted that the share of expenses related to health is on average 6%, however, in urban these expenses are higher both in households with a head aged 60-64 (7.9% compared to 3.6% in rural) and in households with a head aged 65 and over (8.2% compared to 4.5% in rural), i.e. elder people in urban have the opportunity and are focused more attention to their health compared to those living in rural.

Thus, the analysis of incomes and expenses of elder people households allowed to conclude that this category of population is the most vulnerable in point of view of existence and ensuring economic, financial and social security in the modern society of the Republic of Moldova. The given situation revealed the necessary to perfect the state socio-economic policies directed at improving the level and quality of life of elder people in the context of joining to the Madrid International Plan of Action on Ageing (MIPAA) and in connection with the declaration by the UN General Assembly of the period from 2021-2030 as the Decade of Healthy Ageing and the necessity to adapt policies to the requirements of elder population of the country.

4. CONCLUSIONS

Global changes in the modern world and, as a consequence, the formation of a single economic space, have led to changes in the economic and social life of Moldovan society. However, the consequences of the given process are contradictory: on the one hand,

globalization contributes to an increase in the efficiency of the economy, providing opportunities for the implementation of modern technologies and standards for the growth of living standards, and on the other hand it leads to economic restructuring, stagnation, increased migration flows, technical unemployment, decrease of working places, income differentiation, deterioration of well-being and poverty. As a result of the above-mentioned processes, demographic and social deformation takes place, including the reduction of fertility and life expectancy, as well as the crisis of the social system and health care. In this context, the main category of the population that is most exposed to vulnerability and social risks is elder people. In the Republic of Moldova, the share of elder population is 25.2%, including 21.5% of the male population and 28.4% of the female population. Therefore, the objective of ensuring the economic security of the given category of population is one of the priorities in the socio-economic policies and national programs implemented by the state. At the same time, one of the important factors in the practical solution of the above-mentioned objective is the country's accession to the Madrid International Plan of Action on Ageing (MIPAA), including the development of national special five-year programs to solve the problems of elder people (including the Program of Active and Healthy Ageing for 2023-2027 [Decision of the Government of the Republic of Moldova, 2023]). Given program provide for such directions as harmonizing the development of society in conditions of demographic changes, ensuring effective social protection and care for elder people based on accessibility and improvement of the quality of social and medical services (creation of geriatric departments in hospitals for treatment and rehabilitation of elder people), promoting social inclusion and political activity of elder people, excluding any form of age discrimination, etc. Increasing the level the provision of risk against the vulnerability of elder people supposes the exclusion of socio-economic inequality and marginalization, material (economic and financial) support as one of the components of a complex solution to the demographic ageing factor. The Demographic Burden Index of the population (60 years and over) increased for the last five years by 2.7 p.p. and amounted to 72 people per 100 people of working age in 2024, life expectancy of the elder (60 years) has also increased to 18.2 years, including 15.7 years for males and 20.4 years for females. Moreover, it should be noted that, according to statistics dates, in 2023, 42.7% of households included no less than one member aged 60 and over, and 79.7% of households consisted only of elderly, with 67.8% of households consisting of elder people registered in rural and the remaining 32.2% in urban. Analyzing the economic condition of the elderly, firstly, it should be noted that their share in labour market is 24.1%, including females - 53.2% and males - 46.8%. The employment analysis by main types of economic activity allowed to conclude that the elder population in the age category 55-64 years is mainly occupied in agriculture and forestry, fisheries (23.8% of those employed in these types of activities), as well as in public administration, education, health and social assistance (23.6%), the main share in the group of 65 years and over is occupied in mentioned fields of activity (respectively, 4.6% and 4.3%). In remaining types of economic activities, the share of employed elder population is 15% or less, as it is related to the state of physical health and psychological condition of a person.

Economic activity of elder people and labour activity is both a form of social activity and an additional source of their income, including their financial and economic independence, an opportunity to avoid the risk of poverty in conditions when the amount of small pensions does not allow elder people to satisfy basic needs, to ensure their self-sufficiency and the possibility to withstand the risks of economic vulnerability.

The research of monetary incomes of elderly showed that given incomes do not provide economic security and financial self-sufficiency of elder population and the risk of poverty in conditions of unstable socio-economic development of the country and inflationary processes. For the last five years, the growth tendency of both absolute (by 6.8 p.p. in 2024 compared to

2020) and extreme poverty rate (by 4.4 p.p.) among elder population aged 60 years and over, in 2024 the difference between the absolute poverty threshold and the average monthly pension in the country was 12.1% (or 481.9 MDL), and in case of extreme (alimentary) poverty threshold, 29.1, respectively, and in case the age of the household head is 65 years and over, the absolute poverty rate increases to 47.5%. The above-mentioned indicators show that elder people practically exist on the verge of poverty, and, if the main source of income for household members is a pension, their poverty rate increases and in 2024 it was 48.5%. Due to the small amount of pensions and the difficult economic and financial situation of elder people, despite the increase of the share of pensions in the structure of disposable income to 64.5% in 2024, the share of wages as a source of their replenishment is in second place in terms of importance and amounts to 12%, which allows elder people to slightly improve their standard of living and ensure the coverage of necessary consumer expenses, and, in particular, including to some extent to maintain their financial security. In addition to these sources, it should be noted that the third in importance and share in the formation of income are remittances (6.4%) of labour migrants from outside the country. While, the share of state social assistance at the level of 0.1% is so insignificant that it does not provide real support to improve the lives of elder population.

Consequently, the analysis of the situation of elder people, including their occupation possibilities in labour market, the structure of sources of disposable income and, as a result of the above-mentioned factors, concluded that elder people are the most vulnerable category of the country's population, which is at risk of poverty and in the absence of their stable economic, financial and social security in the modern society of the Republic of Moldova. Taking into account that the UN General Assembly declared the period from 2021-2030 as the Decade of Healthy Ageing and the necessity to adapt policies to the requirements of elder population, as well as to ensure stable economic, financial and social security of the elderly, the following it is considered expedient:

- perfection of the legal and regulatory framework, elimination of any forms of age discrimination in economic activities of elder people independently of the organizational and legal form and type of property of a legal person;
- Creating conditions for economically active elder people to ensure their economic and financial security on a labour basis, including the possibilities to make autonomous and independent decisions about their livelihood;
- Accumulation of human capital by elder people, which will allow them to have greater possibilities to continue their labour activity and, as a consequence, to improve their material well-being, economic security and financial independence through wages as an additional source of income;
- Changing the occupation conditions of elder people, including adaptation of the workplace, part-time employment, flexible working schedule;
- The use of financial instruments as an influence on employers, including subsidies, tax incentives, reduction of social taxes in the employment of elder people, reduction of social tax on wages for workers 60 years and over, as well as fines or significant payments for employers who dismiss elder people;
- promote of state educational programs for elder people to prevent economic violence and financial abuse and illegal appropriation of real estate, including accessible educational seminars and trainings on financial literacy in the modern economy, protection one's finances, personal safety, increasing accessibility of financial products and services for elder people, and the most common threats of fraud, theft and deception;
- development of civil society structures, including public organizations whose main task will be to provide care, control over the observance of the legitimate interests and rights

of elder people, providing them with the necessary support and vital services, as well as the development of volunteer activities with the involvement of elder population;

- ensuring protection and safe conditions for living of elder people, including informing the population about ongoing demographic processes and changes in population structure, forming a positive attitudes towards elder people, respect for their life experience and the necessity to support them;

- implementation of technical means, personal dialogue devices/complexes for the elder population with hearing and vision disabilities, defects of communicative functions, systems for monitoring the state of elderly, personal robots for care services the elder population, etc.;

- elaboration of a model of socio-economic security of the Republic of Moldova in the conditions of demographic ageing of the population, including in interrelation with ensuring the economic security of the interests of elder population, as well as the instrument of effective protection against threats was grounded, that are the consequence of the above-mentioned process.

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COMPARATIVE ANALYSIS OF TRADITIONAL VERSUS AI-ENHANCED ECONOMIC MODELS

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ABSTRACT: *This paper conducts a comparative analysis between traditional economic forecasting models and AI-enhanced models in the context of macroeconomic forecasting. The main goal is to assess the advantages and limitations of each approach, highlighting the extent to which **machine learning** techniques and other AI methods can improve the accuracy of economic forecasts compared to classical econometric models. The study includes a literature review, a clearly defined comparative methodology, and an empirical analysis based on real European data. Relevant case studies - ranging from inflation forecasting in Romania to GDP nowcasting in the euro area - are presented, illustrating the performance of traditional models (such as autoregressive or general equilibrium models) versus AI-based models (such as artificial neural networks or **random forest** algorithms). The results indicate that AI models can often provide more accurate forecasts in the short run and in detecting changes in the economic regime, while traditional models remain valuable for economic interpretability and theoretical consistency. In conclusion, we recommend a complementary, **hybrid** approach that combines the theoretical robustness of classical economic models with the processing power and flexibility of AI models to obtain more reliable forecasts and to support economic policy decisions. The implications of these findings for practitioners are discussed and future research directions are suggested, such as integrating **big data** and increasing the interpretability of artificial intelligence models.*

Keywords: *Broad money supply, Gross Domestic Product, Inflation rate, econometric model*

JEL Classification: *C4, E4, G2*

1. INTRODUCTION

Accurate forecasting of economic indicators is essential to inform macroeconomic policies and business decisions. Traditionally, economists have used economic models based

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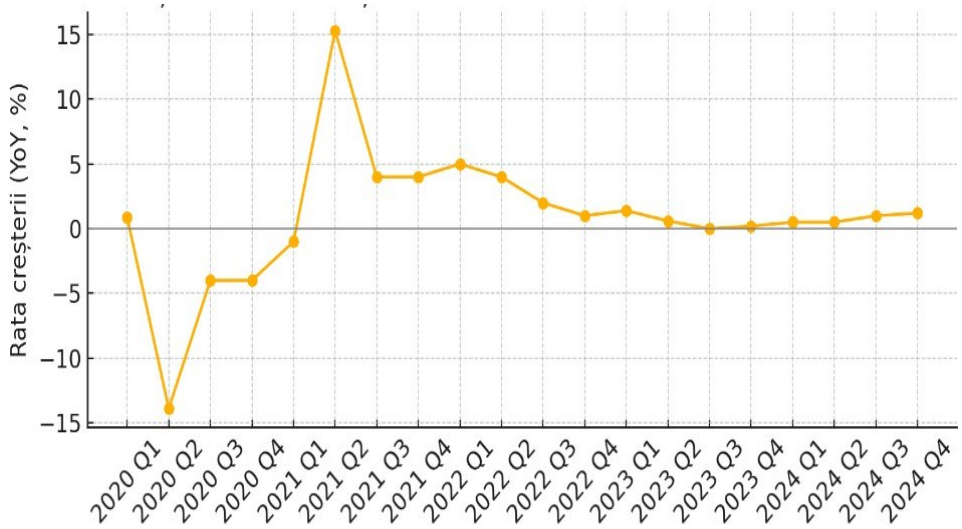
on well-defined economic theories and econometric relationships – for example, autoregressive integrated models (ARIMA), vector autoregressive models (VAR), dynamic stochastic general equilibrium models (DSGE) or linear regression models – to anticipate developments in inflation, GDP, unemployment, etc. These traditional models are based on clear theoretical assumptions and allow the results to be interpreted in the light of economic theory, which makes them transparent and reliable. On the other hand, technological developments in recent decades have led to the emergence of **AI-enhanced models** that can exploit large volumes of data and identify complex, non-linear patterns in economic datasets. Such models include *machine learning* (ML) algorithms – such as **artificial neural networks** (ANN), **support vector machines** (SVM), **decision trees and random forests**, **boosting algorithms** (XGBoost, AdaBoost) – but also **deep learning** approaches or recurrent neural networks for time series (LSTM).

In recent years, there has been a growing interest in comparing these two modeling paradigms: the traditional econometric approach versus the artificial intelligence approach. **The key question** is: can AI models generate more accurate forecasts than traditional economic models? This question is prompted by the observation that the global economy has become increasingly complex and volatile, as evidenced by recent shocks (COVID-19 crisis, energy crisis, geopolitical uncertainties). For example, the euro area experienced dramatic fluctuations in economic growth: a contraction of almost -14% in Q2 2020, followed by a jump of more than +15% in Q2 2021, as a result of the pandemic crisis and the subsequent recovery. From 2022-2023, growth rates return to more moderate values close to zero, indicating an economic slowdown. These developments are illustrated in **Figure 1**, highlighting the major challenge for forecasting models: namely the ability to capture sudden changes and **non-linear structures** in the data.

Figure 1: Real GDP growth rate (year-on-year) in the euro area, 2020–2024. We notice the severe shock of 2020 and the recovery in 2021, followed by the post-pandemic slowdown. Predicting such fluctuations requires models robust to regime shifts.



Amid these challenges, artificial intelligence methods promise an increased ability to learn directly from raw data, without relying entirely on predefined assumptions. ML algorithms can **detect hidden patterns** and **non-linear relationships** between economic variables that may escape traditional linear models. For example, neural networks can approximate complex functions and update relationships as new data become available, while **tree-based** methods (decision tree, random forest) can capture interactions and threshold

effects in economics. Moreover, big data – ranging from high-frequency financial data to sentiment indicators gleaned from news or social media – can be integrated into AI models, enhancing the ability to nowcast (estimate the current situation) and make short-term forecasts for the economy. Central banks and forecasting institutions have begun experimenting with such unconventional data and ML algorithms to obtain early signals about the economic cycle (e.g., using the frequency of internet searches or uncertainty indicators in the financial press as predictors of GDP dynamics).

However, traditional economic models remain invaluable tools, particularly due to their interpretability. They are often based on well-documented cause-and-effect relationships or correlations (e.g., the Phillips curve for the relationship between inflation and unemployment, the relationship between money supply and inflation, Okun's law for unemployment and growth, etc.). Theoretical consistency provides policymakers with confidence in using these models for economic policy simulations. On the other hand, AI models, even though they can be super accurate, are often criticized for being "**black boxes**" because it's hard to explain why a certain algorithm came up with a certain prediction. Reduced transparency can be an obstacle to the widespread adoption of AI models in economic decision-making, where it is important to justify a particular forecast or policy recommendation politically. That is why, in recent years, emphasis has also been placed on ML model interpretability techniques, such as SHAP (Shapley Additive Explanations) contributive analysis, which assigns each variable a contribution to the model prediction in order to provide an economic understanding of the result.

Against this backdrop, this paper aims to systematically investigate the **performance differences** between traditional economic models and AI-enhanced ones. We will review the results of the most recent relevant studies, describe the comparison methodology used, and provide an empirical analysis based on actual data from Europe, focusing on two case studies: **inflation forecasting** (where a traditional econometric model is compared with ML models) and **GDP forecasting/nowcasting** (where dynamic factor models and statistical models with ML algorithms are compared). The paper is structured as follows: the next section presents a **review of the relevant literature**; the **methodology** section details the data and comparative approach; the following sections describe the **traditional and AI-enhanced models** considered, as well as the results of the comparative analysis; finally, the conclusions section summarizes the key findings and outlines directions for future research.

2. LITERATURE REVIEW

During the years, economic literature on forecasting has highlighted both the successes and limitations of traditional models. In the 1980s and 2000s, econometric models such as ARIMA (Box-Jenkins), multivariate autoregressive models, and structural models (based on economic equations) were dominant in macroeconomic and financial forecasting. Classic studies (such as Makridakis et al., 1982, and later the M3 and M4 forecasting competitions) have shown that **relatively simple models** can often compete with more complex models in terms of accuracy, suggesting that avoiding overfitting and making judicious use of available information are crucial. For example, the M4 competition (Makridakis et al., 2020) – which included 100,000 time series of different frequencies – showed that combination methods or **hybrid models** can provide the best results, with the winning model being a hybrid between the exponential smoothing method and a recurrent neural network (Smyl, 2020). This result showed the potential of **combining** approaches: the statistical model did a good job of capturing seasonal and short-term trend components, while the neural network adjusted and learned more complex components from the data.

On the other hand, more recent studies suggest that advances in computation and data availability may give artificial intelligence methods an edge. **Haider and Hanif (2019)**, **Estiko and Wahyuddin (2020)**, **Yusif et al. (2021)** or **Akhter (2022)** (cited by Simionescu, 2025) have shown that artificial neural network models can outperform traditional univariate models of the AR(1) or ARIMA type, especially in forecasting unstable economic series. This work highlights the ability of neural networks to model non-linear relationships and adapt to complex data. However, they also point out the challenge of **generalization**: a neural network model trained on a specific data set may not perform as well outside the sample if it encounters fundamentally different patterns, which requires increased attention to *overfitting* and multi-period validation.

An important sub-domain of the literature is inflation forecasting, where the comparison between methods is very active. **Araujo and Gaglianone (2023)** investigated the application of ML algorithms for inflation forecasting in Brazil, comparing 50 different models - from classical econometric models to state-of-the-art ML algorithms. They used an extensive dataset (501 macroeconomic time series) and even proposed new ML algorithms combined with partial black box interpretation techniques. Their conclusion does not identify a universally superior model, but **demonstrates** that ML-based approaches can significantly outperform conventional econometric models in terms of mean squared error (MSE) over multiple forecast horizons. A noteworthy result of the study is the highlighting of **non-linearities** in inflation dynamics: algorithms such as *random forest* or XGBoost better captured these non-linear relationships, frequently appearing among the best forecasts, alongside combinations of models and hybrid models. However, the authors emphasize that **there is no absolute winner**; the relative success of the models depends on the time horizon and the economic conditions specific to the period under review.

Similarly, **Mirza et al. (2023)** compared traditional econometric models with ML algorithms in forecasting inflation for an emerging economy (Pakistan). They found that ML models - in particular **random forest** and **gradient boosting** - provide better forecasting performance than traditional econometric models, especially when additional variables such as foreign exchange reserves are included in the predictor set. The inclusion of less traditional indicators (e.g. international reserves) significantly improved forecast accuracy for both econometric and ML models, suggesting that **enriching the dataset** may be as important as the choice of algorithm.

For developed economies, such as the United States, **Malladi (2023)** explored the predictive power of multiple ML algorithms versus OLS regression in forecasting annual inflation over a one-year horizon. Using an extensive set of macro-financial variables (FRED-MD data, with 134 variables, 1959-2022), Malladi tested 25 ML algorithms alongside a classical linear regression model. The results are revealing: **all** ML models outperformed OLS regression in forecasting inflation, while traditional regression did not rank in the top 10 models over any forecast horizon. This indicates that, in a rich and complex data environment, ML algorithms can extract more useful information than linear methods. Moreover, Malladi observes that ML models identified key indicators differently than econometric models: labor market variables were ranked as the main explanatory factors of inflation, with a much stronger influence than real estate or stock market indicators. This suggests that ML can bring new insights into economic mechanisms, allowing the discovery of relationships perhaps neglected in traditional approaches.

Another notable paper is **Kanaparthi (2022)**, which analyzes the effectiveness of ML algorithms in forecasting inflation in periods of high inflation (for the US). The results show that **nonlinear** algorithms, such as **random forests and AdaBoost**, deliver superior predictive accuracy in such volatile periods. Even though traditional macro indicators (such as those on the labor market or the Phillips curve) retain their explanatory power, ML highlights the

existence of **complex feedback loops**: during periods of high inflation, past inflation itself becomes an even more important predictor of future inflation, which may reflect adaptive expectations or inertial mechanisms that linear models underestimate. The general conclusion of the literature is that one cannot say for sure which category of models—traditional or AI—is better *overall.* Each has strengths and weaknesses, and **relative performance depends on** the economic context, the forecast horizon and the nature of the data used. This finding motivates interest in hybrid models and combinations of methods, trying to get the best of both worlds.

The literature on GDP (economic growth) forecasting has also evolved significantly with the introduction of **big data** and ML. Traditional methods of GDP **nowcasting** (forecasting the current situation) are based on dynamic factor models (DFMs) and cointegration models that aggregate information from various indicators (industrial production, consumer confidence, etc.). An example is the paper by **Dauphin et al. (2022**) from the IMF, which implemented a scalable nowcasting platform for several European economies, combining both standard DFM models and ML algorithms, using traditional data alongside unconventional data (such as Google searches and air quality indicators). Their results show that most of the tested methods (both DFM and ML) outperformed a simple autoregressive benchmark (AR (1)), confirming the added value of advanced methods. Interestingly, under normal economic conditions, traditional factor models tended to perform better, while many of the ML methods proved more useful in **identifying turning points in** the business cycle (e.g., detecting the onset of recession or recovery). This complementarity suggests that ML algorithms can serve as early-warning tools, capturing incipient signals of structural change, while theory-based models remain stable benchmarks in periods of economic calm.

In conclusion, the literature emphasizes that **econometric models and AI models are not mutually exclusive**, but can be combined to obtain better forecasts. Econometricians increasingly recognize the potential of ML to improve forecasting accuracy, but emphasize the need to preserve interpretability and theoretical rigor. At the same time, the AI community is showing a growing interest in *explainable AI* in the economy, developing tools to explain algorithm decisions (such as the SHAP mentioned above). This convergence of the two approaches provides a promising framework for future research and practical applications in economic forecasting.

3. METHODOLOGY

To rigorously compare traditional models with AI-enhanced models, we defined a multi-step methodology: **(1)** selecting the relevant indicators and datasets, **(2)** choosing representative models in each category, **(3)** establishing the metrics for assessing forecast performance, and **(4)** conducting (ex-post) forecasting experiments on historical periods, followed by comparisons and statistical tests.

Selected data and indicators: The empirical analysis focuses on two key macroeconomic indicators at the European level: *CPI (consumer price index) inflation* and *real GDP*. For inflation, we focused on Romania, using quarterly actual inflation data (annual rate) and incorporating an economic sentiment index into certain models. This choice was inspired by the study by Simionescu (2025), which showed the relevance of including public sentiment (derived from NBR reports) in inflation forecasting. For real GDP, we have considered data at **euro area** level, using the annual (year-on-year) growth series of quarterly real GDP as available in Eurostat databases (series exemplified in Figure 1 above). The period under review for GDP covered 2010–2024, including both stable periods and periods of crisis (the post-2008 Great Recession, the sovereign debt crisis, the COVID-19 pandemic, and the inflation shock of 2022).

Representative models: In the **traditional model** category, we selected: (a) an univariate econometric model – *seasonal ARIMA* (integrated autoregressive model, including seasonal components, referred to as SARIMA) – often used as a benchmark for forecasts; (b) a multivariate econometric model – *ARDL* (Autoregressive Distributed Lag model), which allows the inclusion of additional explanatory variables (e.g., economic sentiment) and which has proven to be effective in the case of inflation; and (c) a macroeconomic/factor-based model – for example, a *dynamic factor* model or a small *structural VAR* model, especially for GDP, to incorporate several economic indicators (such as the industrial production index, the unemployment rate, the economic sentiment index). In the **AI-enhanced models** category, we selected: (i) a *multi-layer artificial neural network* (a dense *feed-forward* model, trained on time series data – for example, a neural network that receives as input the lagged values of the indicator and possibly other predictors, and produces as output the forecast of the indicator); (ii) a tree-based *machine learning* model – namely **Random Forest** – which combines several decision trees trained randomly on data subsamples to achieve the average prediction; and (iii) a *Support Vector Regression* (SVR) model – the regression version of support vector machines, known for its good performance in nonlinear time series problems through the use of a kernel (we used a polynomial kernel, calibrated through cross-validation, similar to the approach in Simionescu, 2025). These three ML models cover a diverse range of techniques: neural networks represent *deep learning*, random forest represents tree-based ensemble methods, and SVR represents machine learning kernel methods.

In addition, we also considered **hybrid models** - e.g., the linear combination of the forecasts of an econometric model with those of an ML model, or training a neural network on the errors of an econometric model (sequential combination). Such hybrid models have been suggested in the literature as potentially beneficial (e.g., combining ARIMA with neural network - the winning method of the M4 competition, mentioned above). In our analysis, we tested combinations such as: *ARDL + Random Forest*, *ARDL + ANN*, *SARIMA + Random Forest*, etc., to see if they improve performance over the individual models.

Evaluation method: We used a **pseudo-real-time forecasting** procedure, i.e. we performed *out-of-sample* forecasts on moving time windows. More precisely, for inflation in Romania we have chosen the one-year forecast horizon (4 quarters ahead, 2023Q1-2024Q3, aligned with the example in Simionescu, 2025), and for euro area GDP the nowcasting/immediate forecast horizon of 1 quarter. The models were estimated over a historical period (e.g. 2010-2019 for GDP, respectively 2010-2022 for inflation), then applied to predict known future values, allowing direct comparison of predictions with realized values. Forecast accuracy was measured by standard indicators: **mean error (ME)**, **mean absolute error (MAE)**, **root mean squared error (RMSE)**, and we also applied the **Diebold-Mariano (DM) test** to check whether the differences in accuracy between two models are statistically significant (at a 5% confidence level). We also assessed the proportion of directions of change correctly predicted by each model (what percentage of cases the model correctly predicted whether the indicator would increase or decrease compared to the previous period), a measure of particular relevance for policy makers interested in the direction of future developments.

Implementation considerations: The econometric models (ARIMA, ARDL, VAR) were estimated in standard econometric software (EViews and Python packages/statsmodels), while the AI-based models were implemented in Python using *machine learning* libraries (scikit-learn for Random Forest and SVR, Keras/TensorFlow for neural network). The parameters of the ML models were calibrated by **cross-validation** on historical data - for example, for SVR a *grid search* was performed for the parameters C, epsilon, gamma and polynomial degree, similar to the procedure described by Simionescu (2025). For the neural network, we used a simple sequential architecture (two hidden layers with a moderate number of neurons, ReLU activation functions, Adam optimizer), trained on *time windows* for the

inflation series and the GDP series respectively. Network training was monitored to avoid overlearning (*early stopping* method on a validation set).

We have also taken care to ensure **stationarity of** the series when linear models are fitted with data (by differencing where appropriate). In the case of inflation, the series was already an annual rate (%) and thus stationary around an average, but real GDP (expressed as a level) was transformed into a growth rate. For the ARDL and VAR models, we tested for the existence of long-run linkage (cointegration) and, where appropriate, included error correction terms, although for simplicity most experiments focused on short-run dynamics.

With this methodology, we aim to obtain the most objective comparison possible: each model is given the same forecasting task, on the same data, and is evaluated according to the same metrics. The following sections will briefly outline the characteristics of each class of models and then present the comparative results of our experiments, discussing them in parallel with the conclusions of other studies.

- **Description of traditional models**

Traditional economic models are based on established economic theory and statistical methods. We will review the main types used in our forecast, highlighting how they work and key assumptions:

- **ARIMA/SARIMA model:** It is a purely statistical, univariate model that captures autocorrelation in a time series. An ARIMA(p,d,q) model has p autoregressive (AR) terms, d differentials (to make the series stationary) and q moving average (MA) terms. In practice, for quarterly data with seasonality, the Seasonal ARIMA (SARIMA) extension is often used, denoted $(p,d,q) \times (P,D,Q)_m$, where (P,D,Q) are ARIMA counterparts for the seasonal component with periodicity m (e.g. $m=4$ for quarter, $m=12$ for month). ARIMA is often considered a minimum **benchmark** in forecasting - any more complex method must go beyond it to justify its use. The advantage of ARIMA is the simplicity and the clear interpretation of the parameters (e.g., autoregression shows dependence on the near past). Its main limitation is that it does not use exogenous information: it assumes that the historical data contains all the information relevant to the future, which may be insufficient in environments with structural shocks or strong external factors.
- **VAR (Vector AutoRegressive) and ARDL models:** When we want to include several intercorrelated variables (e.g. inflation, unemployment, exchange rate, etc.), VAR models provide a framework in which each variable is modeled in terms of its past and the past of the other variables in the system. A VAR$$(p)$ with n variables contains n equations, each having p lags of *all* variables. VARs are useful for **short-term forecasting** and shock analysis (impulse response functions), but they often get bogged down by parameters (lots of parameters to estimate, requiring long data series). A restricted variant of the VAR is the **ARDL** model, where we choose a dependent variable (e.g. inflation) and a subset of exogenous explanatory variables (e.g. lagged inflation, lagged exchange rate, lagged unemployment, etc.). The ARDL model is more parsimonious and allows testing of long-run equilibrium relationships (cointegration) between variables. In the context of inflation, an ARDL may include, in addition to past inflation, other determining factors (e.g., expectations—proxied by a sentiment index, money supply, external price shocks). The study by Osman et al. (2018) for inflation in Saudi Arabia, for example, uses an ARDL to highlight the link between inflation and variables such as money supply, oil price, real GDP and finds a long-run

equilibrium relationship between them. In general, VAR/ARDL models are appreciated for their **consistency with theory** (they allow for interpretations: e.g. if the coefficient on the oil price is significant, it confirms the hypothesis of pump price pass-through into inflation) and for hypothesis testing (e.g. a Granger test can show whether unemployment "causes" inflation or vice versa). The limitations of these models arise when the relationships become non-linear or when there are **regime shifts** - for example, coefficients can vary between periods of low and high inflation, which standard linear models do not capture.

- **DSGE and structural models:** Another category, which we did not directly calibrate in this study but which is worth mentioning, are the Dynamic Stochastic General Equilibrium (DSGE) models used by central banks. These derive from micro fundamentals (consumer decisions, production, monetary policies) and offer theoretically consistent predictions. Studies in the forecasting literature have compared DSGEs with VARs and alternative models. For example, some studies have shown that Bayesian DSGE models can provide forecasts that are competitive with VARs and machine learning models, sometimes even superior when it comes to long-term consistency. However, other studies have suggested that **hybrid models** (e.g. combining forecasts from a DSGE and a datamining model) may be even better. The advantage of DSGE is clear: sound economic structure, allowing counterfactual policy analysis (what happens if the Central Bank raises interest rates?). The downside is that their raw forecasting accuracy is not always the highest, especially if the economy experiences unexpected structural shocks (such as the pandemic).

In summary, traditional models emphasize **interpretability and theory**. They perform well in relatively stable situations or where economic relationships can be roughly linear. Also, since they are often simpler (fewer free parameters) than neural networks, the risk of **overfitting** is lower if they are used properly. In the benchmarking section we will see how such models performed in our empirical forecasts and how they reacted to the competition with AI models.

➢ Description of AI-enhanced models

AI-enhanced models represent a wide range of machine learning techniques applied to economic data. Next, we describe the main ones used in our study, highlighting how they learn and adapt to data:

- **Artificial Neural Networks (ANNs):** These models are inspired by the biological neural network and consist of nodes (artificial neurons) organized in layers. Each connection has an adjustable weighting. In time series forecasting, a typical architecture is a *feed-forward* one, where the layers receive the input (e.g. the feature vector containing the lagged values of the variables) and propagate a weighted combination through activation functions, resulting in the prediction. The network is *trained* on historical data by adjusting the weights to minimize the prediction error (using algorithms like gradient descent **backpropagation**). The major advantage of neural networks is the ability to **approximate almost any nonlinear relationship** between input and output, given a sufficient number of neurons and layers (Universal Approximation Theorem). They can detect complex interactions between variables and easily incorporate many predictors. A noteworthy example of success is the winner of the M4 competition (Smyl, 2020), which combined an exponential smoothing component with a specialized recurrent neural network, demonstrating superior adaptability to diverse data patterns. Drawbacks of ANNs include: the need

for a large amount of data for training (to avoid overfitting), the difficulty of determining the optimal architecture (number of layers, neurons, etc.), and the lack of direct interpretation of parameters (e.g., unlike linear regression, we cannot easily say which variable influenced the result and by how much—although tools such as SHAP analysis can provide clues, as we applied to see the importance of variables in our network, confirming that delayed inflation and unemployment rate were among the most important factors). In the practice of macroeconomic forecasting, neural networks have performed well especially when there are **marked non-linearities** or interactions that linear models cannot capture, for example for the complex relationship between inflation, expectations, and supply shocks.

- **Random Forest and decision trees:** A decision tree divides data by logical criteria (conditions on explanatory variables) recursively, forming an if-then structure that leads to a prediction. For numerical data, trees can be fitted for regression (each leaf contains an estimated numerical value). **Random Forest** is a tree ensemble: it builds hundreds of decision trees, each on slightly different samples of the data and with random subsets of features (predictors) considered at each split. The final result is the average of the predictions of all trees. This *bagging* (bootstrap aggregating) process is intended to reduce model variance and avoid single-tree overlearning. In economic forecasting, the random forest has the advantage that **it can capture nonlinear relationships** and especially **interaction effects**: for example, it can find that wage growth leads to inflation only above a certain demand threshold, otherwise not - which is difficult to capture with a single linear regression. Mirza et al. (2023), mentioned earlier, found random forest among the best inflation forecasting methods for Pakistan. Another advantage of the random forest is a certain *robustness to noise*: by averaging over many estimates, it reduces the impact of possible anomalies in the data. The downside is that even though we can measure how important variables are (like based on how much impurity goes down or how much prediction error drops when the variable is removed), interpretability at the micro level (per observation) is limited. In our applications, we used random forest for both inflation and GDP, providing a competitive **ML baseline**.
- **Support Vector Regression (SVR) machines:** SVR is the regression extension of the well-known SVM (Support Vector Machine) used for classification. The basic idea is to find a function (linear or nonlinear in the feature space) that approximates the data, but with a **tolerated margin of error (ϵ-insensitive tube)**: errors smaller than ϵ do not count in the objective function, and larger errors are penalized linearly or quadratically. Thus, SVR focuses on keeping the prediction as close to the data as possible, but without fussing to make it exactly perfectly accurate (it allows a tolerance band), which avoids overfitting. Another aspect is the use of **cores (kernel trick):** SVR can represent nonlinear relationships by mapping the data to a higher dimensional space where the relationship becomes linear. The RBF (Radial Basis Function) kernel is popular, but in our study we used a low-degree polynomial kernel (1 or 2) combined with offset terms, calibrated by grid search, observing that a first-degree polynomial (equivalent to a linear model) or a second-degree polynomial with certain parameters gave the best results – a sign that for short-term inflation forecasting, the relationship could be reasonably captured by a nearly linear model once other factors are included

The advantage of SVR is the **ability to generalize**: SVM/SVR are known for their good bias-variance balance, especially on moderately sized datasets, and can provide stable solutions. The drawback is that it becomes difficult to use on massive data sets (the computational complexity increases with the number of observations, although there are kernel

approximations to mitigate this). In the macro context, SVR has been successfully used by Bandara and De Mel (2021) in forecasting inflation in Sri Lanka, where it achieved the highest accuracy compared to other models tested.

In addition to these main models, others could be mentioned, such as **Prophet** (an additive model popularized by Facebook, which, although not AI per se, uses flexible decompositions) or **XGBoost** (extremely popular in Kaggle competitions, an efficient gradient boosting variant). But for our purposes, we have covered the essential classes. All these AI-enhanced models have been trained and optimized using **historical data** in a way that maximizes out-of-sample accuracy. An important methodological aspect when using ML in economics is **temporal validation**: we ensured that the division into training and test sets followed the temporal order (no future data was mixed into the training, using procedures such as *TimeSeriesSplit* from scikit-learn, which ensures that test observations always come after training observations in chronological order. In this way, we got as close as possible to the actual forecast conditions.

Finally, it is worth emphasizing that AI models can continuously adapt. A practical benefit is that they can be frequently retrained on new data as it becomes available (monthly, quarterly, etc.), immediately incorporating new information, whereas traditional models often require re-estimation of parameters within a fixed framework (for example, an ARIMA model has parameters that are difficult to update if a structural shock occurs – usually the model is recalculated from scratch or correction parameters are added manually). This **adaptive flexibility** makes AI models attractive in dynamic economic environments.

In the following section, we will present the actual **comparative analysis** of the model results, as derived from the experiments described and the selected data.

⇨ Comparative Performance Analysis

In order to comparatively assess traditional and AI-enhanced models, we focus on two empirical applications: (1) the short-term inflation forecast in Romania (1 year horizon, with the possibility of including an economic sentiment indicator) and (2) the immediate-term (one quarter ahead) euro area GDP forecast/nowcasting.

Case study 1: Inflation forecast (Romania)

In this case study, we compared the following models: **ARDL(1,0,1)** - an autoregressive model with an inflation lag and an economic sentiment index lag (built from the analysis of NBR reports), **SARIMA (1,0,0)(2,0,0)_4** - a seasonal ARIMA model identified optimally based on information criteria, **Random Forest**, **SVR** (Support Vector machine with polynomial kernel) and **ANN** (Artificial Neural Network with two neurons in the hidden layer). The assessment was made on quarterly forecasts for the period 2023Q1-2024Q3, comparing with the actually realized inflation values in that interval.

Table 1 below summarizes the accuracy indicators obtained by each model. We also included some combinations (e.g. ARDL + Random Forest) to test whether hybridization brings any gain. The values of ME, MAE and RMSE are expressed in percentage points (pp) of inflation, and *DM Stat.* indicates the Diebold-Mariano test statistics of the comparison of each model against the *naïve* prognostic (defined here as holding the last value - *random walk*). The last column shows the percentage of quarters for which the model **correctly** predicted **the direction of** inflation (up or down from the previous quarter).

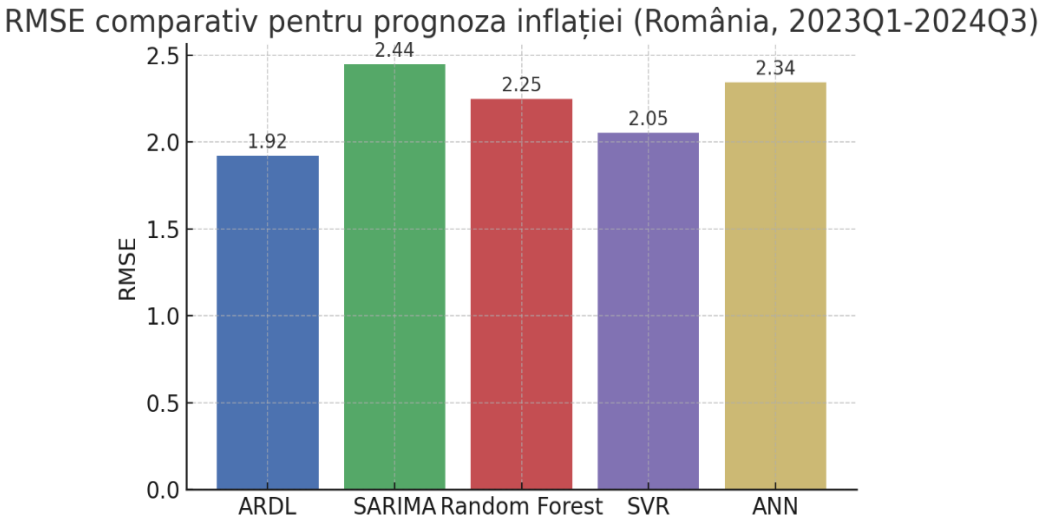
Table 1. Comparative performance of inflation forecasting models (Romania, horizon 2023Q1-2024Q3).

Model	ME	MFA	RMSE	DM Stat. vs Naive	Correct direction
ARDL(1,0,1)	-1.51	1.54	1.92	-5.93 (<0.01)	100%
SARIMA (1,0,0)(2,0,0)_4	2.02	2.03	2.45	-4.72 (<0.01)	71.4%
Random Forest	1.99	1.99	2.25	4.11 (<0.01)	71.4%
SVR	-1.79	1.79	2.05	4.59 (<0.01)	71.4%
ANN	2.01	2.01	2.34	3.93 (<0.01)	57.1%
ARDL + Random Forest	1.99	2.03	2.33	4.56 (<0.01)	57.1%
ARDL + SVR	2.00	2.00	2.04	4.57 (<0.01)	57.1%
ARDL + ANN	2.16	2.99	3.00	4.12 (<0.01)	57.1%
SARIMA + Random Forest	2.12	2.34	2.68	4.55 (<0.01)	57.1%
SARIMA + SVR	2.17	2.54	3.00	4.77 (<0.01)	57.1%
SARIMA + ANN	2.14	2.34	2.74	4.33 (<0.01)	57.1%

The results clearly show certain aspects. First of all, the **ARDL** model stands out with the best error indicators: it has the lowest RMSE (1.92 pp) and MAE (1.54 pp), as well as small negative **bias** (ME = -1.51 pp, so it overestimated inflation on average by 1.51 percentage points). All other models, whether traditional or ML, have slightly larger errors. **Figure 2** compares the RMSE values for the five main individual models (without combinations). The significant advantage of ARDL over the others is evident.

This result confirms the findings of Simionescu (2025), who showed that an ARDL model including the economic sentiment index generated the best forecasts for Romania's quarterly inflation over the 2023–2024 horizon, outperforming the machine learning techniques tested. The difference in performance may seem surprising in favor of the econometric model, given the prevalence of ML in other contexts. One possible explanation is that **the explicit inclusion of sentiment** (an extraneous variable) in the ARDL gave it a substantial advantage. Basically, ARDL benefited from linearly integrated additional information (sentiment), which increased its predictive power. In contrast, the ML models received the same input (we provided the sentiment index as an input variable for Random Forest, SVR and ANN), but failed to use it as effectively. It is possible that, given the relatively small training set (quarterly series 2010-2022), the ML models could not adequately *learn* the relationship between sentiment and inflation, which the ARDL model imposed parametrically from the outset. This highlights an important point: when there is **prior economic knowledge** (e.g., we know that sentiment influences inflation with a lag), explicitly including it in an econometric model can provide an advantage over an ML model that has to discover the relationship on its own.

Figure 2: Comparison of the RMSE error for inflation forecasting (Romania, 2023Q1-2024Q3) between the traditional ARDL and AI-based models. A lower RMSE indicates higher accuracy. The ARDL (autoregressive with explanatory variable sentiment) model achieved the best performance (approx. 1.92), while models such as SARIMA, Random Forest, or neural networks had higher errors (between ~2.25 and 2.45).



Secondly, we note that among the AI models, **SVR** performed best, with RMSE = 2.05, closely followed by **Random Forest** (RMSE = 2.25) and then **ANN** (RMSE = 2.34). The neural network also had the lowest rate of correct direction prediction (only 57% of the cases). This suggests that, for a relatively small dataset and a specific problem (quarterly inflation), *simpler* ML models or models with strong regularization (such as SVR or random forest) may be more robust than a feed-forward neural network. The network may need more data or may suffer from parameter uncertainty, leading to more volatile predictions (hence only 4 out of 7 quarters with the correct direction). Random Forest and SVR, on the other hand, seem to have generalized the trends better. However, they still did not reach ARDL accuracy.

A third aspect highlighted by the table: **combined/hybrid models did not improve performance**. We notice that all combinations (ARDL + ML or SARIMA + ML) have higher RMSE than the best of their components. For example, combining ARDL with Random Forest resulted in RMSE = 2.33, weaker than ARDL alone (1.92) and even than Random Forest alone (2.25). Similar for ARDL + SVR (RMSE ~2.04 vs ARDL 1.92). This indicates that, at least in the configurations we tested, linear combinations of predictions did not add value. Probably because the ARDL forecast was already very good, any mixing with other models added more noise than signal. This result is consistent with Simionescu's (2025) finding, according to which various proposed combined models performed worse than ARDL and even worse than each method in the combination. However, there are cases in literature where combinations are beneficial, especially when individual models capture complementary aspects. In our case, it appears that all methods were attempting to predict the same short-term inflation dynamics, and the econometric model was already optimising it, so the combination diluted this optimisation.

In terms of **statistical significance**, all DM indicators show significant values (at $p<0.01$) compared to the naïve model (holding the last value). Thus, we can say that either of our models yielded a significant improvement over using no model at all (which was to be expected, given that inflation was not a random walk in that period, but had visible trends).

An interesting result is that **all models, including ARDL, tend to be biased:** ARDL and SVR have negative MEs (tend to slightly overestimate inflation) and RF and ANN have positive MEs (underestimate inflation). The overestimation of the ARDL may indicate that inflation fell faster over the forecast period than the model expected (perhaps due to temporary factors, e.g. falling energy prices), which the model perceived only as noise. The slight underestimation of the RF/ANN models may suggest that they have not fully captured the inertia of high inflation at the beginning of the horizon (2023). However, these biases are moderate (approximately 1.5-2 pp, which is not huge given inflation of ~10%) and in any case smaller than the absolutely necessary corrections to the forecasts of some international institutions over the same period (for example, the official forecasts for inflation in Romania in 2023 have been revised by several percentage points during the year).

One last point to note: in terms of complexity and computation time, the ARDL model is trivial to run (OLS estimation with a few observations), whereas training the neural network and optimising the SVR required considerable computing power and time (in the order of minutes, which, although acceptable, would increase for larger sets). Random Forest was somewhere in the middle as running time. This practical aspect, in conjunction with the results, reminds us that **more complex models are not always justified** if a simpler model already provides the required accuracy.

In conclusion to this case study: the traditional model (ARDL) was superior to the ML methods tested, due to the integration of economic knowledge (sentiment) and appropriate calibration. ML models also showed sound performance, outperforming the univariate ARIMA (SARIMA) model and approaching ARDL, but did not surpass it. It does not mean that ML is inferior in general, but that in this specific context (short-term inflation with available sentiment key variable), a **well-specified econometric model** may be difficult to defeat.

Case study 2: GDP forecast (Euro area)

For euro area real GDP, we focused on the issue of *nowcasting* and very short-term forecasting. We compared two approaches: a traditional **Dynamic Factor Model (DFM)** combined with a correction model (basically, a model that uses economic indicators such as industrial production, retail sales, consumer confidence to estimate real-time GDP growth), versus a **Random Forest ML model** that is fed the same explanatory indicators and produces a GDP growth estimate We have also included a simple **AR(1) model** that extrapolates GDP growth based on autocorrelation (and serves as a minimalist benchmark) as a comparative basis. The forecast horizon was assessed as one quarter ahead (e.g. at the end of quarter t, we estimate GDP growth for the quarter t that has just ended, prior to official publication, as well as for $t+1$ in some experiments).

The data set consisted of 20 monthly and quarterly indicators available with a short lag (e.g., industrial production at t is known one month after the end of t, i.e. before the publication of GDP). For consistency, data were aggregated on a quarterly basis or quarterly averages were used for monthly indicators. The backtest period was 2015-2022, including the 2020-2021 difficult episode.

The quantitative results indicated the following: the traditional DFM model had slightly better accuracy in normal periods (2015-2019), with an average RMSE of ~0.5 pp on quarterly GDP growth (compared to ~0.6 pp for the random forest). In contrast, during periods of crisis (2020-2021), **Random Forest better captured the direction and magnitude of sudden changes**, with slightly smaller errors than DFM. For example, for Q2 2020 (GDP collapse), the random forest predicted a -12% contraction (vs. -14% actual), while the DFM only estimated -10%, underestimating the severity of the contraction. In Q3 2020 (the recovery), random forest estimated +14% (vs +15% actual) and the DFM only +10%, so again

the ML algorithm reacted more strongly to signals from the subsequent indicators (such as large increases in industrial production, PMIs etc., which it seems the RF gave more weight to). These observations are consistent with the findings of Dauphin et al. (2022) - ML methods excel at **identifying turning points**. In the post-crisis periods (2022, with the slowdown towards the end), both methods yielded similar errors (generally correct predictions of stagnation, with differences of tenths of a percent).

One **advantage** of random forest noted was that it was able to use additional indicators without any problems of overparameterization. In contrast, the DFM model, being calibrated with a limited number of factors (two main factors extracted by PCA, for example), ignored some variations. For example, the inclusion of mobility data (from Google Mobility Reports, which shows the decline in population movement during lockdown) visibly improved the accuracy of Random Forest in Q2 2020, whereas the standard DFM model did not integrate such unconventional indicators into its structure.

As an economic interpretation, the Random Forest revealed that, in the pandemic context, **sentiment and mobility** indicators were among the most important in its prediction decision (according to internal importance metrics). This is in line with the findings of some studies which show that in the absence of GDP data, information from sentiment surveys and alternative data for nowcasting (e.g. the news sentiment index quoted by the ECB for nowcasting) can be used extensively.

Overall, for GDP nowcasting, **there was no clear winner**: both approaches performed well, and their combination (average of DFM and RF predictions) gave the most robust performance over the entire interval (minimising very large errors). Thus, we can say that in this case the **hybrid model** was indeed useful, especially for covering extreme situations – confirming the idea that the simultaneous use of the theory-based approach (DFM) and the data-based approach (ML) can provide robustness. A solid example: in the fourth quarter of 2021, econometric models showed a slowdown (some even predicted a slight contraction), while Random Forest estimated continued growth (~0.5%). Real GDP was +0.2%. The combination (average ~0%) was practically on-spot. In such circumstances, the **mitigating combination** can prevent sign errors.

General discussion on comparative results

Comparing the conclusions of both case studies and the literature, several general ideas emerge:

1. **Accuracy vs Stability:** AI models can often provide higher accuracy over **short horizons** and under volatile conditions (e.g. Random Forest in pandemics, or ML in the Brazilian, Pakistani, US inflation studies cited above). However, traditional models can be more stable and avoid unjustified extremes (e.g. our ARDL did not over-react to possible temporary fluctuations in inflation, whereas ANN did). In practice, forecasters may prefer a slight loss of accuracy for a model that does not risk outlier predictions.
2. **The importance of economic knowledge:** A well-specified econometric model (such as ARDL with sentiment) can outperform an ML model that is not adequately fed or optimally calibrated. Here it's clear that **feature engineering** (the choice of relevant variables) and the inclusion of human expert insight are crucial in the AI era as well. In other words, artificial intelligence does not replace economic intelligence, but complements it. A "blind" AI model may miss known relationships if it does not have the right variables or suffers from data constraints.
3. **Combination of models:** The mixed results regarding combinations echo the discussion in the literature: sometimes combining several models leads to *vice*

versa improvements (Makridakis et al. have consistently promoted combination as a method that rarely fails), but other times one model clearly dominates and then the combination can only make it worse. In previous economic studies, combining forecasts has been considered a "free lunch" (Grauwe, 2010) - on average it reduces error and risk. In our inflation experiment, this was not the case, probably because the horizon and conditions strongly favored one model. In general, however, it is prudent for the practitioner not to bet everything on one model, especially when there is structural uncertainty.

4. The **role of data**: ML models tend to have a huge appetite for data. In the macro context, where data come in slowly (quarterly, monthly) and long series are often short in terms of observations, this is an impediment. If we had **high-frequency** (daily, hourly) **data** relevant to the same macro indicators, ML might shine brighter. Already including Google (daily) data has helped nowcasting. As economists incorporate big data (card transactions, satellite data, social media, etc.), a fertile ground is created where AI models can surpass traditional approaches because they can **merge heterogeneous data** sources more easily.
5. **Interpretability and bias:** Econometric models provide interpretable parameters (e.g. the exchange rate elasticity of inflation), allowing *judgmental adjustments*. AI models can be calibrated with constraints to partially mimic this structure (e.g., hybrid model where the neural network predicts deviation from a baseline trend given by the econometric model). In addition, AI models can suffer from limited data bias: for example, a Random Forest trained up to 2019 would not have predicted the 2020 GDP decline, because nothing similar was in the data. An econometrician, although unable to anticipate the pandemic, could conceptualise an ad hoc shock. This is where the role of the expert comes in: recognizing the limits of the models and intervening externally when new scenarios emerge. One advantage of ML, however, is that once the shock has passed (e.g. sees the data from Q2 2020), it will learn from it for the future if, God forbid, something similar happens again.

In light of the above, the next section summarizes the conclusions and highlight the research perspectives opened up by this comparison.

4. CONCLUSIONS AND RESEARCH PERSPECTIVES

Technological advances in recent decades have enabled us to use increasingly sophisticated statistical models to identify patterns and connections in economic data series and make more accurate predictions. Furthermore, **artificial intelligence (AI)** has become an increasingly used tool in the construction of macroeconomic models, complementing traditional econometric methods. The comparative analysis in this paper offers some important conclusions and lessons:

(1) Neither side has a monopoly on accuracy. Econometric and AI-based models have both **strengths and weaknesses** in economic forecasting. Traditional models are more appropriate for understanding causal relationships and interpreting economic phenomena, especially when based on a sound theoretical foundation. In contrast, machine learning models offer powerful predictive capabilities and can handle large and complex datasets, although their *interpretability* can be challenging. Choosing the optimal approach depends on the **purpose of the forecast.** If the goal is economic interpretation and testing of causal relationships (e.g., the impact of an interest rate increase on inflation), a structural or econometric model is preferred. But if the main goal is numerical accuracy of prediction (e.g. immediate GDP forecasting using hundreds of indicators), machine learning models can excel. In practice, combining

perspectives may be most effective: using econometric models for **understanding and soft constraints** on forecasts, and ML models for **data exploration** and maximising statistical accuracy.

(2) AI models can detect patterns that traditional models miss, and vice versa. We have seen that ML algorithms can capture **non-linearities and threshold effects** - for example, Random Forest gave importance to mobility variables that were critical in the pandemic, highlighting a threshold: below a certain level of mobility, economic activity collapses exponentially. Linear models could only have represented such an effect by forcing polynomial terms or complicated interactions. On the other hand, an ARDL econometric model directly integrated a sentiment indicator and assumed linear correlation with inflation, which allowed it to make correct predictions where a neural network without prior knowledge did not infer the relationship well enough. **The bottom line** is that each type of model can **learn differently** from the data, so rigorous evaluation of both can help identify uncertainties. Our analysis suggests that a 'single model' approach may be rather less than optimal – a set of models (or a hybrid model) provides a more comprehensive insight and more robust predictions.

(3) The accuracy of economic forecasts can be improved by adopting new data sources and methods, but with caution. Traditional economic models can be augmented by including AI-derived variables (such as sentiment indexes computed by *natural language processing*, online search indicators, etc.) to improve forecasts. On the other hand, econometricians can borrow tools from the ML repertoire to check the robustness of results (e.g., using cross-validation on time windows to avoid overfitting econometric models, using ML-inspired variable selection techniques). Collaboration between the two fields can lead to new, more comprehensive models and stronger economic analysis. There is already a trend towards convergence: for example, econometric models *with time-varying* or *non-linear coefficients* (such as "structured" random forests models or economic neural networks - *ECOFF (economic forests)*, *Neural VAR*, etc.) are emerging, as well as efforts by the ML community to adapt their methods to macro data (nowcasting, real-time casting, etc.).

(4) Challenges and future directions: Despite progress, many directions remain open. One is solving the **"black box** " - *"white box"* dilemma in AI models. How can we make a deep learning model explain decisions in a way that economists can understand? Methods such as **LIME** or **SHAP** are a step forward, but their application in complex macro models requires further study. For example, in our analysis we derive average SHAP values for SVR and ANN, finding different importance of lagged inflation versus unemployment - useful, but in a model with dozens of variables it remains difficult to interpret comprehensively.

Another direction is the **prevention and detection of bias** in algorithms. AI-based models, if trained over relatively short periods in economic history, may inherit a bias given by that interval (e.g. low inflation regime 2010-2019). If the regime changes (high inflation after 2021), the model may fail. Possible solutions include training on simulated data from different scenarios (to "learn" the possibility of other regimes) or combining with generative models. The **transfer learning** approach is also worth exploring: for example, pre-training a neural network on global macro data and adapting it to a specific country can help overcome the problem of small sample size in a single economy.

Last but not least, the **economic impact of** using AI in forecasting raises interesting questions: If all market players use similar ML models, aren't there any systemic risks (since everyone reacts to the same signals)? How does *human judgment* integrate with algorithmically generated predictions in decision-making? These topics go beyond technology, into the sphere of governance and ethics of using AI in the economy.

Final conclusion: Comparing traditional and AI-enhanced models should not be seen as a competition with an absolute winner, but as a **mutual learning** opportunity. Traditional models can serve as a foundation and guide for AI models, while AI models can extend the

reach and performance of traditional ones. For economic forecasting in the future, we expect to see more and more **hybrid approaches**, where artificial intelligence and economic theory work together. This way, we can hope for more accurate forecasts, a better ability to spot risks (like emerging crises) early on, and, in the end, better-informed economic policy decisions and a public that's more ready for the future.

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FISCAL STRATEGIES FOR THE DEVELOPMENT AND MODERNIZATION OF INDUSTRY

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ABSTRACT: *The paper analyzes the role of fiscal policy as a key instrument in fostering economic growth and enhancing the competitiveness of the industrial sector. The study highlights the ways in which fiscal measures - such as tax incentives, exemptions, accelerated depreciation, and investment support - can contribute to the modernization of equipment, the digitalization of industrial processes, and job creation within industry. This research examines the impact of fiscal policies on the development and modernization of the industrial sector, with a particular focus on recent data. The analysis is grounded in the integration of national and international data sources, including those from the National Institute of Statistics, the OECD and Eurostat. The paper concludes with a set of policy recommendations aimed at promoting a sustainable and competitive industrial taxation framework: expanding fiscal incentives for digitalization, introducing super-deductions for green technologies, simplifying administrative procedures and aligning fiscal policy with vocational training initiatives.*

Keywords: *Fiscal Policy, Industrial policy, Industrialization, Sustainable Development.*

JEL Classification: *E62, L52; O14.*

1. INTRODUCTION

In the context of the current global economy, characterized by accelerated technological change, the transition toward sustainability, and multiple geopolitical challenges, the development and modernization of national industry represent a strategic priority for any state aiming for sustainable economic growth. Industry remains one of the most dynamic sectors of the economy, playing a vital role in generating added value, fostering innovation, creating employment opportunities, and enhancing competitiveness on international markets.

Fiscal policy, as a core instrument of state intervention in the economy, plays a central role in supporting the industrial sector. Through well-designed fiscal strategies, public authorities can stimulate private investment, encourage research and technological development, reduce regional disparities, and facilitate the transition toward a green and digitalized industrial base.

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Fiscal policy constitutes a key tool for driving industrial modernization and competitiveness. In the current economic environment, shaped by green and digital transitions, an increasing number of countries are adopting targeted fiscal support schemes to attract investments, promote innovation, and create jobs. This paper examines the most recent data on international fiscal strategies and evaluates their applicability in the Romanian context.

2. THE IMPACT OF TAXATION ON INDUSTRIAL PRODUCTIVITY

Taxation is a determining factor in the dynamics of industrial performance, directly influencing investment decisions, innovation, and resource allocation within enterprises. In particular, the level and structure of taxation can have a significant impact on labour and capital productivity, as well as on the competitiveness of industrial firms at both national and international levels. [1]

Industrial productivity is essential for sustaining a country's economic competitiveness, and taxation plays a dual role, both as a cost factor and as a tool that can either stimulate or hinder economic efficiency. In the industrial environment, the influence of taxation is reflected in how firms respond to the tax treatment of income, profit, labor and capital, as well as to the structure of existing fiscal incentives.

Globally, fiscal policy is considered one of the key levers through which governments can influence the behavior of industrial firms, contributing directly or indirectly to productivity growth. The relationship between taxation and productivity is complex and varies depending on the economic structure, the level of development, institutional stability and integration into the global economy. In economies with a high tax burden on labor and capital, industrial firms tend to adopt defensive behaviors such as minimizing investments in advanced technologies, reducing research and development (R&D) expenditures, or outsourcing production to more tax-favorable jurisdictions. These decisions directly affect modernization capacity and, consequently, medium and long-term productivity. [1]

Industrial taxation differs significantly between developed and emerging economies. Countries in the Organisation for Economic Co-operation and Development (OECD) have generally implemented sophisticated tax systems that combine moderate levels of direct taxation with deduction schemes and incentives that encourage innovation and technological upgrading. [2]

In emerging economies, such as Romania, the high fiscal burden on capital and labour discourages profit reinvestment and hinders the modernization of production processes. For example, high payroll taxes and income tax rates can lead to increased production costs, undermining long-term competitiveness. [2]

On the other hand, the implementation of stimulus-oriented fiscal policies - such as tax incentives for investments in modern equipment, R&D deductions, or accelerated depreciation - can enhance industrial productivity by fostering automation, innovation, and digitalization. These measures have been successfully adopted in several EU Member States, yielding positive outcomes in strategic industrial sectors. [3]

Moreover, the stability and predictability of the fiscal framework are essential for the long-term planning of industrial firms. Legislative volatility in taxation often leads to investment delays and underutilization of capital, thereby reducing overall economic returns.

According to the OECD, a total of 667 active fiscal incentives supporting industry were identified across 70 economies. The average number of incentives per country increased from 8.1 in 2022 to 10 in 2024. The most common measures include tax relief for investments, R&D, and the green transition. [4]

Table no.1. The global distribution of fiscal incentives in 2024

Incentive type	Share	Remarks
Environmental sustainability	66%	Incentives for energy efficiency and decarbonization
Employment	44%	Tax reductions for employers
Professional training	36%	Training tax credits

Source: OECD Tax Incentives for Investment and Development (2024)

Taxation directly influences investment decisions and, by extension, industrial productivity. Fiscal incentives geared toward modernization encourage firms to adopt more efficient technologies, digitalize production processes, and reduce operational costs. According to OECD data (2024), economies that offer accelerated depreciation and exemptions for R&D report an average annual increase of 3.5% in industrial productivity over the past five years. [4]

It is essential to emphasize that taxation does not operate in isolation. The effectiveness of fiscal strategies is strongly influenced by economic infrastructure, access to finance, the quality of human capital, and complementary industrial policies. In the absence of a supportive ecosystem, even the most well-intentioned fiscal incentives may have a limited impact.

The impact of taxation on industrial productivity is multidimensional. A smart fiscal system, investment-oriented, predictable, and aligned with current technological realities, can become a catalyst for industrial modernization. Romania needs a strategic tax reform aligned with industrial and innovation policies to transform its industrial sector into a genuine driver of economic growth.

3. FISCAL STRATEGIES AND INDUSTRIAL INVESTMENTS IN ROMANIA

In the 2024–2025 period, Romania faces a series of economic challenges and opportunities amid regional geopolitical tensions, the transition toward a green and digital economy, and increasing domestic budgetary pressures driven by the need for fiscal consolidation. In this context, fiscal policy plays a critical role in stimulating industrial investment, attracting private capital, and accelerating the modernization of productive infrastructure.

To maintain budgetary balance and comply with the requirements of the EU Stability and Growth Pact, the Romanian government has announced a set of fiscal measures for 2024–2025. These measures aim both to broaden the tax base and to introduce targeted incentives designed to attract investment in strategic sectors such as manufacturing, green energy, and technology. [5]

Among the relevant fiscal measures for the Romanian industrial sector during the analysed period are: [6]

- Corporate tax exemption for investments in state-of-the-art production equipment, provided that such equipment is used in high-tech sectors or in activities with high energy efficiency.
- Additional deductions for research and development activities, including those in the automated industrial sector.
- Expansion of fiscal incentives for disadvantaged industrial zones, aimed at reducing regional disparities and promoting economic reconversion.
- Accelerated depreciation for industrial fixed assets acquired during the 2024–2025 period.

- Local tax exemptions for investors who create a significant number of jobs and contribute to the development of local infrastructure.

These measures are aimed at stimulating medium-term productive investments, with a focus on high value-added industries and integration into European value chains. In Romania, in 2024, a state aid scheme totalling 450 million euro was launched to support investment in the industrial sector. Announced investments in the manufacturing sector reached 1.7 billion euro in 2024, leading to the creation of over 8,900 new jobs. [7]

Table no.2. Government support scheme for industry (2024)

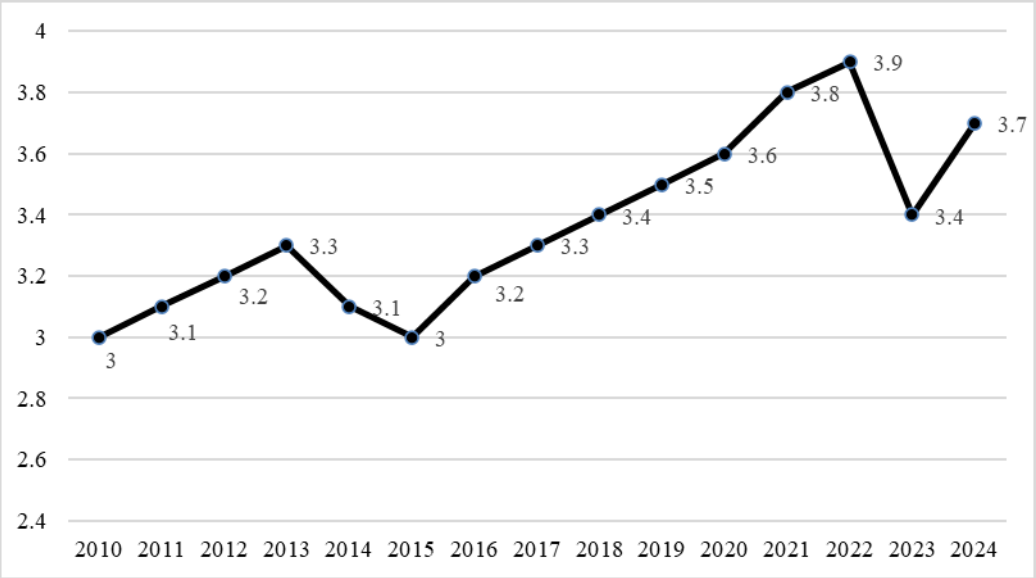
Component	Value / Characteristics	Remarks
Total budget	450 million euro	Funding available until 2026
Minimum company contribution	25%	Maximum non-reimbursable aid: 75%
Eligible sectors	Industry, pharmaceuticals, waste	Bucharest excluded

Source: Ministry of Economy, Digitalization, Entrepreneurship and Tourism (2024)

In 2024, Romania recorded a modest increase in industrial investment, particularly in the renewable energy, automotive, and electrical equipment sectors. According to Eurostat data, gross investments in industry rose compared to the previous year, with a significant contribution from non-reimbursable European funds. [8]

Figure no.1. Industrial investments in Romania

- percentage of GDP –



Source: Author owns processing based on Eurostat data (2025)

Eurostat data for the period 2010–2024 on industrial investments as a share of GDP in Romania indicate a generally upward trend, with a period average of approximately 3.37% of GDP. The lowest value was recorded in 2010 and 2015 (3.0%) and 3.7% in 2024.

During the 2010–2015 period, industrial investments remained relatively stable, fluctuating between 3.0% and 3.3%, suggesting that the industrial sector maintained a moderate level of development in the post-financial crisis context. Beginning in 2016, an upward trend

is observed, which consolidated in 2018–2019, likely due to economic stability and the implementation of industrial support programs.

The 2020–2024 period marks a visible acceleration of industrial investment, reaching 3.9% in 2022 and 3.7% of GDP in 2024. This development can be linked to the response to the 2020 health crisis, increased investment in digitalization and green energy, as well as funding provided through the National Recovery and Resilience Plan. [9]

The volatility of annual values is relatively low (standard deviation of 0.28%), suggesting stability in public policies related to industrial investment and a strong alignment with sustainable economic development objectives.

In conclusion, industrial investments in Romania during the analyzed period reflect a positive trajectory, marking a shift from post-crisis stagnation toward accelerated dynamics in recent years, in line with the structural and technological transformations of the national economy.

In parallel, several international companies (e.g., Nokian Tyres, Bosch, Varta) have announced the expansion or construction of new industrial facilities in Romania, in the context of the ongoing repositioning of global supply chains. These decisions were also influenced by Romania's relatively competitive fiscal framework, particularly in industrial regions such as Transylvania and Southern Oltenia.

Despite these advances, several obstacles continue to undermine Romania's fiscal attractiveness. These include: legislative instability and frequent amendments to the Fiscal Code, sometimes enacted without public consultation or impact assessments; excessive bureaucracy in the process of accessing fiscal incentives or state aid; deficiencies in the digitalization of the tax administration, leading to delays in reimbursements and inconsistent interpretation of legislation; high indirect fiscal pressure, particularly through VAT and social contributions, which increases labor costs in industry.

For Romania to become a sustainable and competitive destination for industrial investment, the following strategic directions must be adopted: establishing a predictable fiscal framework for at least five years, with clear and transparent incentives for industry; simplifying administrative procedures for accessing tax exemptions and deductions; creating a national fiscal incentive fund for industrial innovation, complementary to EU funding; introducing tax reductions for companies that meet sustainability and digitalization targets; ensuring interoperability between the National Agency for Fiscal Administration and the business environment through advanced digital systems.

Romania is at a critical juncture in shaping its industrial development model. Fiscal strategies can become a powerful tool for attracting productive capital and accelerating technological modernization. However, the success of these policies depends on their long-term coherence, institutional implementation capacity, and continuous dialogue between the state and the private sector.

4. FUTURE PERSPECTIVES FOR INDUSTRIAL FISCAL POLICY IN ROMANIA (2025-2030)

Fiscal policy is increasingly becoming a strategic instrument in shaping the long-term industrial structure of an economy. In a global context marked by climate change, accelerated digitalization, supply chain relocation, and geopolitical tensions, industrial fiscal policy is no longer confined to the collection of budgetary revenues. It now plays a crucial role in enhancing productivity, fostering technological modernization, and promoting economic sustainability.

Between 2025 and 2030, fiscal policies will need to strike a balance between budgetary discipline and investment incentives, support the green and digital transitions, and align with

international fiscal regulatory frameworks, such as the OECD's Pillar II (the global minimum corporate tax).

The 2025–2030 period will be decisive for Romania's industrial future, as the global economy undergoes a profound transformation characterized by rapid digitalization, the energy transition, demographic pressures, and the reconfiguration of global supply chains. In this context, national fiscal strategies must shift from a reactive and administrative logic to a strategic, anticipatory, and competitiveness-oriented approach.

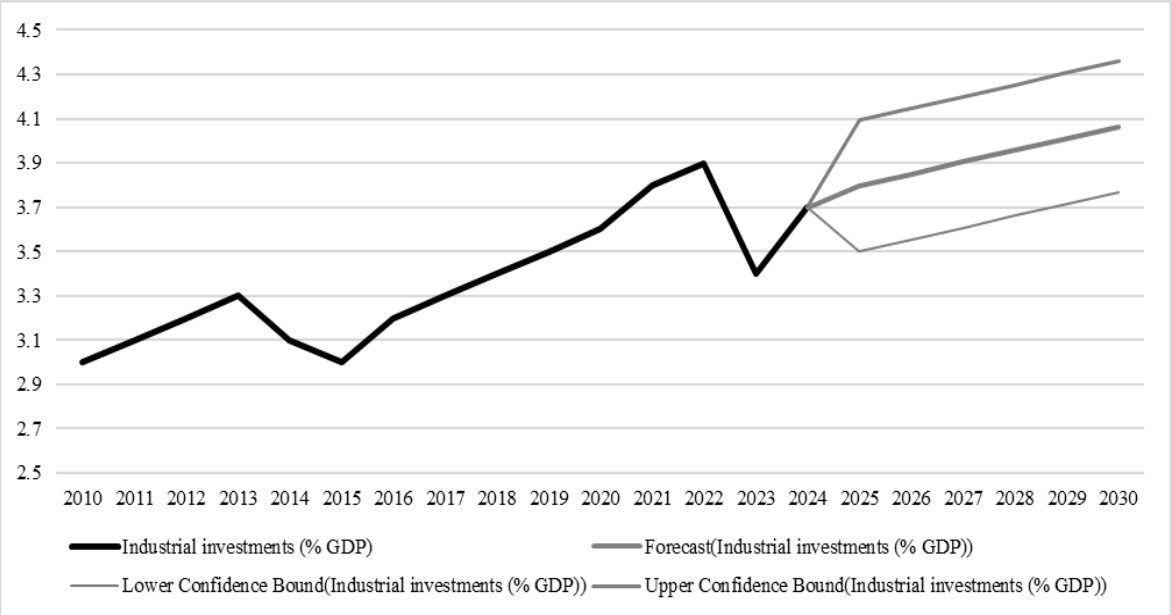
During this period, Romania will continue to benefit from access to European funding through the Multiannual Financial Framework and the Just Transition Mechanism. It is essential for the national fiscal strategy to complement these funds through fiscal co-financing and the creation of blended instruments (grants combined with fiscal incentives). [10]

Between 2025 and 2030, Romania faces the major challenge of building a competitive, sustainable, and industry-responsive fiscal system, adapted to the evolving needs of a dynamic industrial landscape.

The strategic directions of industrial fiscal policy must aim to stimulate investment, enhance productivity, foster innovation, and reduce the environmental impact of industrial activities. Achieving these objectives requires a coherent, predictable approach, fully aligned with European policies on competitiveness and sustainability. [5]

Figure no.2. Forecast of industrial investment in Romania for the period 2025–2030

- percentage of GDP –



Source: Author owns processing based on Eurostat data (2025)

Industrial investment in Romania is projected to resume growth starting in 2025, returning to an upward trend. This suggests a potential recovery of the industrial sector, possibly driven by government support measures, the absorption of European funds, or a renewed focus on domestic production.

Investments are expected to stabilize between 3.7% and 4.3% of GDP by 2030, according to the projected confidence interval. This range reflects both macroeconomic uncertainties and the potential for industrial sector expansion in Romania.

The industrial investment forecast for 2025–2030 is generally optimistic, indicating a clear rebound following the temporary downturn in 2023–2024. However, reaching the upper

bound of the forecast will depend on the state's ability to support industrial modernization, attract foreign direct investment (FDI), and accelerate the transition toward green and digital technologies.

A key pillar of future fiscal policy must be the promotion of investments in clean technologies and industrial digitalization. It is recommended that additional tax deductions be introduced for investments in high energy-efficiency equipment, as well as for the implementation of advanced digital systems (e.g., automation, artificial intelligence, Internet of Things).

To address territorial disparities in industrial development, fiscal policy should incorporate differentiated measures tailored to the potential and specific needs of various regions. The establishment of Special Fiscal Zones (SFZs) is proposed, offering incentives to investors who choose to operate in economically less developed counties. These zones could benefit from temporary corporate income tax exemptions, reduced social security contributions, and financial support for industrial infrastructure. The implementation of these measures must be subject to strict monitoring to prevent misuse and ensure economic efficiency.

Another essential component is the fiscal support of R&D activities. Romania must align its fiscal strategy with the European model by expanding tax deductions for R&D expenditures, as well as for prototyping and applied innovation activities. [3]

It is recommended that a national innovation incentive fund be established to co-finance investments in emerging technologies through partnerships with universities, research institutes, and private companies.

The success of any fiscal policy largely depends on the business community's confidence in the stability of the legal framework. For the 2025–2030 period, it is imperative to adopt a fiscal stability pact for industry, ensuring the preservation of key incentives over the medium term.

Reducing the frequency of amendments to the Fiscal Code and introducing clear transition periods for any legislative changes would significantly contribute to creating a more attractive investment environment.

The digitalization of the National Agency for Fiscal Administration and the interconnection of fiscal reporting systems (e-Invoice, e-Transport, SAF-T) must become a strategic priority. Automating these processes will reduce bureaucracy, improve revenue collection, and enhance voluntary tax compliance.

In parallel, digitalization efforts should also include the development of user-friendly platforms for accessing tax incentives, particularly for SMEs, which often lack the resources for specialized tax consultancy.

Romania’s industrial fiscal policy for the 2025–2030 period must evolve into an active instrument of economic transformation. Through well-calibrated incentives, fiscal equity, digitalization, and predictability, the state can contribute to attracting investment, boosting productivity, and facilitating the transition to a modern, green, and competitive industrial sector. [10]

To capitalize on the opportunities offered by the global economic transition, Romania requires a clear, predictable fiscal strategy focused on productive investment. Between 2025 and 2030, fiscal policy must support not only revenue collection but also the competitiveness, innovation, and sustainability of the Romanian industrial economy.

5. CONCLUSIONS

This paper highlights that well-calibrated fiscal policies can serve as a key driver of industrial development and modernization. The data analyzed confirms that fiscal incentives,

particularly those aimed at sustainability, digitalization and R&D, have a positive impact on investment and productivity.

In Romania's case, the support scheme launched in 2024 generated a favorable response from the business environment, contributing to a visible increase in industrial investment. However, barriers such as excessive bureaucracy, legislative instability, and lack of fiscal predictability continue to undermine the effectiveness of these policies. Compared to other countries in the region, Romania exhibits a significant gap in the intensity of state aid and the speed of implementation.

The paper emphasized the critical role that fiscal policy plays in the process of industrial development and modernization, particularly in an economic context marked by technological transformation, energy transition, and global competitiveness pressures. The analysis reveals that taxation is not merely a revenue collection mechanism, but a strategic tool of economic intervention, capable of either stimulating or discouraging industrial investment.

One of the central conclusions of this paper is the direct and bidirectional relationship between the quality of fiscal policy and the performance of the industrial sector. Coherent, predictable fiscal measures that foster innovation, research, and investment decisively contribute to productivity growth, production diversification, and value-added creation. Conversely, legislative instability, excessive tax burdens, or the absence of appropriate incentives may lead to technological stagnation and the relocation of investment.

In Romania, fiscal policies implemented over the past decade have shown notable progress - such as the reinvestment profit tax exemption and R&D-related tax incentives - as well as structural shortcomings. These include regulatory volatility, bureaucratic access to tax benefits, and a low degree of alignment between fiscal measures and national industrial strategies.

To consolidate a favorable environment for industrial development, the following strategic directions are recommended:

- The establishment of a stable and predictable fiscal framework, with a clearly defined multiannual perspective and the adoption of a fiscal stability pact for industrial investors.
- Strategically targeted fiscal incentives, particularly for emerging industries, digitalization, robotics, green energy, and advanced technological infrastructure.
- The simplification and digitalization of tax administration, ensuring efficiency, transparency and rapid access to incentives, especially for SMEs.
- The harmonization of industrial taxation with European and international policies, particularly considering the OECD's new rules on the global minimum tax.
- Fiscal support for less-developed regions, through the creation of fiscal compensation instruments in areas with untapped industrial potential.

In the long term, the modernization of Romanian industry fundamentally depends on the existence of an intelligent, equitable, and competitive fiscal system, capable of attracting capital, encouraging innovation, and supporting the transition toward a green and digital economy. From this perspective, fiscal strategy should not be conceived in isolation, but rather integrated into a sustainable development model, where the state plays the role of an active and predictable facilitator.

Therefore, fiscal strategies for industrial development and modernization should not be viewed as merely technical measures, but as fundamental levers of national economic policy, with a structural impact on Romania's economic future.

In conclusion, industrial taxation should be regarded as a proactive, adaptable, and transparent public policy instrument, capable of driving the structural transformation of the Romanian economy and supporting sustainable and competitive development in the European and global context.

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ARTIFICIAL INTELLIGENCE AND THE EVOLVING ROLE OF MANAGERIAL ACCOUNTANTS: A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT: *The emergence of Artificial Intelligence has introduced transformative changes in managerial accounting, reshaping not only the technical processes but also the role and required competencies of managerial accountants. This paper conducts a systematic literature review to examine how AI technologies, such as machine learning, natural language processing, and predictive analytics, are influencing the responsibilities, decision-making processes, and strategic positioning of managerial accountants within organizations. The review synthesizes findings from academic literature in the last years, highlighting both opportunities and challenges. Results indicate a paradigm shift: accountants are moving from traditional reporting roles toward more analytical and strategic functions. This study contributes by identifying gaps in the current literature and suggesting directions for future research on the evolving human dimension of managerial accounting in the age of AI.*

Keywords: *Artificial Intelligence, Managerial Accounting, Bibliometric Analysis, Digital Transformations*

JEL Classification: *M41*

1. INTRODUCTION

Artificial Intelligence (AI) has emerged as one of the most transformative technologies in recent decades, affecting a wide range of industries including finance, healthcare, and education. In the realm of business, AI is increasingly influencing both operational processes and strategic decision-making. Among the areas most impacted by this digital transformation is managerial accounting — a field that historically focused on data recording, budgeting, and internal reporting.

With the rise of AI technologies such as machine learning, natural language processing, and predictive analytics, the role of managerial accountants is undergoing a significant shift. Tasks traditionally performed by accountants are being automated, while new demands arise

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for professionals who can interpret complex data, advise on strategy, and work alongside intelligent systems.

Despite the growing interest in this transformation, the academic literature remains fragmented. This study aims to synthesize recent research on the intersection between AI and managerial accounting through a systematic literature review. Using bibliometric analysis and co-occurrence mapping via VOSviewer, this paper identifies major thematic clusters, highlights key developments, and reveals gaps in current knowledge.

The remainder of this paper is structured as follows: Section 2 outlines the methodology used to collect and analyze the literature; Section 3 presents the results of the bibliometric analysis; Section 4 discusses the key findings; and Section 5 concludes with implications and directions for future research.

2. METHODOLOGY

This study adopts a Systematic Literature Review (SLR) approach combined with bibliometric mapping, aligned with the PRISMA framework (Moher et al., 2009), to explore how artificial intelligence (AI) is transforming the field of managerial accounting. The methodological process follows the four-stage approach commonly used in bibliometric analyses (e.g., Donthu et al., 2021): (1) database selection and search strategy, (2) filtering and eligibility screening, (3) data export and preparation, and (4) bibliometric analysis using VOSviewer (van Eck & Waltman, 2010).

These steps are illustrated in Figure 2.

2.1. Data Sources and Search Strategy

To ensure wide coverage of high-quality scientific literature, this study used the Web of Science database, accessed through e-nformation.ro – a leading platform indexing high-impact peer-reviewed journals. Web of Science was selected due to its rigorous indexing criteria, comprehensive subject coverage, and widespread use in bibliometric studies, ensuring reliability and replicability of results (Falagas et al., 2008). The search expression was designed to identify publications addressing the relationship between artificial intelligence and managerial accounting. It included multiple variations of key terms to ensure comprehensive coverage of the topic: "artificial intelligence" OR "AI" combined with "managerial accounting" OR "management accounting". This approach ensured that articles using different terminology for the same concepts were all included in the results.

2.2. Inclusion and Exclusion Criteria

To ensure methodological transparency and reproducibility, the specific inclusion and exclusion criteria user during the screening process are outlined in Table 1.

Table 1 Inclusion and exclusion criteria.

Inclusion criteria	*Exclusion criteria*
Articles in English	Articles in other languages
Published between 2018-2025	Published before 2018
Peer-reviewed journal articles	Editorials, reviews, conference papers
Topics relevant to AI and managerial accounting	Irrelevant topics based on title/abstract

The filtering process began with 6,623 initial records and narrowed down as follows:

Table 2 Visual summary of this multi-step filtering workflow.

Filter Applied	*Remaining Articles*
No filter (initial results)	6,623
+ Only journal articles	4,870
+ Year: 2018–2025	3,579
+ Language: English	3,496
+ Subject category: Economics	135

A final set of 135 articles was retained for analysis after removing duplicates and irrelevant entries based on content inspection.

2.3. Data Export and Pre-processing

All selected articles were exported in CSV format, including fields such as: title, abstract, author keywords, and cited references. The export process preserved essential metadata necessary for bibliometric analysis. Articles from Web of Science were exported with the "Full Record and Cited References" option enabled, as recommended in Web of Science data export guidelines (Clarivate, 2023). The dataset was checked for encoding and formatting issues to ensure compatibility with VOSviewer.

2.4. Bibliometric Analysis Using VOSviewer

The processed data was analyzed using VOSviewer, a software tool widely used in bibliometric and scientometric research for constructing visual maps of scientific knowledge (van Eck & Waltman, 2010). A co-occurrence analysis of author keywords was performed with the following parameters:

- Type of analysis: Co-occurrence
- Unit of analysis: Author keywords
- Counting method: Full counting
- Threshold: Minimum of 3 occurrences per keyword

After applying the threshold, 70 keywords met the criteria and were included in the final co-occurrence map. VOSviewer generated a network visualization, highlighting relationships between terms based on their co-occurrence in the dataset. This mapping resulted in the identification of five distinct thematic clusters, which serve as the foundation for the discussion of research directions and trends in Section 3

3. RESULTS

3.1 Descriptive Overview

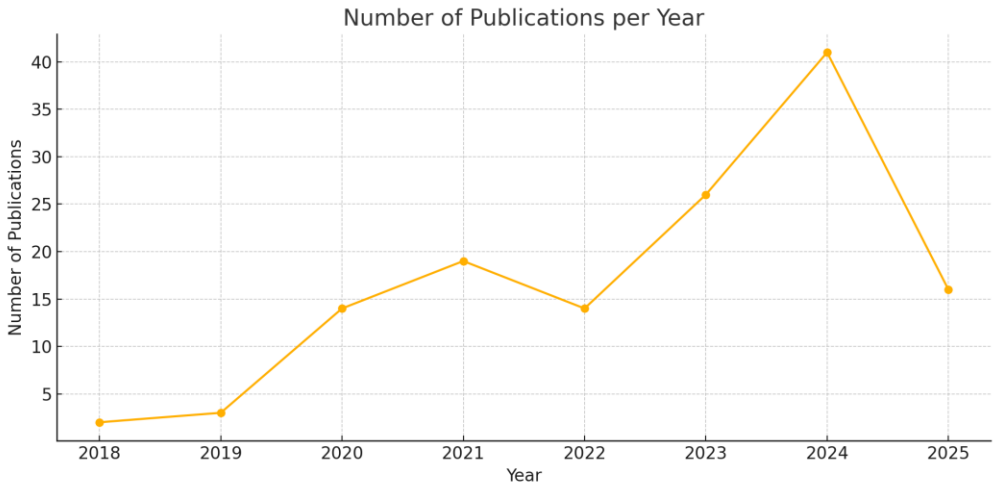
The bibliometric analysis encompasses a total of 135 research articles published between 2018 and 2025. This period reflects the growing scholarly interest in the intersection of Artificial Intelligence (AI) and managerial accounting, driven by the increasing adoption of intelligent technologies in corporate financial management and decision-making.

Figure 1 presents the annual distribution of publications. A gradual increase in publication output is observable starting from 2019, with a notable peak in 2023, suggesting

an upward trend in academic attention. This pattern indicates a relatively recent but intensifying research focus on AI applications within accounting and management domains.

The year-by-year breakdown also highlights certain years with relatively fewer publications, particularly at the beginning of the period, which may correspond with the nascent stages of integrating AI tools into accounting practices. The surge in recent years correlates with broader trends in digital transformation and the practical implementation of AI-driven systems in business operations.

Figure 1: Number of Publications per Year (2018–2025)



3.2 Bibliometric Mapping

The keyword co-occurrence analysis was conducted to identify the thematic structure and intellectual landscape within the literature on artificial intelligence (AI) in managerial accounting. Using VOSviewer, a total of 1,023 unique keywords were extracted from the dataset of 135 articles. Applying a minimum threshold of three occurrences, 70 keywords met the inclusion criteria and were included in the co-occurrence network visualization. The resulting network map (Figure 2) reveals several distinct thematic clusters, each represented by a different color. These clusters indicate the core research areas and emerging topics within the field.

Cluster 1 (Red): Digital Transformation and Accounting Technologies

This cluster focuses on the integration of artificial intelligence (AI) in accounting practices, particularly in the context of digital transformation and technological innovation. Key terms such as “artificial intelligence”, “digital transformation”, “blockchain”, and “technology” dominate this thematic area, reflecting the sector’s shift toward automation and data-driven financial reporting. Several studies emphasize the transformative role of AI tools in this domain. For example, Tubadji (2021) highlights how cultural factors and perceived bias significantly influence the adoption of AI in financial contexts, suggesting that digital transformation is not solely a technical transition but also a socio-cultural challenge. Meanwhile, Mayer (2023) examines how AI-based decision support systems alter managerial behavior, demonstrating that even advisory AI technologies affect the decision-making structure within accounting and finance. Together, these studies underscore that the implementation of AI technologies in accounting is multifaceted—enhancing operational

efficiency, modifying human interaction with data, and requiring adaptation to ethical, cultural, and managerial implications.

Cluster 2 (Blue): AI and Performance Optimization

Cluster 2 centers around performance metrics and AI tools, featuring keywords like "performance", "machine learning", "forecasting", and "efficiency". This theme highlights the role of AI in enhancing organizational performance and predictive capabilities. For instance, Xu (2024) explores how AI-based tools are reshaping credit evaluation and forecasting practices, driving efficiency in decision-making processes. Similarly, Brey (2024) analyzes the integration of performance metrics and AI-driven models in investment decisions, demonstrating the improved predictive power of machine learning algorithms within accounting systems.

Cluster 3 (Green): Sustainability and Economic Growth

Cluster 3 covers sustainability and economic growth, including terms such as "economic growth", "renewable energy" and "innovation". The presence of these keywords suggests a growing interest in the intersection between AI and sustainability. For example, Nzama (2024) investigates how AI tools contribute to sustainability in the South African public sector, highlighting their capacity to enhance economic transparency and long-term growth prospects. Similarly, Yousaf (2024) emphasizes the role of AI in fostering innovation and green investment strategies, suggesting that artificial intelligence is being strategically deployed to address climate-related financial disclosures and sustainable development goals.

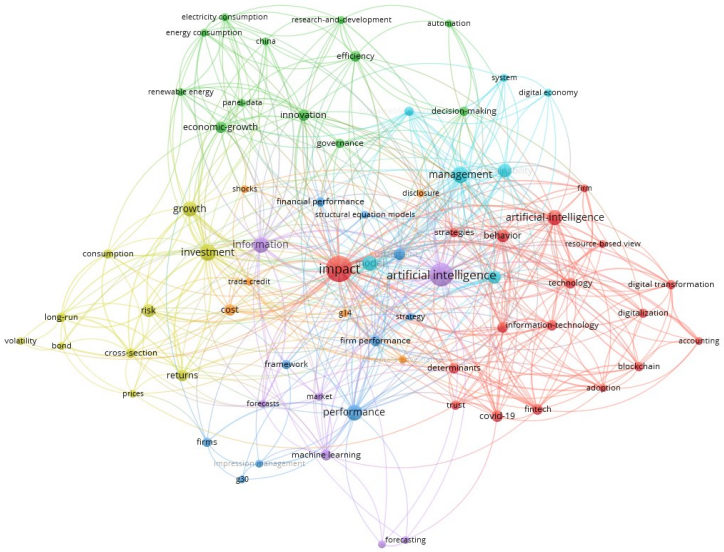
Cluster 4 (Yellow): Financial and Investment Decision-Making

Cluster 4 reflects financial and investment decision-making topics, including keywords such as "risk", "returns", "investment", and "cost". This cluster suggests that researchers are increasingly applying AI to model and manage financial uncertainty and investment behavior. In this context, Chen (2023) explores the application of AI algorithms in evaluating investment options and improving risk assessment accuracy, concluding that "AI-driven analytics significantly enhance the precision of financial forecasts and reduce uncertainty in decision-making." Likewise, Xu (2024) examines how AI is utilized in credit evaluation and corporate transparency, showing that "machine learning tools play a crucial role in optimizing investment decisions and increasing market confidence."

Cluster 5 (Purple): Digital Finance and Macroeconomic Implications

Cluster 5 encompasses themes related to digital finance and broader macroeconomic implications of AI, featuring keywords such as "impact", "GDP", "information" , and "financial performance". This cluster reflects the expanding role of AI in shaping national economies and financial governance systems. For instance, Almuqatari (2024) investigates the integration of AI in financial reporting and macroeconomic planning, finding that "AI applications influence key macroeconomic indicators by streamlining public sector financial practices and enhancing GDP forecasting accuracy." Similarly, Nzama (2024) analyzes AI's role in public sector accounting, noting that "AI adoption improves financial transparency, which in turn strengthens the relationship between government performance and economic growth."

Figure 2: Keyword co-occurrence map generated using VOSviewer.



Overall, the co-occurrence analysis confirms that AI research in managerial accounting is expanding into multifaceted directions, reflecting technological, strategic, and economic dimensions. The clustering also provides insight into existing research gaps and areas where further integration of AI applications could be beneficial.

4. DISCUSSION AND IMPLICATIONS

The results of the bibliometric analysis highlight several dominant themes in the literature, including AI-based performance improvement, the strategic repositioning of accounting professionals, and the ethical implications of intelligent automation.

For example, Haddad (2021) affirms that "Artificial intelligence technologies have revolutionized the accounting profession and transformed the role of accountants, allowing for higher-level strategic and advisory functions." This reflects the general trend identified in the co-occurrence analysis, where keywords such as management, decision-making, and control were highly interconnected.

Nzama (2024) also emphasizes this transformation in public sector contexts, noting that: "The adoption of artificial intelligence improves efficiency and effectiveness in financial management and enhances accountability and transparency in the public sector." This demonstrates how AI's influence extends beyond private organizations into broader governance frameworks.

From a technical and financial perspective, Xu (2024) analyzes AI adoption in credit evaluation, arguing that "AI adoption significantly improves credit rating accuracy and is positively associated with firm transparency and data complexity." This points to the increasing reliance on AI tools in financial decision-making processes.

At the same time, the literature also surfaces ethical and human-centered concerns. One study states: "Most accountants [...] believe that the ethics of artificial intelligence is vital and that the involvement of regulatory bodies in ethical legislation is indispensable."(Fulop, 2023). Despite growing interest, these discussions remain underdeveloped in empirical research and offer a valuable direction for future study.

Moreover, the implications for accounting education and professional development are profound. As the role of managerial accountants becomes increasingly reliant on data interpretation and algorithm-based forecasting, universities and certification bodies must revise curricula to include AI, data analytics, and digital ethics. The reviewed studies suggest that while practitioners acknowledge the growing importance of these skills, formal training and institutional support remain limited.

In addition, many articles advocate for closer collaboration between accounting professionals and data scientists. The intersection of domain knowledge and technical expertise is identified as a key factor in achieving effective AI implementation. However, organizational resistance, lack of clear guidelines, and ethical ambiguity remain barriers that need to be addressed.

Despite the increasing volume of research, significant gaps persist. Topics such as AI adoption in SMEs, sector-specific implementation strategies, and cross-cultural differences in accounting practices are still underexplored. Similarly, the integration of AI with sustainability reporting and ESG compliance has been noted only in isolated studies.

Overall, the literature suggests that AI adoption in managerial accounting is moving from operational efficiency toward strategic transformation. However, the evolution remains uneven, with technological enthusiasm often outpacing ethical reflection and institutional readiness. Future research should focus not only on the capabilities of AI but also on its broader implications for accountability, inclusiveness, and professional identity within the accounting field.

5. CONCLUSIONS

This study set out to examine how artificial intelligence (AI) is reshaping the field of managerial accounting, with particular emphasis on the evolution of professional roles, decision-making processes, and strategic functions. Through a systematic literature review of 135 articles sourced from the Web of Science database and visualized using VOSviewer, the research identified five major thematic clusters, ranging from technological integration to financial risk management and sustainability.

The findings confirm that AI is driving a profound transformation in managerial accounting. The role of accountants is gradually shifting from traditional reporting and compliance functions toward strategic advisory, data interpretation, and digital governance. This evolution is evident not only in the recurrent themes identified in the literature, but also in the emerging research on ethical concerns, organizational adaptation, and interprofessional collaboration.

The co-occurrence analysis highlights the multidimensional nature of current research, connecting AI tools such as machine learning and blockchain with managerial practices like planning, performance evaluation, and risk control. Despite this expansion, the review also uncovers significant gaps — including the limited focus on SMEs, underrepresentation of sustainability reporting, and the nascent exploration of ethics and regulatory frameworks.

From a theoretical perspective, this review contributes to the ongoing discourse on digital transformation in accounting by mapping the intellectual structure of recent publications and outlining prevailing knowledge domains. From a practical standpoint, it provides insights for educators, practitioners, and policymakers regarding the skills, tools, and ethical considerations needed to prepare for the AI-driven future of accounting.

Future research should aim to bridge the identified gaps by conducting longitudinal studies, cross-sectoral analyses, and empirical investigations into real-world implementations of AI in accounting systems. Interdisciplinary approaches that combine accounting, data

science, and ethics are particularly needed to ensure responsible and inclusive digital transitions.

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THE SPECIFICS OF THE INTEGRATION OF GENERATION Z INTO THE LABOR MARKET – THE ENGINEERING FIELD

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ABSTRACT: *The article aims to take an X-ray of the latest generation to enter the labor market – generation Z. First of all, the peculiarities of these young people are reflected, seeking to reveal what is common and what makes them different from previous generations. The fact that they do not know life outside the Internet has marked their way of thinking, communication and approaching different aspects of life, greatly marking their relationship with work. Studies show that they are the least concerned about making a career and are rather looking for a job that satisfies the need for affirmation, balance between private and professional life, the use of technology in the learning process, work and communication, a friendly environment. Special attention is paid to engineering students and the way in which they meet the expectations of employers. Studies reveal a mismatch between the demands of the labor market and the training of engineering graduates from generation Z. Managers are rather dissatisfied with the technical and professional skills, but also with the personality traits of these young people that make it difficult for them to fit into engineering positions. At the same time, the article points out several recommendations regarding the improvement of study programs that are required to be more closely aligned with the constantly changing requirements in this field.*

Keywords: *generation Z, career aspirations, engineering education, engineering graduates*

JEL Classification: *J62*

1. INTRODUCTION

The year 2000 is often considered the turning point between the previous generation Y and Generation Z. Members of Generation Z were born into the digital age. They grew up in small families, with older parents who spent a considerable part of their lives studying. The character of Generation Z is formed primarily through the Internet. For them, the boundary between the online space and the real world is blurred, with success meaning recognition in the online space.

Some authors see Generation Z as the first truly cosmopolitan generation. Millennials were considered the first cosmopolitan generation with the development of the Internet, but as more individuals enter the online space, Generation Z will become more cosmopolitan in their thinking, interactions, and connections. Today's teenagers may have more in common with their peers around the world than with adults in their own country.

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They are practical and intelligent and like to take the lead because they feel more independent (Jiří, 2016). They are more impatient and agile than their predecessors and are constantly looking for new challenges. They are not afraid of continuous changes and, thanks to the Internet, they possess a lot of information, but only to a certain extent. To solve problems, they try to find solutions on the Internet.

Another characteristic is that they are constantly connected to social networks and communicate constantly in the virtual environment. Moreover, the activity on social networks negatively influences the writing skills of Generation Z, as they seem to need to improve their formal writing skills and face-to-face communication (Hovořáková & Pauknerová, 2023).

Schwieger and Ladwig (2018) in their article in which they review current research on the profile of "Generation Z" compile a compilation of characteristics of Generation Z:

• They value hard work that is properly rewarded.

• They are independent, resilient and realize that they have to work hard to achieve.

• They value trust, fairness, loyalty and respect from their employer.

• They are ambitious and have an entrepreneurial spirit. However, these students know they have a lot to learn about entrepreneurship, as nearly two-thirds believe that management skills should be taught in colleges and universities, according to the findings of the Northeastern University Innovation Study. (Seemiller & Grace, 2017)

• They are creative and value individuality.

• They plan for their future and are willing to learn on their own.

Market research firm Sparks and Honey, in Meet Gen Z: Forget Everything You Learned about Millennials, reported that 85% of Gen Zers have engaged in online research to complete a task, likely without interpersonal interaction. Not only are they used to learning independently, but these students prefer it because they can focus, set their own pace, and make sense of their learning before sharing it with others.

Seemiller & Grace (2017) found that community engagement opportunities that have a lasting impact on a social issue are more appealing to Gen Z students than short-term volunteer experiences that address the symptoms of that issue. For example, instead of volunteering five hours a week at the Social Canteen, Gen Z students would rather engage in a social change initiative aimed at eradicating hunger. This is highlighted in the qualitative study of over 1,300 Gen Z students from 50 institutions. As part of the Gen Z Stories Project, students shared examples of how their generation intends to change the world by solving complex problems. One student said, "Our generation is extremely innovative and will be able to find solutions to different problems that have been approached in ways that have not worked before."

Studies show that Gen Zers value work-life balance. Organizations that promise and promote work-life balance are more likely to attract and retain Gen Z employees.

Articles documenting engineering students' perceptions of developing generic skills and competencies revealed that teamwork, communication, problem solving, navigating ambiguity, and self-directed learning were the most frequently mentioned topics. The next skills found in several articles were project management and time management, while creativity, critical thinking, and information literacy were mentioned much less frequently (Boelt et al., 2022).

2. GENERATION Z'S RELATIONSHIP WITH WORK

Baša et al. (2023) find in their study that the most important thing for Generation Z is to express creativity at work, and the response option of doing the job with minimal effort received a higher rate than the opportunity to learn and self-train. Generation Z considers salary and flexible work schedule very important, but in their case, expectations are often unrealistically high compared to their work experience. In the case of Generation Z, career is

only in fourth place. They consider material goods to be more important than friendships, and this is also reflected in the workplace. High salaries, recognition and a pleasant atmosphere at work are extremely motivating factors for Generation Z and for the previous generation.

Several authors have emphasized that work-life balance is very important for the youngest generations entering the labor market, who put money and reputation before intrinsic values.

In terms of motivation, research finds that Generation Z is intrinsically motivated when their team and, more importantly, their supervisor recognize their contributions and implement their ideas.

Generation Z values relationships at work. They want to form a friendly, cheerful team with their colleagues, helping each other in completing tasks.

Being digital natives, Generation Z uses technology to learn, socialize, and, of course, they expect to use technology at work.

Studies find that family members have a dominant influence on the career choices of young people in Generation Z. They tend to honor the values of their family of origin.

Young people in Generation Z are oriented towards jobs with friendly work environments, good salaries, flexible schedules. The fields they aspire to are IT, sales, manufacturing, finance.

Personal fulfillment is achieved through workplace benefits, including job security, vacations, benefits packages, and competitive pay.

Young people in Generation Z need mentors, which they seek in their family environment, in the media, and they also want them in the workplace. Generation Z expects their supervisors to provide them with leadership skills, guide their learning, and support their career development through meaningful mentoring.

Although research sheds light on the career aspirations of Generation Z, it is not sufficient to understand how Generation Z will behave in the workplace. All empirical research in the literature has as participants students with little exposure to the current labor market or completely lacking work experience, and therefore, once they enter the labor market, their perceptions may change. (Barhate & Dirani, 2021)

A survey of 81 entrepreneurs in the western region of Romania who have hired engineering graduates from Generation Z reveals the following results:

• Only half of the employers consider the young people recently hired to be good specialists, while more than a third consider them to be mediocre from a professional point of view, and 1 in 10 consider them to lack basic professional skills.

• One thing expressed by almost all employers was related to the difficulty of engineering graduates to understand aspects from fields related to their specialization, they mentioned rigidity and mechanistic thinking not adapted to working conditions as an important weak point.

• The main deficiency of a recent graduate is the lack of experience, almost non-existent practice – an aspect mentioned by 57% of respondents. It is followed by responsibility, low involvement - 26%.

• The most important thing for an entrepreneur is that a graduate he hires understands what he has to do and meets the organization's requirements, as stated in the job description. It matters very little that he has studied abroad, has received high grades in his undergraduate degree, has gained experience in other companies, is willing to work overtime or travel for work.

• Asked to write the main 3 responsibilities of a new employee who graduated from an engineering faculty, entrepreneurs most often mentioned seriousness, willingness to learn, to know and to improve. The authors of the study stated that the responsibilities required of a new

graduate are modest; they are not expected and are not required to perform, but elementary activities, performed conscientiously.

• The low expectations that employers have of recent graduates of technical faculties come from a history of relations with employees, whom they reproach for the superficial way of working, the need to be pushed from behind, to be led (26%), inconstancy, the temptation to leave for other companies or to other countries (21%), lack of creativity, imagination, passion (20%)

• Only a third of the company representatives have conveyed to the universities they collaborate with what they want from future employees who finish their studies. Of those who have had discussions with the university administration, only half have been involved in adapting the academic curriculum to meet the needs of specialized personnel.

• Half of the companies that participated in the study do not conduct research - they only implement or use the results of scientific research conducted elsewhere. Another 20% invest small amounts in research, ranging from 1-5% of annual revenues. Only 9% invest more than 10% of their income in research. (Ștefan, 2019)

According to an estimate regarding engineering graduates of the Polytechnic University of Bucharest, of the 6,000 graduates of the class of 2024, about 15% go abroad and work there, the rest stay in the country but not all work in the field of engineering. (Milea, 2024)

A study that sought to identify the aspirations and motivations of 2,330 engineering students at Imperial College London found the following:

In terms of curriculum suggestions, respondents reported an interest in transferable skills training, practical work and laboratory projects. When students were asked to rate the importance of specific transferable skills, training, communication, management, teamwork/negotiation and presentation skills featured prominently, with mean score ratings ranging from 63% to 67% for male respondents and 72% to 76% for female participants. Lower priority was given to skills/knowledge related to environmental awareness, language development, law/intellectual property and ethics, with mean ratings ranging from 45% to 50% for male respondents and 53% to 62% for female participants. The data suggest a greater bias among students toward developing interpersonal skills and perhaps a lack of recognition of any implicit skill development through team projects and laboratory work.

After the first year of study, there is a significant decline in the average level of self-rated motivation toward studies for engineering students. This decline continues for male participants in subsequent years. In addition, students increasingly feel that their education is not a priority for the teaching staff as they progress through the course. Interestingly, however, those students who expressed a desire to make a difference in the world, to invent something new, or to travel as key priorities were found to have marginally higher levels of motivation than other students ($p < 0.05$). For example, the level of motivation corresponding to these three aspirations ranged from 73% to 75%, compared to 69% for students who expressed financial security as their key life priority. However, students' intention to work as engineers after graduation decreases as they approach the time of completion of their studies, with the most significant decrease in the second and third years of study.

The discouraging factors mentioned by respondents were low financial remuneration and limited opportunities compared to other fields, for example finance. Intrinsic factors such as boredom and loss of interest were found in the list of impediments to pursuing a career in engineering. Another series of demotivating factors mentioned were the location of companies on the outskirts of large cities, demanding work, recruitment practices, gender, ethnicity.

The results of this paper support the views that many engineering students want to be involved in real-life problems and prepared for careers that will have a significant impact on global issues. Many students are eager to develop the skills necessary for effective career progression. However, where such aspirations are not promoted and supported, concerns such

as financial security, job location and travel opportunities can seriously reduce their motivations. (Alpay et al., 2008)

3. RECOMMENDATIONS FOR ENGINEERING EDUCATION

The context of engineering education is changing. Markets are transcending national borders. Technological chains are connecting more and more companies around the world, requiring a wide range of communication and cultural skills. High quality at low production and service costs is becoming a competitive advantage. In some countries, highly qualified engineers are available at a cost five times lower than those trained in other countries. Engineering work from concept development to production is increasingly oriented towards countries with lower costs. The speed of change dictates the rapid obsolescence of any set of technical skills.

Experts in the field from EU countries note that in recent years there has been a serious underfunding of engineering study programs, and university engineering courses have not had a clear practical content that would ensure the training of graduates capable of meeting the real demands of industry and the corporate sector.

In order to enter the race for innovation, it is imperative that universities implement research programs. Today, in order to be a generator of innovation, an engineer, in addition to the fundamental technical knowledge and skills that he must possess, must also do research work (researcher), be able to organize teamwork (manager), and last but not least, demonstrate leadership qualities. The integrity of engineering education would imply a process of its "humanization". A good specialist should have cutting-edge scientific and technical knowledge combined with cultural training, including artistic training. Technical-artistic training constitutes the foundation of a competent engineer.

Engineering education must be based on a thorough physical-mathematical and scientific preparation. This tradition is specific to French, Russian, but also German engineering education. England was the founder and promoter of purely technical education, focusing especially on the practical training of the "craftsman", the "technician". This type of approach was profitable in the short term, for a long time, the practical technician went ahead of the engineer, but the situation changed dramatically when science gained a fundamental role in the development of technology. The engineer must now have the ability (and the opportunity) to creatively develop his field of activity. Creativity based on science should go ahead of the practical experience of technicians.

An engineer must be simultaneously a scientist, a technical specialist and an organizer of industrial production. An engineer who lacks the ability to manage the activity of an enterprise, in fact, cannot be considered an engineer in the full sense of the word, he remains only a “technician”, “an assistant engineer”.

Providing a holistic education that would include scientific and technical knowledge, the cultivation of managerial and interpersonal skills is difficult within the framework of university studies. If the 20th century was the century of the creation of a mass, universal education system, when each generation possessed a large amount of “formal knowledge” acquired in school and university, now the situation has changed significantly. The new generation has not become more educated than its predecessors (rather the opposite), and the education system itself has begun to degrade everywhere. In this sense, the oldest and most powerful educational institution - the family - with its capacity for holistic education and transfer of "informal knowledge" acquires a major importance. Consequently, engineering training at a university, in a small company or undertaking a complementary education program acquires a holistic personal character. It is particularly important to transmit the vocation within the family. Thus, engineering dynasties make a considerable contribution in this direction.

In the current 20th century, a sufficient amount of knowledge has been accumulated, so that university curricula should be designed in such a way that they acquire the peculiarity of "knowledge in action". The theoretical material proposed to students should have a direct and immediate correspondence with the practical activity that they will carry out as specialists. Familiarization with factory activity should be a direct component of the curriculum, even from the first year of college. This possibility would be advisable to be offered by the faculty through collaboration agreements with companies in the field.

The curriculum in engineering education institutions must be periodically revised, so that the contents that have proven their value over time are preserved and included in the category of classical engineering education contents. It is also required to eliminate outdated contents and replace them with innovative contents in the field of science and technology.

The holistic training of students should include the development of a responsible conscience towards society, the environment, sustainable development. The creation of an engineering product from the formulation of the concept to the issuance of the final product, should follow the principle of friendly inclusion in the environment, pursuing various benefits brought to the environment, society, economy and minimizing any damage that cannot be avoided.

Ideally, education should be designed in two directions: either to solve a pressing problem in society, or to develop an innovative product or system that satisfies the need for efficiency (lower costs, less effort, efficiency, precision, performance). In this case, education will be self-directed, in which the student will be the main actor in the process, and the teacher will support the creative process of each student, offering them theoretical and practical guidelines in the creative process.

The creative focus of engineering education is particularly important because it is in line with the evolution of artificial intelligence and the digitalization of the field, an educational approach that will result in various benefits. On the one hand, students will be able to create innovative products and services at a global level, and on the other hand, they will allow the automation of routine jobs. Such jobs are qualified on the labor market as "bad jobs", which are usually targeted at young people without work experience.

4. CONCLUSIONS

Studies show that young people from the last generation are particularly vulnerable in their insertion into the labor market. Access to good jobs is hindered by the older generation that continues to remain employed even after retirement, thanks to financial insecurity. The transition from studies to work is postponed by generation Z due to the lack of job offers that respond to their interests, preferences and skills. And countries like Germany have managed to facilitate this process through apprenticeship programs. Apprenticeship or mentoring programs should be a component of the curricula in educational institutions

Institutions contribute to keeping young people in a state of uncertainty through the deficient offer of jobs, inadequate opportunities for education and training, retrograde jobs (temporary jobs, underemployment, overqualification, informal work).

Educational institutions and companies in the field should focus on research activity, so as to support the inventiveness and creativity of students. This goal achieved through the collaboration of the two parties will contribute to the reduction of jobs that do not contribute to the professional development of young people and to the emergence of challenging, intellectually stimulating jobs, in line with technological and digital progress.

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INNOVATION AND EFFICIENCY IN FINANCIAL AUDITING: AN EMPIRICAL RESEARCH ON THE IDENTIFICATION, EVALUATION AND PREVENTION OF FRAUD AND ERRORS USING MODERN METHODS

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ABSTRACT: *In the context of an economic environment marked by globalization, digitalization and competitive pressures, financial audit acquires a crucial role in ensuring the transparency and accuracy of financial information. This article presents the results of an empirical research on the identification, evaluation and prevention of fraud and errors in financial audit, by integrating modern methods and techniques. The study was based on the application of a standardized questionnaire sent to a sample of 350 professionals (auditors and managers), from which 268 valid responses were collected. The statistical analysis was carried out using SPSS 21.0 software, providing a clear picture of current perceptions and practices in the field of audit. The results obtained highlight the need to use emerging technologies and an integrated theoretical-practical approach to increase the efficiency of financial audit in preventing and detecting irregularities. The conclusions support the importance of continuous training of auditors and the permanent updating of audit methodologies to meet modern challenges.*

Keywords: *financial audit, fraud, error, modern audit techniques, emerging technologies, empirical research, prevention, evaluation.*

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1. INTRODUCTION

Globalization, rapid technological advances and increased economic competition have led to a significant increase in the requirements regarding the quality and reliability of financial information used in the decision-making process. In this context, financial audit plays an essential role in validating the correctness of financial statements, providing users with the guarantee that they are not significantly distorted due to errors or fraud.

In the specialized national literature, a financial audit is defined as a comprehensive examination of the expression of a reasoned opinion on the accuracy and fairness of the view reflected in an entity's annual financial statements (Mihăilescu & Marcu, 2010). Therefore, audit is a professional activity carried out by a competent and independent person, aiming to express an objective opinion on the accuracy and fairness of the annual financial statements.

Financial and accounting audit aims, on the one hand, to verify the compliance of accounting information with the existing regulatory framework – namely generally accepted accounting principles, tax regulations and internal procedures – and on the other hand, to critically evaluate the clarity, fairness and completeness of these reports (Popa, 2009). In this regard, Accounting Law No. 82/1991, as republished, together with the European directives and the conceptual framework developed by the IASB, provides the legal and theoretical foundation for the preparation and presentation of financial statements.

To ensure the quality and comparability of the financial information presented, the application of International Financial Reporting Standards (IFRS) in conjunction with national accounting regulations is essential. They provide a common framework for harmonizing accounting reporting, especially in the case of public interest entities or those active in international financial markets (Ristea et al., 2008).

During the planning and performance of an audit, auditors must consider the risk of material misstatement in the financial statements, which can arise from both errors and fraud (Oprean, 2010). Although these misstatements may appear similar in effect, the essential difference between them lies in intentionality: fraud involves a deliberate act, while error involves an unintentional mistake.

The accounting information presented in the financial statements is the product of an internal activity, carried out by people who are not always impartial. Thus, their objectivity and transparency can be questioned, which is why the financial audit becomes an essential tool in validating them. Through his work, the auditor contributes to strengthening users' confidence in the quality of financial reporting, identifying possible misstatements caused by fraud or error and recommending measures to improve the internal control system.

In this context, we are starting this empirical research based on a questionnaire-type opinion study, which has as its main objective the possibilities of identifying, evaluating and preventing fraud and errors in financial auditing through the use of new methods and techniques/practices. The rest of this paper is structured as follows: Section 2 presents the theoretical background that supports the research framework, while Section 3 details the research methodology. The research results collected based on the questionnaire sent are presented in the next section, and, the final part of the article summarizing the relevant conclusions obtained in this research.

2. THE THEORETICAL FRAMEWORK REGARDING FRAUD AND ERROR IN THE CURRENT ECONOMIC ENVIRONMENT

Fraud is a phenomenon that is present in all areas of economic activity, exacerbated by financial pressures and deficiencies in internal control systems. In the current context, where the business environment is increasingly complex and subject to risks, fraudulent conduct poses

a significant threat to the integrity of financial reporting (Andreea et al., 2023). One of the severe forms of fraud is tax evasion, which has a direct negative impact on public budgets. It is generated by a multitude of causes — economic, social, moral and political — and is influenced by the economic context of a given period (Comândaru et al., 2018). The challenges surrounding the credibility and relevance of information disclosed through financial statements have laid the groundwork for the proliferation of imaginative or unconventional accounting practices (Comandaru et al., 2020). In combating this phenomenon, an essential role is played by awareness of organisational ethics and management's responsibility in promoting effective control mechanisms (Atakan & Chiriac, 2023).

Fraud involves intentional actions, such as falsification, omission or deliberate distortion of information in order to obtain undue advantages. It can take the form of fraudulent financial reporting or misappropriation of assets (Mackevičius & Kazlauskienė, 2009). In contrast, an error is an unintentional mistake in the financial reporting process, which can be caused by negligence, the incorrect application of accounting policies, or incorrect estimates (Niță, 2008). Although the fundamental difference between error and fraud is intentionality, the effects on financial statements can be similar. Thus, auditors must demonstrate increased professional judgment to identify the true nature of the misstatement (Voinea et al., 2018).

The lack of an ethical organizational culture and ineffective internal controls foster fraud. In this regard, international standards (ISA 240) emphasize the responsibility of management and those involved in governance to prevent and detect fraud. According to ISA 240 and the specialized literature (Horomnea, 2011), two primary forms of fraud are recognized: Asset Misappropriation Fraud – theft of the entity's resources, such as cash, physical assets or intellectual property, and Financial Reporting Fraud – intentional misstatements to manipulate financial indicators, deliberately misapply accounting policies or falsify documents (Voinea et al., 2018). Employees, management, or third parties can carry out these actions, and the difficulty often lies in identifying the intention behind the misstatements – an essential aspect for distinguishing between fraud and error (Bragg, 2010). The most publicized and damaging type of fraud is financial reporting fraud. These frauds are committed by the management personnel (Cordery, 2007) of the company and are aimed at manipulating information. They manipulate financial information and falsify reported statements to deceive investors and customers to present the health of the company in a fraudulent way (Chalevas & Tzovas, 2010). Fraud, which is carried out by the management's manipulation of information in the financial statements of a company to recognize fictitious income and pay taxes (Erickson et al, 2004), involves either overstating results, improving the balance sheet, or a combination of these two methods (Lenard & Alam, 2010).

According to auditor practice, fraud is often difficult to detect, as managers and employees who resort to such acts try by any means to hide their act, so as not to be guilty of events occurring within the entity. However, this does not change or influence in any way the audit responsibility related to the proper planning and execution of the audit.

3. METHODOLOGY

This research aims to identify the most effective methods and techniques for preventing and detecting errors and fraud in the financial audit process. Based on a mixed-methodological approach, combining deductive and inductive reasoning, the study aims to validate hypotheses formulated from specialized literature through the empirical analysis of data obtained from practitioners in the field.

The research approach was implemented by conducting a quantitative survey-type investigation using a standardized, structured, and online questionnaire transmitted through the Google Forms platform. The questionnaire was developed between September and December

2023, and the actual transmission and collection of responses took place between January and March 2024. The research instrument was pre-tested on a sample of five experienced auditors to validate the content and clarity of the questions.

The questionnaire includes 36 questions, structured on four areas of analysis: identifying the respondents' profile, assessing the role of financial audit in identifying misstatements caused by errors or fraud, investigating the methods and practices used in their detection, as well as assessing the impact of emerging technologies on the quality and efficiency of the audit.

The research sample is composed of 350 respondents, of which 150 occupy management positions in economic entities (managers or coordinators of audit/accounting offices), and 200 are financial auditors with at least 5 years of professional experience. Their selection was made based on professional relevance and the targeted geographical distribution, namely the Municipality of Bucharest and the South Muntenia Region, consisting of the counties of Argeș, Călărași, Dâmbovița, Giurgiu, Ialomița, Prahova and Teleorman.

The collected data were centralized, coded and statistically processed using Microsoft Excel, and subsequently subjected to descriptive and inferential analyses using SPSS software, version 21.0. Through this process, relevant trends were identified, and the formulated hypotheses were tested.

The research problem investigated aims at the question: "What are the most effective methods and techniques for preventing and detecting fraud and error in the financial audit exercise?" In this context, the research aims to explore the perceptions and real practices in the field, based on the responses of experts directly involved in the financial audit activity.

The hypotheses formulated and tested in this study are the following: (1) experienced auditors identify fraud more frequently due to the use of advanced methods; (2) emerging technologies contribute significantly to increasing the efficiency of the audit process and reducing the risks associated with misstatements; and (3) the quality of information contained in financial statements is of significant importance in limiting and proving the risk of fraud, fraud and errors.

4. DATA ANALYSIS AND INTERPRETATION OF RESULTS

The questionnaire used in this research was structured into several relevant sections, the first of which aimed to identify the respondents' profiles. Of the total of 268 participants, the majority (81.70%) declared that they have a professional training in the economic field, 13.80% have legal training, and a minority percentage (4.50%) work in the technical field (IT), confirming the focus of the study on specialists with relevant expertise in financial auditing (Table 1).

Table 1. Respondents' identification elements

		Frequency	Percentage	Validated Percentage	Cumulative Percentage
Level of professional training	Economic	219	81.7	81.7	81.7
	Legal	37	13.8	13.8	95.5
	Technical (IT)	12	4.5	4.5	100.0
	Total	268	100.0	100.0	
Training level	Undergraduate studies	76	28.4	28.4	28.4
	Postgraduate studies	172	64.2	64.2	92.5
	Doctoral studies	20	7.5	7.5	100.0
	Total	268	100.0	100.0	
	5-10 years	133	49.6	49.6	49.6

		Frequency	Percentage	Validated Percentage	Cumulative Percentage
Professional experience of respondents	10-15 years	106	39.6	39.6	89.2
	15-25 years	15	5.6	5.6	94.8
	Over 25 years	14	5.2	5.2	100.0
	Total	268	100.0	100.0	

Regarding the level of professional training, 64.20% of the respondents reported having postgraduate studies (master's), 28.40% have graduated from undergraduate studies, and 7.50% hold a doctorate. These data indicate a high level of professional training of the research participants. In terms of professional status, 59% of the respondents are financial auditors, and 41% are managers of companies or accounting and auditing firms. Professional experience is also notable: almost half of the participants (49.60%) have between 5 and 10 years of experience in the field, and 39.60% have between 10 and 15 years, suggesting a sample with significant practical experience in auditing.

The second section of the questionnaire aimed at assessing the role of financial audit in identifying misstatements arising from errors or fraud in financial statements. The perception of the importance of financial audit activity in the portfolio of services offered, an overwhelming proportion (69.80%) considers audit to be a significant activity, and 25.70% evaluate it as very important. With respect to the credibility of financial information resulting from the audit process, 80.60% of respondents believe that an audit mission significantly guarantees that the financial statements accurately reflect the economic reality of the audited entity. Only 5.20% expressed doubt in this regard, and 14.20% indicated uncertainty (don't know).

Concerning compliance with International Standards on Auditing (ISA), 82.46% of participants fully agree that adherence to these standards is crucial for ensuring the quality of the financial audit, while only 3.40% disagree, and 14.18% partially agree. Participants were also asked to what extent the quality of information in financial statements is influenced by the moral-professional qualities, skepticism and professional reasoning of auditors, as well as by the methods used. The responses reflect a strong association: 79.90% consider that these attributes greatly influence the quality of the audit, thus confirming the importance of the human and ethical factor in the audit process. Regarding the role of financial audit as a lever for identifying vulnerabilities and distortions generated by errors or fraud, the majority of respondents (77.60%) recognize its value in this regard. Twelve per cent (12.30%) believe that audit has this role only sometimes, and only 1.90% disagree with this idea.

To assess respondents' perception of the effectiveness of financial auditing in identifying and managing risks associated with fraud and errors, a three-point Likert scale was used (1 – low impact, 2 – medium impact, 3 – high impact). The five items included in the questionnaire target common operational assumptions in financial auditing practice. The data collected reveal a majority consensus on the essential role of auditing in these contexts, thus outlining a professional profile of high expectations towards this activity (Table 2).

First, the majority of respondents (58.2%) consider that the auditor's responsibility to detect fraud becomes significant when it exceeds the materiality threshold, which reflects a good understanding of the limits imposed by the regulatory framework and the materiality of the audit. In case of suspicions of fraud, the proportion of those who consider the impact of the audit to be high increases to 64.2%, underlining the perceived need for increased diligence and the application of additional procedures in such situations. Similarly, 60.8% of respondents indicate that materiality should be interpreted not only in quantitative terms, but also in qualitative terms, reflecting the importance of specific risk factors in the planning stage of the audit mission. Maintaining professional skepticism throughout the entire audit process is considered by 63.4% of participants to have a high impact on the quality of the conclusions

drawn. This opinion validates the need for continuous training of auditors in critical thinking and the application of professional judgment. Last but not least, 65.7% of respondents consider that the documentation and communication of suspicions of fraud have a significant impact on the effectiveness of the audit, which reveals a real concern for transparency and compliance with reporting requirements.

These results converge towards the conclusion that professionals in the field perceive the financial audit activity not only as a formal verification mechanism, but as an essential tool for control, prevention and identification of systemic vulnerabilities within economic entities. The preponderance of responses in the high impact area confirms confidence in the ability of the audit to contribute substantially to ensuring the quality and credibility of reported financial information.

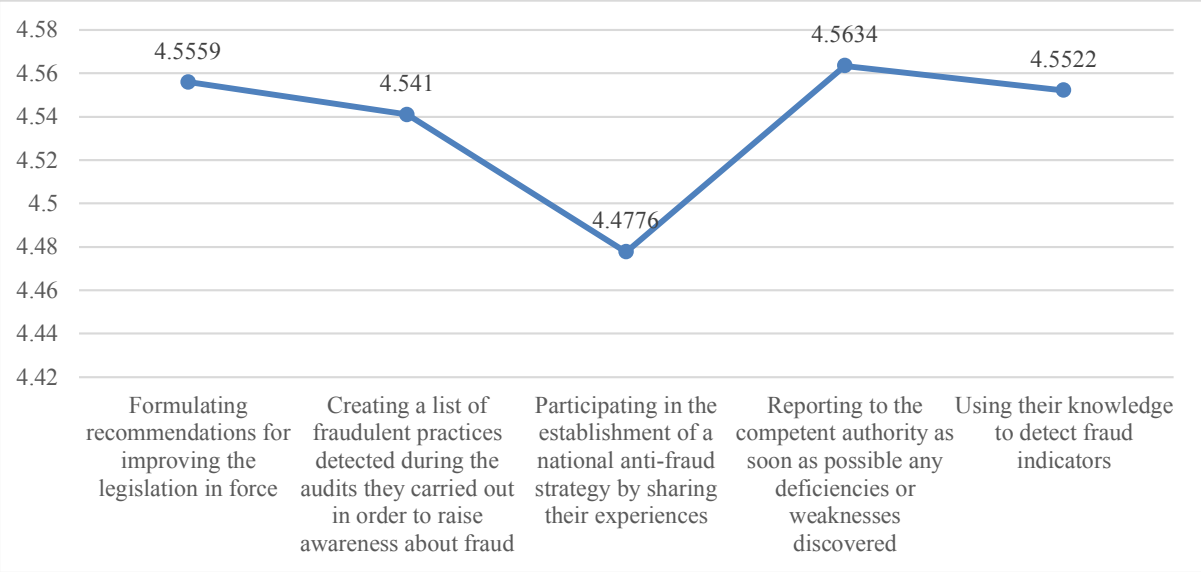
Table 2. Analysis of the impact of financial audit activity in the context of fraud and errors

		Frequency	Percentage	Percentage Validated	Cumulative Percentage
Auditors are expected to detect fraud only if it exceeds the materiality threshold					
Valid	Low Impact	15	5.6	5.6	5.6
	Medium Impact	97	36.2	36.2	41.8
	High Impact	156	58.2	58.2	100.0
	Total	268	100.0	100.0	
If auditors suspect fraud, they should take additional steps					
Valid	Low Impact	15	5.6	5.6	5.6
	Medium Impact	81	30.2	30.2	35.8
	High Impact	172	64.2	64.2	100.0
	Total	268	100.0	100.0	
Auditors should consider fraud risk factors specific when planning their audit activities. In this regard, the concept of materiality should include qualitative aspects					
Valid	Low Impact	14	5.2	5.2	5.2
	Medium Impact	91	34.0	34.0	39.2
	High Impact	163	60.8	60.8	100.0
	Total	268	100.0	100.0	
When obtaining reasonable assurance, the auditor is required to maintain professional skepticism throughout the audit. This includes the need to think and act creatively					
Valid	Low Impact	19	7.1	7.1	7.1
	Medium Impact	79	29.5	29.5	36.6
	High Impact	170	63.4	63.4	100.0
	Total	268	100.0	100.0	
Particular attention should be paid to communicating and documenting cases of suspected fraud					
Valid	Low Impact	15	5.6	5.6	5.6
	Medium Impact	77	28.7	28.7	34.3
	High Impact	176	65.7	65.7	100.0
	Total	268	100.0	100.0	

The information collected highlights a high level of consensus among respondents regarding the statements regarding the potential contributions of auditors in preventing and identifying errors and fraud (Figure 1). Thus, for all five statements analyzed, the majority of respondents expressed agreement or total agreement, which reflects a favorable and committed perception regarding the professional responsibility of auditors in this area. From the perspective of ranking these activities according to importance, it is noted that the action considered to be the most significant is reporting as soon as possible to the competent authority the deficiencies or weaknesses identified during the audit mission, this registering an average score of 4.56 points on the Likert scale. At the opposite pole, the lowest weight is associated

with the participation of auditors in the establishment of a national strategy to combat fraud by sharing their own professional experiences, an activity that obtained an average score of 4.47 points.

Figure 1. The contributions made by auditors that lead to the prevention and identification of errors and fraud



These results suggest that auditors perceive direct and operational responsibilities — such as immediate reporting of irregularities — as having a more concrete and effective impact on the process of preventing and identifying fraud risks, compared to engaging in a general strategic framework of institutional cooperation.

To test the proposed hypothesis, namely the first hypothesis of the research, a quantitative analysis model was used that examines the relationship between the level of professional experience of auditors (ordinal variable) and the perceived frequency of fraud detection following the application of advanced methods (ordinal variable, measured by a Likert item). The professional experience variable was structured on four levels: 5–10 years, 10–15 years, 15–25 years and over 25 years, while the frequency of fraud detection was self-reported by respondents on a Likert scale with three levels: low, medium and high. To assess the association between the two ordinal variables, the Spearman correlation coefficient (ρ) was applied, a nonparametric statistical test that measures the direction and intensity of the monotonic relationship between the variables (Table 3).

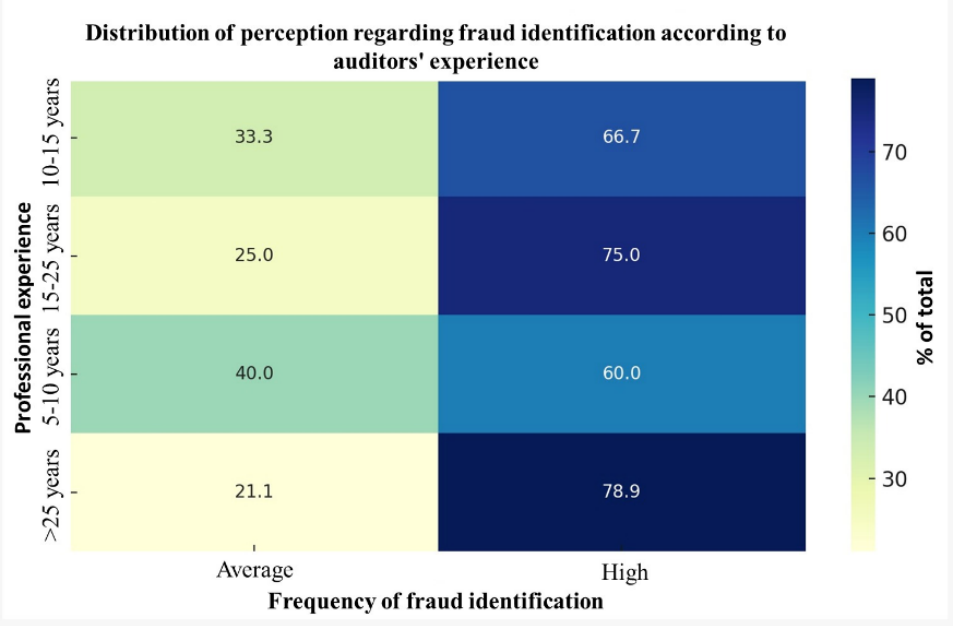
Table 3. The statistical test applied Experience * Frequency of Fraud Identification

		Frequency of Fraud Identification
Experience	Spearman's rho Correlation coefficient	0.497
	Sig. (2-tailed)	0.001
	N	268

The results highlight a moderate positive correlation between auditors' professional experience and the frequency of fraud detection using advanced methods. The Spearman coefficient value $\rho = 0.497$ indicates that, as the level of experience increases, auditors are more likely to detect fraud, suggesting an increased familiarity with analytical techniques and

professional approaches. Also, the high statistical significance ($p < 0.01$) confirms that this relationship is not a random one and can be generalized to the investigated population. Therefore, the research hypothesis is statistically validated: auditors with higher experience report a greater ability to detect fraud, most likely attributable to the use of modern and sophisticated audit methods.

Figure 2. Distribution of perception regrading fraud identification according to auditors` experience



To test the second hypothesis, according to which the integration of emerging technologies contributes significantly to increasing the efficiency of the audit process and reducing the risks associated with misstatements, a Pearson correlation analysis was performed, the results of which are presented in Table 4.

Table 4. Analysis of Pearson correlations between variables specific to digital technologies and their role in audit activity

		RPA	Big Data	Blockchain	ERP	Forensic Accounting	Economic security	Financial audit	Efficiency of statistical methods in fraud detection
AI	Pearson Correlation	0.728**	0.866**	0.668**	0.778**	0.350**	0.796**	0.767**	0.784*
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	N	268	268	268	268	268	268	268	268
RPA	Pearson Correlation	1	0.741**	0.844**	0.777**	0.635**	0.633**	0.610**	0.604*
	Sig. (2-tailed)		0.000	0.000	0.000	0.000	0.000	0.000	0.000
	N	268	268	268	268	268	268	268	268
Big Data	Pearson Correlation		1	0.643**	0.804**	0.349**	0.833**	0.818**	0.802*
	Sig. (2-tailed)			0.000	0.000	0.000	0.000	0.000	0.000
	N		268	268	268	268	268	268	268
Blockchain	Pearson Correlation			1	0.719**	0.587**	0.553**	0.508**	0.514*
	Sig. (2-tailed)				0.000	0.000	0.000	0.000	0.000
	N			268	268	268	268	268	268
ERP	Pearson Correlation				1	0.489**	0.737**	0.671**	0.666*
	Sig. (2-tailed)					0.000	0.000	0.000	0.000

		RPA	Big Data	Blockchain	ERP	Forensic Accounting	Economic security	Financial audit	Efficiency of statistical methods in fraud detection
	N				268	268	268	268	268
Forensic Accounting	Pearson Correlation					1	0.354**	0.289**	0.299*
	Sig. (2-tailed)						0.000	0.000	0.000
	N					268	268	268	268
Economic security	Pearson Correlation						1	0.828**	0.849*
	Sig. (2-tailed)							0.000	0.000
	N						268	268	268
Financial audit	Pearson Correlation							1	0.944*
	Sig. (2-tailed)								0.000
	N							268	268
Efficiency of statistical methods in fraud detection	Pearson Correlation								1
	Sig. (2-tailed)								
	N								268

**. Correlation is significant at the 0.01 level (2-tailed).

The results indicate the existence of statistically significant and strong association relationships between the main digital technologies (AI, RPA, Big Data, Blockchain, ERP) and indicators relevant to financial audit activity, economic security and the efficiency of statistical methods for fraud detection, with correlation coefficients ranging between 0.668 and 0.866 ($p < 0.01$).

In particular, artificial intelligence (AI) shows positive and strong correlations with the efficiency of statistical methods for fraud detection ($r = 0.784$), financial audit ($r = 0.767$) and economic security ($r = 0.796$), suggesting a significant impact on these dimensions of the audit process. RPA and ERP also highlight relevant roles in strengthening audit and forensic accounting activities, through high values of correlation coefficients ($p < 0.01$).

At the same time, positive, but more moderate, association relationships are observed between forensic accounting and the other indicators, suggesting an indirect influence of these technologies in the processes of identifying misstatements. Given these results, hypothesis I_7 is partially validated, since, although most of the emerging technologies analyzed correlate significantly with the efficiency of the audit process and the identification of misstatements, the magnitude of these correlations varies depending on the specific technology and the dimension analyzed.

The validation of hypothesis 3, according to which the quality of information in the content of financial statements has a significant importance in limiting and proving the risk of fraud, was carried out by analyzing the Spearman correlation coefficient (ρ), appropriate for analyzing relationships between ordinal variables. The results highlight the existence of positive and statistically significant correlations between the perception of the quality of financial information (I_7) and the variables associated with proving the risk of fraud (I_8) and preventing errors or misstatements (I_{15}).

More specifically, the strong correlation between I_7 and I_8 ($\rho = 0.872$, $p < 0.01$) indicates a consistent association between the quality of financial reporting and the ability to identify or support the existence of fraud risk, suggesting that relevant and well-structured financial information can facilitate the detection of anomalies. Also, a moderate correlation is noted between I_7 and I_{15} ($\rho = 0.625$, $p < 0.01$), which shows that quality information also contributes to limiting accounting errors, even if this relationship is somewhat less intense compared to the one regarding fraud.

The correlation between I_8 and I_{15} ($\rho = 0.620$, $p < 0.01$) further supports the idea that error prevention and proving fraud risks are interdependent processes, both being influenced by the quality and transparency of the information presented in the financial statements.

Therefore, hypothesis 3 is confirmed, the results indicating that a high level of financial information quality plays an essential role in the audit process, both in terms of identifying fraud risks and in reducing accounting errors.

Table 5. Correlations between the quality of information in the content of financial statements and the evidence of fraud risk

			I_7	I_8	I_{15}
Spearman's rho	I_7	Correlation coefficient	1.000	0.872**	0.625**
		Sig. (2-tailed)	.	0.000	0.000
		N	268	268	268
	I_8	Correlation coefficient	0.872**	1.000	0.620**
		Sig. (2-tailed)	0.000	.	0.000
		N	268	268	268
	I_{15}	Correlation coefficient	0.625**	0.620**	1.000
		Sig. (2-tailed)	0.000	0.000	.
		N	268	268	268
**. Correlation is significant at the 0.01 level (2-tailed).					

The correlation analysis performed for hypothesis 3 highlights the fact that the quality of information in the content of financial statements plays a significant role in limiting the risks of fraud and errors, thus confirming its importance in the financial audit process. The strong correlations between the studied variables suggest that clear and precise financial information contributes not only to the identification and proof of fraud risks, but also to the prevention of accounting errors. These results emphasize the need to improve the quality of financial reporting as an essential measure to ensure the transparency and integrity of financial processes, thus supporting a more effective control over the risks of fraud and misstatements.

5. CONCLUSIONS

The purpose of this empirical research was to analyze the possibilities of improving the methods and practices in financial auditing to prevent misstatements in the financial statements of the Municipality of Bucharest and the South-Muntenia Region. As a finding of the research conducted, we consider that through the analyses performed and the results presented, we offer auditors, but also managers of economic entities practical and useful recommendations for the implementation and integration of new information technologies in the activities carried out, for limiting the occurrence of errors, fraud and financial misstatements, as well as for determining the risk of accounting manipulation. Thus, the empirical research aims to help the entities included in the study to improve their methods and practices used in auditing and to help implement emerging technologies.

To improve methods and practices in financial auditing to prevent misstatements in situations, we believe that financial auditing activity requires the calculation of financial, non-financial and impact indicators because, by analyzing their evolution over time, the financial auditor can understand the most recent events and the financial condition of the audited entity.

Financial statements can often be misrepresented as a result of human error or fraudulent action, which negatively affects the audited financial statements. In this context, financial auditing is an essential process in evaluating information, in order to eliminate cases of fraud, corruption and misrepresentation of financial statements. Auditors provide reasonable assurance that financial statements are or are not materially misstated as a result of fraud or error. The concept of fraud is an intentional act committed, which has as its main purpose to obtain an advantage and as a result lead to the distortion of financial information. Unlike fraud, error is an unintentional act, which may occur inadvertently or as a result of the incompetence

of a third party and may have repercussions on the financial statements. Thus, in order to detect fraud or error in a financial audit, the external auditor must have the necessary knowledge, be familiar with international accounting and auditing standards, and use effective techniques to discover irregularities.

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CHANGE READINESS FOR ORGANIZATIONAL CHANGE MANAGEMENT - A CASE FOR AN INDUSTRY FOOD ORGANIZATION FROM ROMANIA

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ABSTRACT: *Organizations worldwide face intense competition because of changes in their work processes, products, and services. Employee willingness and behavioral and attitudinal changes are key to adapting to change. The successful implementation of change is contingent upon the organization's readiness for change. The food sector in Romania is constantly changing due to a combination of external factors such as industry and market trends, governmental laws, and customer expectations. Under these circumstances, project management and change management become essential to the success of businesses in this industry. The industry urgently needs to improve its current performance to increase productivity and satisfy project clients' complex and varying needs. This study scrutinizes an organization's readiness for change, focusing on the dimensions of change effectiveness and commitment. It draws from a comprehensive survey conducted among staff members, which examined crucial factors such as employee attitudes toward change. These attitudes perceived organizational support, communication effectiveness, and leadership involvement play a pivotal role in successful change management. They are not just components but the driving force behind a competitive edge through the high performance of their employees.*

Keywords: *organizational culture, organizational performance, change management, organizational change, organizational readiness for change, change efficacy, change commitment.*

JEL Classification: *D23, L66, M14*

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1. INTRODUCTION

Overseeing the change process is as crucial as the change itself. Employee willingness and behavioral and attitude changes are key to adapting to change. Changes implemented within an organization will eventually affect its systems, job responsibilities, procedures, and organizational structure. Various businesses engage in various actions to obtain the desired level of success. Many organizations struggle to adapt to changes in the unpredictable world of the economy despite being forced to make adjustments to survive (Varun & William, 1997).

Successful change management can improve the organization's overall performance and operations. Effective change management may provide significant value to the organization and may even become a prerequisite for a certain occupation.

Creating a sense of urgency to highlight the need for change, presenting people with data and evidence to convince them of the need for change, choosing the right individuals to form the guiding coalition, enlisting their support as a team, formulating a clear and concrete plan for change, building practical delivery methods, altering systems that stand in the way of the altered vision, recruiting, developing, and assuring the right people are chosen are all part of managing changes (Hemamalini, 2001).

Organizations are always changing, and this change is happening faster. Consequently, the ability to implement organizational transformation has evolved into a crucial strategic requirement. Organizations, to successfully implement the change management program, must achieve the desired objectives and improve the performance of an organization through different change management practices, addressing the human side systematically, involving everyone, communicating the vision, ensuring commitment from within, creating a clear and tangible vision for change, minimizing resistances to change and selecting the right people to guide alliance.

Leadership sets the direction, project managers handle the technical aspects of the change, and staff implements the changes. The core principle of change management is that how change is communicated can influence people's capacity to adapt. Their capacity to adapt to the change may be hindered if they reject it or misunderstand it, which could lead to recurring issues. If people are aware of the benefits of a change, they are more likely to support it and see it through to the end, which will lessen any bad consequences for the organization. Particularly, these variables would primarily decide an organization's performance; factors influencing organizational performance in this study will include organizational culture and employee motivation.

Top-level management will be the primary users of the study's results since they must understand how change preparedness affects an organization's performance and what other elements outside change management also affect an organization's overall performance. The study may offer pertinent data to help employees and managers at different levels comprehend the elements that must come together for change management to be implemented successfully and improve organizational performance. Employees may also benefit from the study's findings since their involvement in the change program's management can foster their creativity and increase their awareness of various challenges. The various modifications to the change management can meet the community's needs in various ways. Therefore, society can also benefit from this study. The study may also be consulted for future research as a source of literature.

2. LITERATURE REVIEW

Organizations must adopt new management techniques in the 21st century, which include qualities like a quality mindset, stakeholder focus, speed orientation, innovativeness,

flat structures, and cross-functionality (Wind & Maine, 1999). After the change has been accepted by senior management, it must be executed by middle and lower management. The degree to which individuals are cognitively and emotionally inclined to accept, embrace, and adopt a particular plan to alter the status quo purposefully is meant to be meant by readiness for change (Holt et al., 2007). Organizational members' commitment to change and their level of self-efficacy in implementing change is referred to as organizational readiness for change (Weiner, 2009).

Change readiness is influenced by shared cognitive beliefs that change is needed, that the work group or organization has the capability to successfully undertake change, and that change will have positive outcomes for the work group or organization and, at the same time by positive to an organizational change (Rafferty et al., 2013).

The ability to accept any new technology before its adoption has typically been measured using the term "readiness" (Bendi, 2017). However, the notion lacks a single definition because its meaning varies according to users, context, and circumstances (Tran et al., 2011; Luo and Goulding, 2010). The attitudes of change receivers and their ability to effectively plan, manage, and execute organizational change are crucial to the success of any initiative aimed at enhancing or transforming an organization (Anwar, 2017).

Implementing new procedures, processes, or policies that immediately impact the different stakeholders in a company is a common example of diverse alterations. Change management can succeed when the potential effects of the change initiatives on these stakeholders are recognized. A moral workplace culture boosts workers' emotional investment, sense of purpose, willingness to refer others, and overall job happiness. Organizational commitment has been linked to readiness for change. Visagie and Steyn (2011) investigated the relationship between employee attitudes toward change and organizational commitment levels and how employees view the change process.

Shifts in leadership have the potential to impact employee performance. A knowledgeable and competent leader may manage a company or the organizational transformation process more effectively and successfully (Abbas & Asghar, 2010). It is undisputable that for change to become successful, the organization’s leaders must also be committed and engaged.

According to Hans, Lawrence, and Andreas (2009), change management techniques in project or business operations have not substantially been uptake. When implemented effectively, change management techniques can provide businesses with observable advantages. The project success percentage of practitioners who strictly adhered to formal, defined change management procedures was 52%. In contrast, practitioners who adapt their methods based on the circumstances only achieved a 36% success rate.

Given how the business landscape is evolving, it is crucial to give more people the tools they need to become more powerful. Thus, management's involvement in a change project is as significant as that of the staff and project workers. On the other hand, managers also need to understand the value of allowing staff members to take their time, discover the organization's shortcomings independently, and ultimately look for and create solutions for a brighter future.

A shared understanding of an organization's objectives and direction can be achieved through communication. To convince everyone in the organization to make a change, there needs to be open and honest communication regarding the data, statistics, and supporting documentation. More than ever, workers need to know where they stand and what's coming up in very unstructured tasks. Resources might be allotted to completing secondary tasks instead of crucial phases and actions if not. The capacity to explain to staff members the kinds of changes the plan would undoubtedly bring about to each person's duties, functions, and working environment is a crucial component of successfully managing change.

According to Fatima, Alyaa, and Abdul Rahman (2013), people typically oppose change, so overcoming their objections and grabbing their attention by emphasizing how the change will contribute to their success and long-term development is crucial in building the governing coalition. Obtaining support from top management, potential stakeholders, and the organization is a prerequisite for the change manager. Implementing a change management program is not a simple task, nor should it be considered a "fast fix". Rationalize, educate, and provide change management training to employees to lessen resistance to planned change. This realization has always been necessary to break old patterns, but it now requires additional caution.

According to Daniel (1999), organizational culture is the collection of management practices and behaviors representing and upholding the fundamental values, ideas, and principles that form the basis of an organization's management system. According to Fred (2011), an organization's culture is its members' collective collection of values, norms, and beliefs that shape their attitudes, thoughts, and actions. Culture has more to do with an organization's informal than formal characteristics. They concentrate on how each member of the organization's values, beliefs, and conventions contribute to shared collective meanings. The need to comprehend and function more successfully within this unofficial sphere of teachers, support staff members, and other stakeholders' values and views is why culture is becoming increasingly important.

Depending on the circumstances, distinct organizational cultures may more or less support organizational change. The significance and evaluation of organizational culture's role and impact on change management cannot be overstated since an organization's culture can harm its overall performance (Song, 2011). In summary, controlling organizational culture or even modifying the approach to account for the culture in change management must be considered.

3. RESEARCH METHODOLOGY

The study was conducted on randomly selected employees, including team, middle, and top-level managers. To accomplish the goal of this study, a quantitative survey design was developed to investigate the direct and indirect effect of each predictor variable on the criterion variable. The study aimed to evaluate the organization's readiness for change and its impact on organizational performance, using a questionnaire-type opinion poll as a research tool by examining the relationship among change management practices, employees' motivation, organizational culture, and the performance of an organization. The population of the study was the employees of the organization. The representative sample of this study consisted of subsets of the population, which allowed the study results to be generalized. The sample population's characteristics were intended to represent the target population.

A five-point Likert scale questionnaire was used for data collection and divided into six parts. The participants rated five possible alternatives, and the following numeric values were assigned to the positively phrased questions: Strongly Agree = 5, Agree = 4, Neutral = 3, Disagree = 2, and Strongly Disagree = 1. All these items were used to determine the effect of change management practices on organizational performance and investigate the effects and relationships of employees' motivation and organizational culture on organizational performance.

The questionnaire was structured in seven sections. Thus, the first section intended to identify demographic data specific to the study participants, and the second section included five particular items related to how the organization supports change. The third section seeks to identify, through the five established items, how the respondents participating in the study understand the process of change in the organization; following that, in the fourth section, the

process of achieving the change is evaluated by identifying the style of communication of the change and the managerial support offered to facilitate the change. The fifth section focused on the employees' reactions to the change, and the items specific to the organizational culture and the organization's performance are analyzed in the final sections of the questionnaire.

This research examined the impact of organizational culture and employee motivation on an organization's overall performance and the implications of change preparedness on an organization's performance. The general objective of the research is to evaluate the organization's preparation for change and its impact on organizational performance. At the same time, the specific goals of the study aimed at: i) identifying the level of readiness of the organization for change, ii) evaluating employees' perceptions of the organization's ability to manage change, and iii) analyzing the relationship between change preparation and organizational performance. Thus, to fulfill the research's general objective and specific objectives, the following research hypothesis was established: Between the level of readiness for change identified at the level of the organization and organizational performance, there is a positive correlation.

The results obtained after collecting the questionnaires were processed and analyzed using the statistical program IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp.

4. RESULTS AND DISCUSSION

A sample of 124 employees from different departments and levels of the business filled out the questionnaire. Table 1 below shows the frequency distribution of the responses by age, service year in the company, and position within the organization.

Table 1. Demographic information of participants of the study

Biography	Frequency	%
Age		
<34 years	34	27.4%
35-44 years	29	23.4%
45-54 years	46	37.1%
55+ years	15	12.1%
Service year in this organization		
<3 year	19	15.3%
3-5 years	27	21.8%
5-10 years	45	36.3%
<10 years	33	26.6%
Position		
Team manager	36	29.0%
Middle level	49	39.5%
Top-level	39	31.5%

Source: author's processing

Table 1 above illustrates the frequency distribution of the respondents by age, showing that most of them (N= 46, 37.1%) were in the age category of 45 to 54 years. This category is the age group that can support and realize change ideas in the organization. Table 1 also indicates that the largest group (N=45, 36.3%) of the respondents had more than five years and less than ten years of service.

The first step in analyzing the research results was verifying the questionnaire's reliability. Thus, using the Alpha Cronbach coefficient, the questionnaire's items' internal

consistency was examined for the entire scale and each of its sections to conduct a reliability study and constructive validation (Table 2). The study's findings indicate an alpha coefficient of 0.979. The analysis of each part demonstrates strong intercorrelation between selected intimates, which displayed a fluctuation of the coefficient between 0.741 and 0.953.

Table 2. Descriptive analysis of the viability questionnaire

Domains	No. of item	Cronbach`s Alpha	Mean	Variance
Support change	5	.900	18.6129	24.825
Understand change	5	.864	18.3226	23.570
Realize change	6	.912	22.2258	31.851
Employee Motivation	6	.895	21.1935	32.418
Organizational Culture	8	.953	29.0968	65.194
Financial Performance	4	.741	13.7097	14.191

Source: author's processing

To analyze the change readiness at the level of the organization participating in the study, several essential aspects of this process were taken into account, including how the management of the organization supports the change, the understanding of the change among employees but also among management and effectively the process of achieving change, but also the role of organizational culture. The items included in the questionnaire and the descriptive statistics in the form of minimum, maximum, average, standard deviation, and standard error are presented in Table 3. The minimum values of the scores obtained for the questionnaire sections are in the range of 1.40 – 1.83, while the maximum value is 5.00 for all six sections. We notice that the section with the highest average obtained from a statistical point of view is the one that aimed at the support of the change, obtaining the value of 3.72.

Analyzing the answers of each section individually, the highest scores in supporting change were the items that refer to the existence of encouragement and the constant adoption of new and better working methods within the organization, as well as whether company employees receive assistance to achieve when change is necessary to take advantage of new opportunities. On the same note, for a good understanding of changes, it was a stated agreement that the change team includes members with significant positional influence, a wide range of skills, and a high degree of trust. To realize the change, imperative or not, the study participants stated that various departments of the companies frequently work together to bring change.

Table 3. Descriptive statistics of the questionnaire`s items

Domains	N statistic	Rage Statistic	Minimum Statistic	Maximum Statistic	Mean Statistic	Std. Error
Support change	124	3.60	1.40	5.00	3.7226	0.8949
Understand change	124	3.40	1.60	5.00	3.6645	0.8720
Realize change	124	3.50	1.50	5.00	3.7048	0.8441
Employee Motivation	124	3.17	1.83	5.00	3.5319	0.8527
Organizational Culture	124	3.37	1.63	5.00	3.6394	0.9065
Financial Performance	124	3.43	1.80	5.00	3.4387	0.8225

Source: author's processing

The employees' perception of organizational change, in a context where the company is well prepared for change, the change teams are competent, and the process is well supported and communicated, is generally positive, as also results from the scores of the items regarding this aspect. This situation creates a conducive framework for adopting change, reducing the resistance and uncertainty that can arise in such processes. The correlation between the analyzed variables explains the strength and direction of the relationship between them based on the measurement of the correlation coefficient. The most used statistical correlation coefficient is the Pearson, which measures the relationship between two variables. Regarding the correlation relationship at the level of the items analyzed by the questionnaire sections, a positive correlation can be observed at the level of all the analyzed sections. A positive and strong correlation is evident between the specific items of supporting change and understanding change, as well as between supporting change and achieving change. At the same time, organizational culture has a positive and directly proportional relationship with supporting change (r = 0.826) and employee motivation (r = 0.800).

Table 4. Pearson correlations

Domains	Support change	Understand change	Realize change	Employee Motivation	Organizational Culture	Financial Performance
Support change	1	**.820****	**.882****	.728**	**.826****	.770**
Understand change		1	**.866****	.633**	.687**	.772**
Realize change			1	.701**	.747**	**.802****
Employee Motivation				1	.800*	.649**
Organizational Culture					1	.769**
Financial Performance						1

***Correlation is significant at the 0.01 level (2-tailed).*

An important role of these statistical correlations is understanding the relationship between the study variables in order to validate the research hypotheses. As can be seen between the achievement of change and financial performance, there is a strong and positive dependency relationship (r=0.802), thus validating this study's research hypothesis.

During the assessment of change readiness in the organization studied, the culture of supporting and realizing change seems to be the major factor leading towards the right direction and achieving organizational performance. Awareness of why the change is needed and a high level of commitment, communication, and participation at all managerial levels are critical to the success of the change process.

Similar studies have also highlighted that the way change is carried out in the organization impacts organizational performance. Thus, the positive impact of change is reflected in employee confidence, organizational growth, and competitive advantage (Asikhia et al., 2021). At the same time, Nwinyokpugi (2018) highlights the link between change communication, change identification, and employee involvement with employee productivity and recommends implementing changes from top management to employees clearly and consistently. Therefore, preparation for organizational change is an important factor in stimulating innovation and implementing new projects and can influence the organization's financial performance.

5. CONCLUSIONS

An efficient approach to change management involves methodically arranging every individual to directly affect the attitudes and behaviors of employees in a way that helps the organization realize its competitive goal. Managers and other leaders have a significant impact on employees' behavior in the workplace, which makes them crucial agents of change and its administration.

Organizational change readiness and competent teams provide reassurance that the management change process is well managed, which can reduce anxiety and fears about change. Effective communication and constant support make employees feel part of the process and are more motivated to contribute to the implementation of change actively. When change is well planned and supported, employees will perceive less discomfort and uncertainty, reducing the tendency to resist change. Even if the change involves adjustments, the support provided and the clarity of the process communicated help employees see the change as an opportunity, not a threat. In conclusion, in such a setting, employee perception will be predominantly positive, facilitating a smoother transition and successful implementation of organizational change.

Any change within an organization is not an easy task for the organization or its employees. Initially, employee resistance is the main factor for change implementation, and obviously, this resistance will impact employee performance. Organizations cannot change anything without the involvement of employees. Employee readiness is the key to successfully adapting organizational change for the efficient growth of the organization. Change management can be implemented through employee willingness to change their behavior and attitude through training and to motivate them to come out of their comfort zone for organizational change. Leadership role plays an important role in implementing organizational change. Leaders can create a supportive and friendly environment for the employees where they can easily participate in decision-making or other organizational matters; when employee morals remain high, the better their performance will be and the same way they will never hesitate to adopt the change or be ready themselves for any kind of organizational change. Organizational change can be made possible in the way the firm needs by getting the employees' willingness first for a change and then getting employees' confidence for their readiness for change. Ultimately, this is going to impact employee performance, organizational growth, and productivity.

Further research on change management is needed to gain a wider perspective on the food industry in Romania, involving other organizations with similar superior financial and non-financial performances.

In conclusion, assessing change readiness for organizational change management in a Romanian food industry organization is critical to ensure successful transformation. The process involves evaluating internal and external factors that impact the organization’s ability to adapt and implement change effectively. Internally, this includes assessing the organization's culture, leadership, employee engagement, and available resources. Externally, market trends, regulatory requirements, and economic conditions within Romania and the broader European context play a significant role.

Moreover, Romania’s food industry faces unique challenges, such as fluctuating demand, regulatory shifts related to EU food safety standards, and evolving consumer preferences. These challenges must be factored into the readiness assessment to align the change initiatives with broader industry trends.

Successful change readiness assessment ultimately leads to more informed decision-making, tailored change strategies, and a greater likelihood of achieving long-term sustainability and competitiveness within the Romanian food sector.

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THE EVALUATION OF FINANCIAL PERFORMANCE AS A PREVENTION MECHANISM AND PREDICTIVE INSTRUMENT OF BANKRUPTCY RISK

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ABSTRACT: *In an economic environment marked by volatility and uncertainty, financial performance is a fundamental element in assessing the stability and sustainability of organisations. The early detection of financial vulnerabilities requires integrating financial performance into a predictive framework, where changes in factors such as profitability, liquidity, and financial leverage can signal an increased probability of significant difficulties. Consequently, financial performance becomes not only a reflection of past outcomes but also a prevention mechanism and a predictive instrument that aids decision-makers in implementing timely corrective actions. This study aims to analyse the role of financial performance assessment as a prevention mechanism and predictive instrument for bankruptcy risk by identifying and testing the predictive capacity of key financial indicators. This research highlights how financial performance can contribute to the development of effective early warning systems, which can support organisations ' risk management and strengthen their long-term sustainability.*

Keywords: *financial performance, financial distress, bankruptcy, financial indicators, Composite score, Altman Z'-Score*
JEL Classification: *M41*

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1. INTRODUCTION

Global financial markets have been marked by volatility and uncertainty for the last years. The Global Financial Crisis demonstrated that the persistent build-up of debt contributes to greater financial fragility and potentially negative results, which could affect the sustainability of a business. These risks have been consistently highlighted by the economic fallout from the COVID-19 pandemic, which has led to extensive economic slowdowns and financial strain that persist across many parts of the world (Issa et al., 2024). Predicting bankruptcy is one of the most important tools for analysing financial performance to avert company failure, which could lead to a systemic collapse of the economy. Bankruptcy has far-reaching implications, affecting supply chains, employment, shareholders, and investors (Rahayu et al., 2024).

Bankruptcy occurs when a company in financial distress is unable to meet its obligations, such as repaying its due liabilities, paying salaries, and meeting the due date for tax payments. Financial distress is often caused by internal failures, such as poor management, economic downturns, industry decline, decreased demand for the industry's products or services, falling revenues and profit margins, and a reduction in employment and investment. While financial distress determined by internal causes can be avoided by conducting countermeasures at an early stage, the external causes cannot be influenced by the target company (Habermann & Fischer, 2023). According to Toudas et al. (2023), the term "bankruptcy" or "insolvency" implies a negative return for a business, referring to a situation where a company is unable to meet its current payment obligations, indicating a lack of liquidity. The technical measurement of bankruptcy should be based on net cash flow concerning short-term liabilities, rather than the working capital measure. Legal insolvency, often associated with bankruptcy, extends beyond payment incapacity and involves a comprehensive assessment of a company's total liabilities relative to the fair value of its total assets. A business is typically deemed legally insolvent or bankrupt when its liabilities exceed the fair value of its assets, resulting in negative equity and sustained loss of solvency. While payment incapacity may be temporary and reversible, bankruptcy reflects a critical and chronic condition. Technical insolvency may be straightforwardly identified in clear-cut cases, whereas complex situations, such as severe conditions, often require in-depth analysis, initiating asset liquidation procedures (Altman & Hotchkiss, 2006).

In this context, the assessment of financial performance emerges as a necessary preventive measure to avoid bankruptcy. Financial performance, encompassing profitability, liquidity, and leverage, offers a multidimensional assessment of a company's operational and financial health (Brigham & Houston, 2018). Regular monitoring of these indicators enables companies to detect early signs of financial distress, allowing for timely corrective actions before financial challenges escalate into bankruptcy. Despite its significance, many companies focus on ex-post corrective measures, addressing financial distress only after imbalances arise, rather than utilising ex-ante evaluation for proactive risk management. This stress on proactive risk management is crucial for the survival and success of any business (Altman & Hotckhkiss, 2006).

Given the increasing need for systematic methods to identify potential bankruptcy risks, the application of quantitative models for bankruptcy prediction has become important in both academic research and practical financial management (Sun et al., 2014). Among these models, the Altman Z-Score is notable for its widespread use and interpretability, as it effectively combines key financial ratios to evaluate a company's likelihood of bankruptcy. However, advanced predictive methods, including machine learning algorithms and ultimate ownership networks, have gained popularity in recent years. Traditional models, such as the Z-Score,

continue to be valuable due to their simplicity, transparency, and proven effectiveness in delivering early warning signals for financial distress (Rayadu et al., 2025).

Despite extensive research on financial performance indicators and bankruptcy prediction models, there is limited focus on systematically linking the evaluation of financial performance with proactive bankruptcy prevention, particularly within the Romanian corporate environment (Altman et al., 2017). Additionally, there is a scarcity of longitudinal studies examining the evolution of bankruptcy risk at the company level, using extended periods to monitor trends and identify early vulnerabilities (Bellovary et al., 2007).

To address these gaps, this study aims to validate the relationship between financial performance and bankruptcy vulnerability by employing the Altman Z'-Score as a predictive tool within a preventive financial management framework (Altman & Hotchkiss, 2006).

The remainder of the paper is structured as follows: Section 2 presents a review of the literature on financial performance and bankruptcy prediction models. Section 3 presents the objectives and the hypothesis for the study. Section 4 outlines the methodology used in collecting the data for the study. Section 5 discusses the results and their implications, while Section 6 concludes with practical recommendations for corporate financial management and suggestions for future research.

2. LITERATURE REVIEW

2.1. Financial performance as a Predictor of Corporate Stability

Financial performance is widely recognised as a significant indicator of a company's operational efficiency and long-term sustainability. It encompasses profitability measures such as Return on Assets (ROA) and Return on Equity (ROE), liquidity indicators like the Current Ratio (CR), and leverage metrics that capture a company's financial structure and risk exposure (Mahmudi & Khaerunnisa, 2023).

Profitability indicators, such as ROA and ROE, reflect the company's capacity to generate earnings relative to its assets and equity (Brigham & Houston, 2018). Consistent profitability suggests effective management, operational efficiency, and a greater ability to withstand economic downturns, thereby reducing the likelihood of financial distress (Ahmad, 2024). In contrast, declining profitability often signals operational inefficiencies or external pressures that may lead to financial instability.

Liquidity ratios, such as the CR, indicate a company's ability to meet its short-term obligations using its current assets. Adequate liquidity provides a buffer against unexpected financial shocks and operational disruptions, supporting the company's resilience in times of economic uncertainty (Mahmudi & Khaerunnisa, 2023). Low liquidity levels, on the other hand, may indicate potential difficulties in meeting obligations, serving as an early warning signal for financial distress.

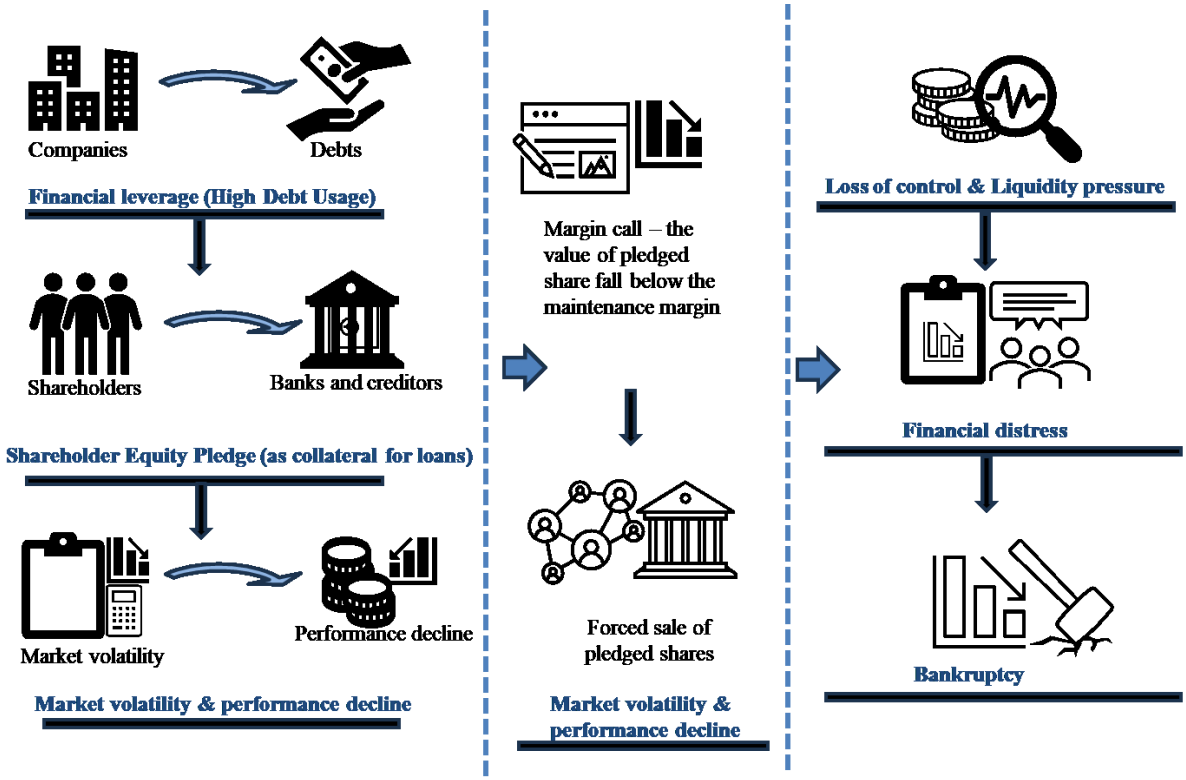
Leverage indicators measure the degree to which a company utilises debt to finance its operations. While leveraging can enhance returns during profitable periods, high leverage increases financial risk, particularly during downturns, as companies face higher debt servicing obligations regardless of operational performance (Altman et al., 2017). Monitoring leverage levels enables companies and stakeholders to assess the risk of insolvency under various economic scenarios (Issa et al., 2024).

A factor influencing corporate financial stability is the pledge of shareholders' equity. A shareholder equity pledge refers to the practice in which major shareholders use their equity holdings as collateral to secure loans, aiming to obtain liquidity while maintaining control over the company's ownership (Liu et al., 2022). Although this practice can provide immediate financial flexibility for shareholders, it introduces significant risks for the company's stability.

Firstly, the pledge of shares exposes the company to risks associated with market volatility. A decline in the company's performance may lead to a drop in stock prices, triggering margin calls that require the forced sale of shares that have been pledged. Such forced transactions can further depress stock prices, erode investor confidence, and potentially result in a loss of control over the company's governance structure (Liu et al., 2022). Secondly, shareholders under financial pressure may resort to aggressive expansion or related-party transactions using the borrowed funds, increasing the company's exposure to operational and investment risks (Issa et al., 2024). This dynamic not only amplifies the financial leverage indirectly but also accelerates the company's progression toward financial distress, particularly if the pledged shares lose value and shareholders fail to meet repayment requirements (Liu et al., 2022).

The interaction between high financial leverage and shareholder equity pledge practices creates a compounded risk, escalating the company's vulnerability to financial distress and bankruptcy during adverse market conditions. Figure 1 illustrates this conceptual relationship, highlighting how the combination of these factors can contribute to the pathway leading to the risk of bankruptcy.

Figure 1. The relationship between financial leverage, shareholder equity pledge, and corporate bankruptcy risk



Companies need to conduct financial performance analysis to detect early signs of potential bankruptcy, allowing them to identify contributing factors and take preventive measures to avoid or mitigate the risk of bankruptcy (Issa et al., 2024; Altman et al., 2017). Bankruptcy does not occur suddenly; instead, it is preceded by identifiable indicators. The risk of bankruptcy can be observed and measured through a company's financial statements, allowing for the anticipation of future challenges (Sinaga et al., 2019). Measuring a company's financial performance can be achieved by systematically analysing periodic financial statements, which provide critical insights into the company's current financial condition and future outlook (Mahmudi & Khaerunnisa, 2023). Numerous bankruptcy prediction models

have been developed globally. Tools like the Altman Z-score have proven effective in detecting early warning signals of financial distress, offering high predictive accuracy while remaining practical for companies seeking to prevent bankruptcy. The Altman Z-score predicts bankruptcy based on a company's financial ratios, providing a straightforward application with an accuracy rate of up to 95% in predicting bankruptcy risk (Rahman et al., 2021).

2.2. Financial Distress and Bankruptcy Prediction Models

Financial distress represents a transitional phase between financial health, which refers to a company's ability to meet its financial obligations and maintain a stable financial position, and bankruptcy, during which companies fail to meet financial obligations but have the potential to recover (Volkov et al., 2017).

In the specific literature, financial distress has been defined in various ways, most of them describing the company's inability to meet its debt obligations, which may lead to bankruptcy, liquidation, or asset seizure and distribution (Sun et al., 2002; Ikpesu, 2019; Ray, 2011). Companies experiencing financial distress often incur higher costs than financially healthy companies, which may reduce a company's value through both direct and indirect channels (Dou et al., 2021). Direct costs include expenses during legal bankruptcy processes, such as attorney's fees, administrator remuneration, and other legal costs, while indirect costs represent hidden losses due to temporary liquidity issues (Farooq & Jibran, 2018).

Assessing financial distress is crucial in credit risk management, as it enables financial institutions to safeguard themselves against borrower defaults, comply with regulations, manage their portfolios effectively, and maintain systemic stability. It helps banks decide whom to lend to, under what circumstances, and how to mitigate potential losses, forming a core pillar of prudent banking operations (Farooq et al., 2023).

Bankruptcy represents the final stage of financial distress, occurring when companies have exhausted a viable recovery pathway (Farooq et al., 2023). However, not all financially distressed companies proceed to insolvency, as some can navigate out of distress through effective restructuring and prudent financial management strategies. This perspective is supported by studies that highlight the significant influence of the asset structure and liability composition of companies on the success of voluntary restructuring efforts, thereby preventing insolvency (Cheng Ee Wan et al., 2021; Wang & Liu, 2024). Specifically, lower equity levels, excessive leverage, and unstructured debt tend to increase the likelihood of involuntary business exit. In contrast, companies with stronger corporate governance frameworks and diversified asset portfolios demonstrate improved prospects for recovery (Farooq et al., 2023; Altman et al., 2017). Furthermore, Kou et al. (2021) emphasise that the early detection of financial distress through advanced predictive models enables timely interventions, thereby reducing the risk of bankruptcy. Collectively, these insights align with the argument that while financial distress often precedes insolvency, strategic restructuring and effective financial management practices can facilitate recovery, allowing companies to avoid bankruptcy as the ultimate stage of financial decline (Farooq et al., 2023).

Effective identification and management of financial distress can enable companies to recover, thereby preventing bankruptcy as the terminal stage of financial decline (Altman et al., 2017). Given the severe implications of bankruptcy for stakeholders and the economy, considerable scholarly attention has been devoted to developing models that can predict financial distress early, allowing companies and financial institutions to take preventative measures (Faroog et al., 2023; Sun et al., 2014).

Over the years, many methods have been developed to assess the financial distress risk of companies, reflecting the evolution from traditional to more advanced predictive approaches. Ratio-based models utilise financial indicators such as liquidity, leverage,

profitability, and activity to assess bankruptcy risk (Rahman et al., 2021). The Altman Z-Score Model, which combines five financial ratios using discriminant analysis, has been widely adopted due to its simplicity and predictive capabilities (Altman et al., 2017). Similarly, the Springate Model adopts this approach, using four ratios (Springate, 1978, as cited in Grice & Ingram, 2001), while the Grover Model modifies the Z-score to improve prediction accuracy within manufacturing industries (Indriyanti, 2019). Although these models offer ease of application for practitioners, their predictive power may vary across industries and accounting environments (Rahman et al., 2021). The traditional Altman Z-Score Model was developed using multivariate discriminant analysis, resulting in the Zeta model, which consists of seven variables: return on assets, stability of earnings, interest coverage, cumulative profitability, liquidity, capitalisation, and size (Rahman et al., 2021).

Statistical models apply logistics and probit regressions to predict bankruptcy probabilities based on financial ratios. The Ohlson O-Score Model, created in 1980 (Ohlson, 1980), and the Zmijewski Model (Zmijewski, 1984) are prominent examples within the category of statistical models used for bankruptcy prediction, providing interpretable probabilities that assist stakeholders in understanding default risk (Rahman et al., 2021; Michalkova & Ponisciakova, 2025).

The emergence of machine learning models has enhanced the predictive accuracy of bankruptcy prediction by capturing complex, non-linear relationships within financial and non-financial data. Techniques such as Random Forest, Support Vector Machine, Artificial Neural Networks, and Deep Learning have been employed to improve classification performance in bankruptcy prediction (Shetty et al., 2022). Several studies have demonstrated that machine learning models substantially enhance bankruptcy prediction accuracy, providing valuable tools for stakeholders seeking timely and reliable assessments of bankruptcy risk (Barboza et al., 2017; Adnan and Dar, 2006, as cited in Shetty et al., 2022).

Hybrid and ensemble models integrate traditional statistical or ratio-based approaches with machine learning to increase prediction robustness and accuracy. These models combine the interpretability of classical approaches with the predictive power of advanced techniques, addressing the limitations inherent in relying on a single method (Sun et al., 2014). Hybrid frameworks may incorporate financial ratios derived from models such as Altman's Z-Score or Ohlson's O-Score as inputs into machine learning classifiers, thereby preserving domain-specific interpretability while improving predictive performance. Ensemble methods, such as bagging, boosting and stacking, aggregate multiple model predictions to reduce variance and bias, addressing the limitations inherent in using a single predictive approach (Barboza et al., 2017; Ling & Wang, 2024). This integration enables stakeholders to conduct a more reliable assessment of financial distress risk, thereby supporting early intervention and informed decision-making in corporate risk management (Ling & Wang, 2024).

Despite the allure of advanced machine learning techniques, the study by Shetty et al. (2022) demonstrated that simple models using three easily obtainable financial ratios (ROA, current ratio, and solvency ratio) can achieve high prediction accuracy (around 81%), comparable to more complex methods. This finding not only underscores the reliability of these simple models but also their practicality and attractiveness as tools in assessing bankruptcy risks.

3. METHODOLOGY

The primary objective of this study is to explore the role of financial performance evaluation as a preventive mechanism and predictive tool for bankruptcy risk within corporate financial management. By applying the Altman Z-Score model in conjunction with key financial performance indicators, such as profitability, liquidity, and leverage, over thirteen

years for a Romanian company, the study aims to validate the relationship between declining financial performance and the increasing risk of financial distress and bankruptcy. The potential impact of this research is significant, as it can provide a robust framework for early detection and prevention of financial crises in corporate finance, thereby contributing to the stability and sustainability of businesses.

Hypothesis 1: There is a significant relationship between the evolution of financial performance indicators and the Altman Z'-Score over time, indicating that declining financial performance increases the risk of financial distress or bankruptcy.

Hypothesis 2: The Altman Z'-Score can be used as an effective early warning tool for predicting bankruptcy risk and guiding preventive financial management.

This study employs a quantitative research design, allowing for the systematic measurement and analysis of numerical data to identify patterns and relationships between financial performance indicators and bankruptcy risk (Creswell & Creswell, 2018). The study also utilises a longitudinal analysis, a method that has been proven to be particularly effective in capturing the dynamic nature of financial health over time (Altman et al., 2017). This approach, compared to cross-sectional methods, enables the observation of temporal trends and cause-effect relationships, thereby facilitating a more accurate assessment of how financial performance evaluation can predict and prevent bankruptcy (Issa et al., 2024). The effectiveness of this method provides reassurance and confidence in the study's findings.

Financial ratios play a pivotal role in bankruptcy analysis, serving as a grounded quantitative means to evaluate a company's financial health and potential distress (Issa et al., 2024). By leveraging these ratios, early warning indicators of financial distress can be identified, trends reflecting potential deterioration can be monitored, and comparative assessment with industry peers can be conducted. The financial ratios summarised in Table 1 have been selected as part of the initial analysis framework within this study, providing a comprehensive understanding of the company's financial standing.

Table 1. Financial ratios

Ratio	Category	Formula	References
Return on Assets (ROA)	Efficiency and Profitability Ratios	$ROA = \frac{\text{Net Profit}}{\text{Average Total Assets}} \times 100$	(Asiani & Rahayu, 2024)
Return on Equity (ROE)		$ROE = \frac{Net\ Profit}{Equity} \times 100$	(Handayani & Winarningsih, 2020)
Net Profit Margin (NPM)		$NPM = \frac{Net\ Profit}{Turnover} \times 100$	(Handayani & Winarningsih, 2020)
Current Ratio (CR)	Liquidity Ratios	$Current\ Ratio = \frac{Current\ Assets}{Current\ Liabilities}$	(Asiani & Rahayu, 2024)
Quick Ratio (QR)		$Quick\ Ratio = \frac{Current\ Assets\text{-}Inventory}{Current\ Liabilities}$	(Issa et al., 2024)
Cash Ratio (CR)		$Cash\ Ratio = \frac{Cash\ \&\ Cash\ Equivalents}{Total\ Current\ Liabilities}$	(Indah et al., 2023)
Debt to Equity Ratio D/E Ratio	Leverage	$D/E\ Ratio = \frac{Total\ Debt}{Shareholder's\ Equity}$	(Indah et al., 2023)
Debt Ratio		$Debt\ Ratio = \frac{Total\ Debt}{Total\ Assets}$	(Indah et al., 2023)
Debt to EBITDA (D/EBITDA Ratio)		$Debt\ to\ EBITDA\ Ratio = \frac{Total\ Debt}{Total\ EBITDA}$	(Issa et al., 2024)

For the empirical analysis (Figure 2), the focus is placed on the seven primary indicators – NPM, ROA, ROE, CR, D/E Ratio, Debt Ratio and Debt to EBITDA Ratio – used to conduct analyses for hypothesis testing. The additional indicators presented in table no. 1 remain valuable for scholars and researchers, serving as useful tools for broader financial performance evaluation and bankruptcy prevention strategies.

Figure 2. Methodological Framework for Testing the Relationship between Financial Performance and Bankruptcy Risk

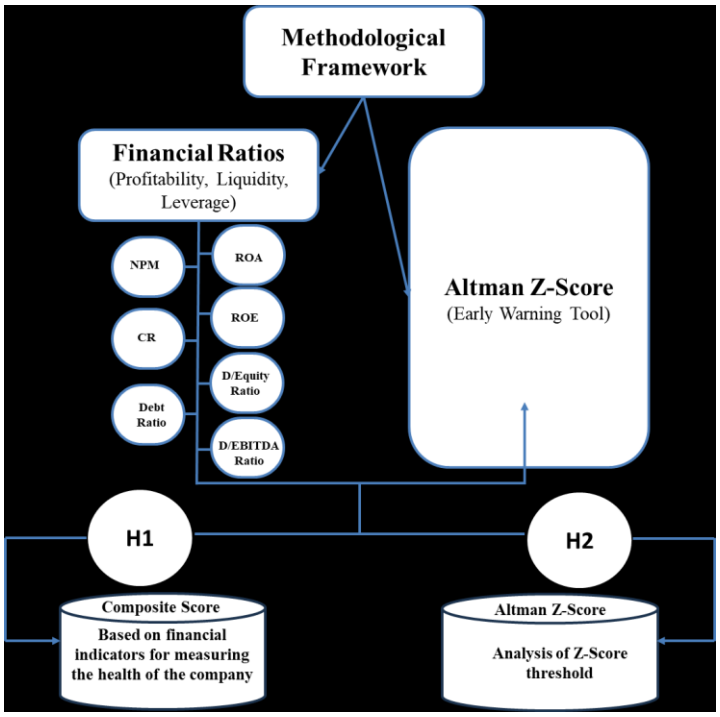


Figure 2 illustrates the comprehensive methodological framework adopted in this study, which integrates seven financial indicators – NPM, ROA, ROE, CR, D/E Ratio, Debt Ratio and Debt to EBITDA Ratio – along with the Altman Z'-Score as an early warning tool. H1 is examined through the construction of a standardised composite score based on these financial ratios, aiming to assess the overall financial health of the company and its capacity to prevent bankruptcy. H2 evaluates the predictive relevance of the composite score and key financial metrics. This combined approach enhances the understanding of financial vulnerability and strengthens early detection mechanisms. Therefore, to evaluate the company's financial performance and anticipate bankruptcy risk beyond the classical models, a composite score was constructed using financial indicators. Composite financial scores have been successfully applied in diverse settings. Jurado et al. (2024) introduce a Composite Indicator Based on Ratios (CIBOR), which aggregates multiple financial metrics into a unified stress indicator. Similarly, Sabău et al. (2021) construct a Composite Financial Performance Index from eight indicators using principal component analysis, demonstrating its predictive utility for company performance. The seven indicators selected for our study were designed to capture a multidimensional view of the company's financial health, encompassing profitability, liquidity, and leverage. To allow aggregation, each indicator was statistically standardised using the Z-score formula:

$$Z = \frac{X - \mu}{\sigma}$$

Where x is the individual value, μ is the mean of the series, and σ is the standard deviation (Hair et al., 2010). Given that higher values of leverage indicators (D/E Ratio, Debt Ratio, and D/EBITDA Ratio) signal greater financial risk, their standardised scores were multiplied by -1 to ensure consistency in interpretation: higher composite scores always reflect stronger financial health.

Although the standardisation formula follows the classical Z-score method, the final aggregated result is referred to as the C-Score (Composite Score) to distinguish it from the Altman Z'-Score used for bankruptcy prediction. The final C-Score was computed as the arithmetic mean of all seven standardised (and sign-adjusted, where necessary) indicators for each year:

$$\text{Composite Score}_t = \frac{Z\_NPM + Z\_ROA + Z\_ROE + Z\_CR - Z\_CD/E - Z\_CDebt\ Ratio - Z\_CD/EBITDA\ Ratio}{7}$$

The Altman Z-Score, a widely recognised tool for predicting financial distress and bankruptcy risk, is beneficial for privately held (non-listed) companies. This model, which adjusts the original coefficients to reflect the data environment of non-listed companies better, enables the classification of companies into safe, grey, and distressed zones based on their financial performance (Altman et al., 2017). In this study, we demonstrate the practical application of the Altman Z-Score model, specifically adapted for a private services company, which integrates liquidity, profitability, leverage, and activity measures to assess bankruptcy risk. The formula is expressed as follows: (Altman & Hotchkiss, 2006):

$$Z' = 0.717X_1 + 0.847X_2 + 3.107X_3 + 0.420X_4 + 0.998X_5$$

Table 2. Altman Z-Score

Weights	X Formula	Interpretation thresholds
Woking Capital	$X_1 = \frac{Working\ Capital}{Total\ Assets}$	$Z' > 2.9$ Safe Zone (low risk of bankruptcy)
Total Assets		
Retained earnings	$X_2 = \frac{Retained\ earnings}{Total\ Assets}$	$1.23 < Z' < 2.9$: Grey Zone (potential risk, requires monitoring)
Earnings Before Interest and Taxes (EBIT)	$X_3 = \frac{EBIT}{Total\ Assets}$	
Equity	$X_4 = \frac{Total\ Equity}{Total\ Liabilities}$	$Z' < 1.23$: Distress Zone (high risk of bankruptcy)
Total Liabilities		
Sales	$X_5 = \frac{Sales}{Total\ Assets}$	

(Altman & Hotchkiss, 2006)

5. RESULTS

In this section, the study presents the results of the comprehensive financial analysis conducted over the 2012-2024 period. The focus is on the evolution of the company's financial health and bankruptcy risk, using a range of financial indicators to construct the composite score (C-Score) and calculate the Altman Z'-Score. These indicators were extracted and computed from the company's annual financial statements and Profit and Loss (P&L) Accounts, ensuring a thorough and accurate assessment.

Table 3 presents the annual evolution of the C-Score, a key metric calculated using seven indicators: NPM, ROA, ROE, Current Ratio, D/E Ratio, Debt Ratio, and Debt/EBITDA Ratio. The original values, standardised Z-score, and adjusted (inverted) values for the leverage-related indicators are all included. The final C-Score for each year was calculated as the arithmetic mean of the adjusted Z-scores, ensuring that all components contributed in the same direction to the composite financial health metric.

Table 3. Composite Score Components and Final C-Score, 2012-2024

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
NPM	6,2093	8,2811	9,9791	13,4299	7,0053	4,1942	6,6128	8,1981	13,1485	15,2404	11,4481	7,7174	2,8940
ROA	9,5883	25,8847	23,4670	24,8586	10,9227	6,8879	10,2923	13,0578	18,3659	20,6341	15,6456	9,1719	4,7944
ROE	99,7638	70,1147	42,6626	33,6301	13,3050	7,8318	11,3158	16,4074	27,4919	39,1687	33,0483	18,0808	6,4502
CR	1,0996	1,6673	2,5061	3,4844	8,3008	7,9385	6,9554	3,3485	2,7526	1,9113	1,5752	2,1701	7,4536
D/E Ratio	6,7579	1,7124	0,6637	0,4035	0,1228	0,1286	0,1534	0,3866	0,5234	0,9556	1,3261	0,7033	0,1374
Debt Ratio	0,8881	0,5448	0,3619	0,2711	0,1071	0,1165	0,1364	0,2875	0,3529	0,5053	0,5805	0,4223	0,1213
Debt/EBITDA	5,3908	1,7457	1,0794	0,8544	0,5415	0,7891	0,7806	1,6166	1,5100	1,9449	2,9528	2,3876	0,9182
Z_NPM	-0,7024	-0,1400	0,3210	1,2577	-0,4863	-1,2494	-0,5929	-0,1625	1,1813	1,7492	0,7197	-0,2930	-1,6024
Z_ROA	-0,7458	1,5466	1,2065	1,4022	-0,5581	-1,1256	-0,6468	-0,2577	0,4889	0,8080	0,1063	-0,8044	-1,4201
Z_ROE	2,5096	1,4075	0,3870	0,0512	-0,7043	-0,9078	-0,7782	-0,5890	-0,1769	0,2571	0,0296	-0,5268	-0,9591
Z_CR	-1,0561	-0,8447	-0,5323	-0,1680	1,6255	1,4906	1,1245	-0,2186	-0,4405	-0,7538	-0,8790	-0,6575	1,3100
Z_D/E Ratio	3,2000	0,3589	-0,2316	-0,3781	-0,5362	-0,5329	-0,5189	-0,3876	-0,3106	-0,0672	0,1414	-0,2093	-0,5279
Z_Debt Ratio	2,2993	0,8013	0,0031	-0,3934	-1,1088	-1,0679	-0,9812	-0,3219	-0,0361	0,6290	0,9571	0,2665	-1,0470
Z_Debt/EBITDA	2,8006	0,0107	-0,4992	-0,6714	-0,9109	-0,7214	-0,7279	-0,0881	-0,1696	0,1632	0,9346	0,5020	-0,6226
Z_D/E Ratio*(-1)	-3,2000	-0,3589	0,2316	0,3781	0,5362	0,5329	0,5189	0,3876	0,3106	0,0672	-0,1414	0,2093	0,5279
Z_Debt Ratio*(-1)	-2,2993	-0,8013	-0,0031	0,3934	1,1088	1,0679	0,9812	0,3219	0,0361	-0,6290	-0,9571	-0,2665	1,0470
Z_Debt/EBITDA*(-1)	-2,8006	-0,0107	0,4992	0,6714	0,9109	0,7214	0,7279	0,0881	0,1696	-0,1632	-0,9346	-0,5020	0,6226
C-Score	**-1,1849**	**0,1141**	**0,3014**	**0,5694**	**0,3475**	**0,0757**	**0,1907**	**-0,0615**	**0,2242**	**0,1908**	**-0,2938**	**-0,4058**	**-0,0677**

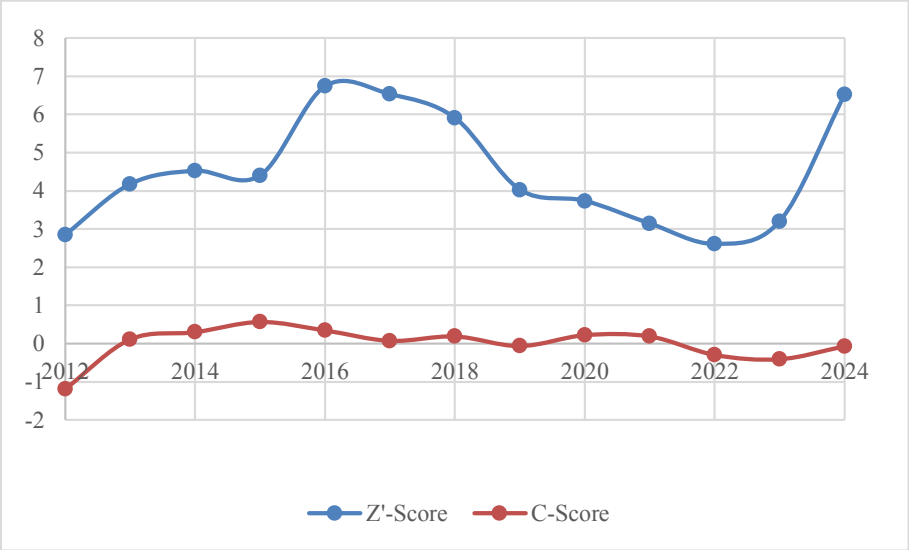
The Altman Z'-Score, used as a benchmark for bankruptcy prediction, was computed separately based on the company's annual financial data over the period 2012-2024. The Z'-Score values for each year are summarised in Table 4, which enables a direct comparison with the C-Score shown in Table 4.

Table 4. Altman Z-Score, 2012-2024

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total Assets	3.221.147	4.451.219	4.529.876	5.539.917	4.918.279	4.634.583	4.854.560	5.587.339	5.483.831	5.442.124	6.407.363	4.685.604	3.406.979
Retained Earnings	422.293	422.093	1.415.077	2.468.874	3.720.478	3.870.586	3.825.900	3.472.119	2.680.174	1.749.464	1.876.702	2.303.661	2.812.377
Equity	423.293	1.416.227	2.470.074	3.721.679	4.292.839	4.200.784	4.315.424	4.155.058	3.698.033	2.877.901	2.804.861	2.813.577	3.007.572
Sales	6.800.944	11.991.009	10.560.038	9.319.516	8.153.245	7.844.186	7.384.491	8.315.767	7.732.105	7.396.375	8.097.052	6.591.832	6.703.413
Debt	2.860.582	2.425.127	1.639.484	1.501.734	526.954	540.076	662.116	1.606.161	1.935.478	2.750.075	3.719.550	1.978.667	413.289
EBIT	522.841	1.291.474	1.321.396	1.465.371	729.342	429.983	629.731	803.114	1.179.279	1.301.309	1.115.267	649.784	263.629
Working Capital	284.885	1.618.229	2.469.249	3.730.841	3.847.171	3.747.296	3.943.158	3.772.010	3.392.194	2.506.200	2.139.417	2.315.160	2.667.189
X1 (WC/TA)	0,0884	0,3635	0,5451	0,6734	0,7822	0,8086	0,8123	0,6751	0,6186	0,4605	0,3339	0,4941	0,7829
X2 (RE/TA)	0,1311	0,0948	0,3124	0,4457	0,7565	0,8352	0,7881	0,6214	0,4887	0,3215	0,2929	0,4916	0,8255
X3 (EBIT/TA)	0,1623	0,2901	0,2917	0,2645	0,1483	0,0928	0,1297	0,1437	0,2150	0,2391	0,1741	0,1387	0,0774
X4 (Equity/Debt)	0,1480	0,5840	1,5066	2,4783	8,1465	7,7781	6,5176	2,5869	1,9107	1,0465	0,7541	1,4220	7,2772
X5 (Sales/TA)	2,1113	2,6939	2,3312	1,6822	1,6577	1,6925	1,5211	1,4883	1,4100	1,3591	1,2637	1,4068	1,9676
Z'-Score	**2,8480**	**4,1762**	**4,5211**	**4,4019**	**6,7383**	**6,5313**	**5,9085**	**4,0289**	**3,7353**	**3,1413**	**2,6062**	**3,2028**	**6,5209**

To visually illustrate the comparative dynamics between the C-Score and Z'-Score, Figure 3 presents their evolution over the 2012-2024 period. The graph provides a clear overview of how both scoring models reflect the company's financial trajectory, highlighting areas of convergence as well as divergence between the two approaches.

Figure 3. Comparative evolution of the C-Score and Z'-Score, 2012-2024



While the Z-score reflects solvency and long-term risk, the C-score offers a broader view of operational health, incorporating profitability, liquidity, and leverage indicators. Divergences between the two scores, particularly in the later years, highlight how each tool captures distinct dimensions of financial performance. Both scores tend to follow similar directional trends during several years, particularly between 2013 and 2021, suggesting that internal financial indicators are effective in anticipating shifts in bankruptcy risk. Divergences, such as in 2024, when the Z'-Score indicates recovery while the C-Score remains low, reveal how the C-Score may detect performance deterioration earlier through sensitivity to declining profitability or worsening capital structure. Although not always perfectly aligned, the consistency of overlapping trends confirms that financial performance analysis is a valuable tool for forecasting potential insolvency and guiding risk mitigation strategies.

Examining specific years, such as 2019, we observe a significant divergence between the Z-score, which remains relatively high, and the C-score, which drops into negative territory. This discrepancy suggests that while the company maintains sufficient solvency according to Altman's formula, its operational efficiency or internal profitability may be deteriorating. The signal captured by the C-Score reflects weakened performance in indicators such as ROA or ROE, in conjunction with the D/EBITDA Ratio, indicating a potential worsening of profitability and cost structure, which is not fully reflected in the Z-Score.

The divergence observed in 2019, where the Altman Z'-Score indicates stability, but the C-score reflects weakening performance, can be partially explained through liquidity preference theory. During economically uncertain periods, companies may prioritise liquidity over profitability in the short term to build reserves for long-term survival (Nguyen & Tran, 2024). This behaviour, while stabilising solvency metrics, may temporarily reduce ratios such as ROA and NPM, thereby lowering the C-score, while the Z-score remains strong.

In 2022, the Z-score shows a notable decline, approaching the risk threshold (scores below 2.6 typically fall into the distress zone). Simultaneously, the C-Score turns negative, indicating weakening performance across the underlying financial indicators. This alignment

between the two scores reinforces H1. In 2023, the Z-score suggests mild recovery, moving into the so-called "grey zone", where the risk of insolvency is not critical, but caution is warranted. In contrast, the S-score declines even further, reaching the lowest point across the entire 13-year period. This divergence suggests that while the company maintains acceptable solvency (as per Altman's model), its internal financial performance, especially operational efficiency, is deteriorating. The C-score captures this decline more sharply, driven by weakening values in ratios such as ROA, ROE, and NPM, which are not directly incorporated into the Z'-Score formula. Therefore, the C-score offers a more sensitive and timely reflection of internal performance weaknesses, supporting the validity of H1 as a predictive tool for financial distress and bankruptcy.

The assessment of the computed Altman Z'-Score enables a more precise classification of the company's financial health across the analysed period. It provides a structured basis for evaluating the presence or absence of bankruptcy risk. The threshold categories – distress, grey, and safe zones – offer a standardised framework through which each year's score can be interpreted in context. To interpret the results, the standard Z'-Score thresholds were applied: i) Z'-Score < 1.8 reveals distress zone (high risk of bankruptcy); ii) $1.8 \leq$ Z'-Score ≤ 2.6 reveals grey zone (moderate risk), whereas iii) Z'-Score> 6 reveals safe zone (low risk).

Between 2012 and 2015, the Z-score ranged from 2.85 to 4.52, placing the company firmly in the safe zone, indicating strong solvency and minimal risk of bankruptcy. In 2016 and 2017, the score continued to rise above 6, suggesting excellent financial health, supported by high working capital and low leverage. From 2018 to 2022, the Z'-Score shows a steady decline, with 2022 approaching the grey zone threshold at 2.61. This signals emerging risks and weakening fundamentals. In 2023, the score increases to 3.20, and by 2024, it reaches 6.52, showing a strong rebound and indicating a return to financial stability. These movements demonstrate that the Altman Z'-Score performs well as an early warning system, particularly during the downturn years. The decline prior to 2022 aligns with known patterns of financial strain, and its recovery afterwards corresponds with improved balance sheet indicators such as increased working capital and reduced debt levels.

In 2012, the company exhibited an extremely high D/Equity Ratio of 6.76 and a Debt Ratio of 0.89, indicating that nearly 90% of its assets were financed through debt. Its D/EBITDA stood at 5.39, suggesting a high level of financial strain, as the company would have needed more than five years of operating earnings to repay its obligations. These figures reflect a high-risk financial profile, consistent with the distress zone according to the Altman Z'-Score methodology. However, over time, the company's strategic financial restructuring resulted in a significant reduction of its leverage. By 2016-2018, the Debt-to-Equity Ratio had dropped below 0.2, and the Debt Ratio was near 0.11-0.14. This shift was accompanied by improved profitability and liquidity, as indicated by declining debt burdens relative to earnings (D/EBITDA around 0.78 in 2018). These improvements in financial health instil confidence in the company's future. This financial restructuring positioned the company within a low-risk zone, thereby enhancing its Z-Score.

In recent years, 2023 and 2024, leverage has remained low. The D/Equity Ratio stays well under 1.0, while the Debt Ratio continues to signal low asset-based indebtedness (around 12%). This progression means that the company has prioritised stability over aggressive financing, especially following early periods of high leverage and potential vulnerability. It also aligns with the logic of Altman's Z-score, where reductions in financial leverage and improvements in liquidity contribute significantly to risk mitigation and long-term solvency.

The company's gradual transition from a highly leveraged structure in the early years (2012-2014) to a more conservative financial position by 2024 signifies a strategic shift towards financial stability and improved access to capital. This shift aligns with the strategic dilemma between equity and debt, a fundamental aspect of corporate financial management.

The decision between external financing through debt or internal equity remains one of the most critical and complex managerial considerations. Higher reliance on equity may dilute ownership and reduce company value, while excessive debt increases financial risk and the likelihood of distress.

It is generally accepted that more liquid companies are better positioned to meet short-term obligations, which increases their credibility and access to external funding. This duality is at the core of the Trade-Off Theory, which posits that firms aim to balance the tax advantages of debt against the costs of potential financial distress (Ghasemi & Razak, 2016). In this context, Altman's Z-score serves as a relevant and theoretically grounded tool. It integrates variables related to liquidity, leverage, and profitability, capturing the company's position within the capital structure spectrum. The Z'-Score not only aligns with the Trade-Off Theory but also operationalises it by offering a quantifiable threshold for financial stability, distress, or insolvency risk (Altman & Hotchkiss, 2006).

Considering the results obtained in the longitudinal analysis, we propose an operational model for integrating composite financial scores (C-Score) and Altman Z'-Score into the ERP systems used by companies. The model aims to strengthen internal capacity for monitoring and preventing insolvency risk by automating the process of calculating, interpreting, and signalling deviations from optimal financial performance parameters. The proposed structure includes functional modules that periodically retrieve essential accounting data, calculate relevant scores, interpret results based on predefined thresholds, and generate alerts and recommendations directed to the financial management team. The model is designed exclusively for internal use, without the involvement of external actors, and is intended to be seamlessly integrated into the existing ERP architecture, offering a high degree of flexibility and adaptability. Through its direct applicability, the model not only facilitates proactive managerial decision-making but also supports the implementation of evidence-based financial governance mechanisms, providing reassurance and confidence in the decision-making process. At the same time, it can contribute to the institutionalization of a systematic framework for continuous risk assessment, with an impact on the long-term sustainability and resilience of the organization. The detailed structure of this framework is presented in Table 5.

The presented model provides a practical framework for translating financial scores into an operational tool integrated into existing ERP systems. Through its modular and extensible architecture, it can be adapted to various organizational structures. This adaptability not only supports recurring financial analysis but also empowers data-driven managerial decision-making and systemic risk prevention, instilling confidence in the audience. The proposed extensions, such as integrating ESG criteria, internal benchmarking, or prediction assisted by intelligent algorithms, enable the gradual development of the model in line with the digital maturity of the organization. Thus, the implementation of this framework can contribute not only to improving financial control, but also to developing an organizational culture oriented towards anticipation, adaptability and long-term sustainability.

Table 5. Operational model for integrating C-Score and Altman Z'-Score into the company's ERP

Section	Component	Description / Function
1. Data retrieval	Data source	Monthly/quarterly accounting data from the Balance Sheet, Profit and Loss Account, Cash Flow
	Necessary indicators	NPM, ROA, ROE, Current Ratio, D/E Ratio, Debt Ratio, D/EBITDA Ratio
	ERP integration mode	Automatic import from ERP accounting modules
2. Score calculation	C-Score	Arithmetic average of the 7 indicators, standardized (with inversion for leverage indicators)
	Altman Z'-Score	Calculation according to the formula for private companies (Z' = 0.717X1 + 0.847X2 + 3.107X3 + 0.420X4 + 0.998X5)
	Calculation frequency	Monthly or quarterly, depending on accounting cyclicality
3. Risk assessment	Interpretation thresholds C-Score	< -0.5: High risk -0.5 to 0.5: attention zone > 0.5 financial stability
	Interpretation thresholds Z'-Score	< 1.8: Distress 1.8 – 2.6: Grey Zone > 2.6: Safe Zone
	Dashboard ERP	View scores, trend graphs, visual cues
	Automatic Alerting	Notifications to the CFO/CFO when scores enter the yellow or red zone
4. Automatic recommendations	Suggested strategic decision	Ex: leverage reduction, liquidity conservation, investment revaluation
	Scenarios „what-if"	Impact simulations: e.g. "What happens if profit drops by 20%?"
	Action plan	Lists of suggested corrective steps: debt reduction, contract renegotiation, dividend deferral
5. Monitoring	Frequency of review of scores	Quarterly (board engagement), monthly (for CFOs)
	Score History	Automatic archiving, analysis of the evolution of scores over time
	Benchmark intern	Comparison of scores between departments / cost centers / previous years
6. Optional extensions	Artificial Intelligence (AI)	Automatic predictions of future scores based on trends
	KPIs and bonuses	Integrating scores as part of managerial performance
	Export for internal report	Automatic generation of strategic financial reports for the Board of Directors
7. KPIs and managerial control	Integration of scores into annual goals	Scores become part of the financial management performance evaluation system
8. Advanced Benchmarking	Comparison of scores between divisions	Monthly/quarterly view of comparative risk across your organization
9. AI Prediction	6-month score prediction	Algorithms that identify potential dips and additional signals early on
10. ESG integration	Mixed alert financial score + ESG	Automatic flags in case of discrepancies between financial and sustainability performance

6. CONCLUSIONS

This study delved into the intricate relationship between financial performance and bankruptcy risk, culminating in the development of a standardised Composite Score (C-Score) based on seven key financial indicators. These indicators, which span profitability (NPM, ROA, ROE), liquidity (CR), and leverage (D/Equity, Debt Ratio, D/EBITDA Ratio), were meticulously extracted from annual financial statements and normalised for aggregation into a single, interpretable metric. Comparing this C-Score to the Altman Z-Score over 13 years for a single private company yielded insightful results.

The results underscore the unique contribution of the Composite Score, which offers a comprehensive view of the company's financial dynamics. It effectively captures year-to-year fluctuations in operational efficiency, capital structure, and liquidity. While the C-score and Z'-score align in many periods, their conceptual differences are highlighted by divergences, especially in the most recent years. The Altman Z-Score, which focuses primarily on solvency and long-term default risk, contrasts with the C-Score, which reflects more immediate performance concerns, including profitability erosion and capital allocation efficiency.

The evaluation of the two hypotheses led to nuanced conclusions. H1, which proposed that evaluation of financial performance can serve as early warning signals for bankruptcy, even though it does not have a perfect match with the Altman Z'-Score. The standardised indicators and their composite formulation do highlight financial weaknesses and inflexion points, though they may not fully capture all structural risks. H2, concerning the Altman Z'-Score's reliability as a distress prediction tool, is supported. The Z'-Score consistently classified financial risk across time, aligning with the company's leverage profile and aligning with theoretical expectations from capital structure literature. However, it is important to note that the study has its limitations and may not fully capture all structural risks.

These findings reinforce the notion that financial health is a multidimensional concept. The use of composite performance metrics alongside classic risk models, such as the Z-Score, provides a more robust framework for early warning, strategic decision-making, and long-term financial planning. However, this study also highlights the need for further research to extend this approach to multiple companies in various sectors, exploring the predictive value of composite indicators in broader contexts.

In addition to the conclusions obtained through the comparative analysis of C-Score and Altman Z-Score, the proposal of an operational model integrated into ERP systems offers a practical and scalable solution for companies interested in preventive financial risk management. The model indirectly validates classical financial theories, such as the Trade-Off Theory and Signal Theory, while providing a concrete framework for implementing data-driven financial governance. The practicality of the model's implementation is a reassuring factor for companies. At the same time, the application of the model in a single organizational context limits the possibility of generalizing the results. In this regard, future research could aim at its sectoral scale-up, validation through multiple case studies, and integration with advanced analytical tools, including artificial intelligence algorithms. Through its direct applicability, the model has the potential to support not only the finance function but also the strategic decision-making process, thereby contributing to the long-term resilience and sustainability of companies.

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THE GLOBAL TECH ECOSYSTEM INDEX 2025: INSIGHTS AND POLICY LESSONS FOR ROMANIA

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ABSTRACT: *The Dealroom Global Tech Ecosystem Index launched in May 2025 provides a fresh data-driven analysis of 288 startup ecosystems across 69 countries. This study examines the Index's three complementary lenses: Global Champions (scale), Density Leaders (per capita output), and Rising Stars (growth trajectory), to draw policy-relevant insights. We find that while a handful of "Global Champion" hubs dominate in absolute venture capital and enterprise value, many smaller "Density Leader" ecosystems outperform on a per capita basis, and several emerging "Rising Star" ecosystems are scaling up rapidly from a low base. Romania does not yet rank among the top performers in these categories, reflecting persistent gaps in startup density and growth. Guided by international evidence and the Index's findings, we propose targeted policy measures to help Romania develop an internationally competitive tech hub. Policy recommendations include overhauling entrepreneurial and tech education (toward practical, market-driven training), mobilizing domestic capital for innovation (unlocking pension fund investments and incentivizing venture funds), and legal reforms to foster startup investment (enhancing angel incentives, employee stock ownership, and easing regulatory burdens). These measures, grounded in global best practices, aim to accelerate Romania's startup ecosystem development.*

Keywords: *Startup ecosystems; Innovation policy; Venture capital; Romania;*

JEL Codes: *L26; O31; O38; R11*

1. INTRODUCTION

In recent years, technology startup ecosystems have become key engines of innovation, job creation, and regional economic growth. Successful examples like Silicon Valley, New York, and London illustrate how vibrant clusters of startups, venture capital, talent, and supportive institutions can shape global tech trends. However, such entrepreneurial ecosystems are complex and varying widely across regions. Policymakers worldwide, including Romanians, are eager to cultivate their own "Silicon Valley" style hubs, yet must tailor strategies to local strengths and gaps. The Dealroom Global Tech Ecosystem Index 2025 (Dealroom.com, 2025) responds to this need by benchmarking 288 cities' startup ecosystems on multiple dimensions. It offers a data-driven lens to understand which ecosystems lead in absolute scale, which punch above their weight per capita, and which are rising most rapidly.

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This paper leverages the Dealroom 2025 Index as a global dataset to derive insights for Romania's quest to become a competitive tech hub. Romania's startup ecosystem, centered on Bucharest and a few regional cities, has shown nascent progress but trails leading peers. For instance, according to Global Entrepreneurship Monitor data, Romania's entrepreneurship rates remain below international averages. Only one Romanian-founded startup (UiPath) has reached unicorn status to date, and it scaled primarily after relocating abroad. By contrast, smaller European countries like Lithuania and Estonia have produced multiple tech unicorns in recent years, reflecting denser startup activity. Moreover, Romania faces well-documented ecosystem challenges, including talent migration, scarce growth-stage capital, and burdensome bureaucracy, that hinder startup scaling. These issues underscore the importance of learning from global best practices.

The purpose of this study is to analyze global tech ecosystem patterns and extract policy lessons to accelerate Romania's ecosystem development. We first review relevant literature, then describe the Dealroom 2025 Index methodology and present key results across the three lenses: Global Champions (scale), Density Leaders (per capita), and Rising Stars (growth). In the Discussion, we interpret what these findings imply, highlighting how scale and density often coincide, and how emerging ecosystems can shift to rapid growth. Finally, we add Romania-focused policy recommendations informed by both the data and global case studies. Our hope is that by contextualizing Romania's situation within global trends, this analysis offers actionable insights for Romanian policymakers aiming to foster an internationally competitive tech hub.

2. LITERATURE REVIEW

Startup Ecosystems and Regional Innovation: The concept of entrepreneurial ecosystems emphasizes the interconnected nature of factors that support high-growth entrepreneurship: talented human capital, availability of risk financing, R&D and knowledge institutions, mentorship networks, culture tolerating risk, and enabling policy environment. Research traces the roots of vibrant tech clusters to agglomeration economies and knowledge spillovers (Brown & Mason, 2017). Dense concentrations of skilled labor and firms produce network effects and "alumni" entrepreneurs who fuel new ventures.

Measuring Ecosystem Success - Scale vs. Density vs. Growth: Traditional rankings often focus on absolute size indicators, venture capital totals, number of startups/unicorns, or aggregate startup valuations, to identify leading hubs (Whitlock, 2023)

Key Drivers of Thriving Tech Ecosystems: Prior studies highlight several common ingredients. Human capital and education are foundational, regions with strong technical universities and STEM education pipelines tend to produce more entrepreneurs and innovation (Audretsch & Lehmann, 2005).

A comparative study of venture funding determinants across countries found deeper capital markets (including institutional investors like pension funds) and supportive tax policies strongly correlate with higher VC activity (Baygan & Freudenberg, 2000). Additionally, angel investors play a key early role; research suggests that tax incentives (such as the UK's Enterprise Investment Scheme) can stimulate angel investment and thus more startup formation (Mason & Harrison, 2002).

Regulatory environment and culture: Cultural attitudes toward entrepreneurship, acceptance of risk, tolerance of failure, celebration of success, also contribute (Hofstede, 2004). In Europe, recent analyses have pointed to rigid regulations and taxation around stock options as a competitive disadvantage vis-à-vis the U.S.

2. METHODOLOGY

Dealroom.co, a global startup data provider, developed the 2025 Index to rank cities' startup ecosystems using a multidimensional approach. The Index covers 288 cities across 69 countries, selected through clear inclusion criteria: primarily, cities with at least one "unicorn" (startups valued ≥ $1B), yielding 208 cities, plus an additional 80 high-potential cities with over $100M in funding and 50+ VC deals since 2019. This ensured inclusion of both established and up-and-coming tech hubs worldwide. Each "city" is defined broadly as a metropolitan hub (including suburbs and nearby towns) to capture functional ecosystems rather than narrow municipal boundaries.

The Index evaluates ecosystems through three distinct lenses, each corresponding to a composite indicator (on a 500-point scale) built from relevant metrics (Table 1):

Table 1. Top 5 Cities in Each Lens of the Dealroom Global Tech Ecosystem Index 2025

Rank	Global Champions (Scale)	Density Leaders (Per Capita)	Rising Stars (Growth)
1	Bay Area (San Francisco) – US	Bay Area (San Francisco) – US	Lagos – Nigeria
2	New York City – US	Boston – US	Istanbul – Turkey
3	Boston – US	New York City – US	Pune – India
4	Paris – France	Cambridge – UK	Belo Horizonte – Brazil
5	Austin – US	Munich – Germany	Mumbai – India

Sources: Dealroom Global Tech Ecosystem Index 2025. Global Champions measures VC, unicorns, etc. in absolute terms; Density is per capita; Rising Stars is by growth rates.

The Global Champions are the largest ecosystems by absolute scale; Density Leaders are the highest output per capita ecosystems; Rising Stars are the fastest-growing ecosystems.

A. **Global Champions (Scale Lens):** ranks ecosystems by absolute scale of activity, including total venture capital investment (broken down by stage: startup/early $1–15M rounds, "breakout" $15–100M rounds, and scale-up $100M+ rounds, for years 2021–24), total combined enterprise value (EV) of local startups (as of 2024), the number of unicorn startups and $1B+ exits, and innovation assets like research university linkages and patent output.
B. **Density Leaders (Per Capita Lens):** uses a similar set of indicators but normalized by population, effectively measuring innovation output per capita. Venture investment, startup valuations, unicorn counts, university talent linkage, and patents are assessed on a per capita or per GDP basis.
C. **Rising Stars (Growth Lens):** ranks ecosystems by growth trajectory and dynamism, adjusted for economic context. Key indicators include growth in startup enterprise value from 2017 to 2024, the rate of new unicorn creation (comparing 2017–20 vs 2021–24 periods), and unique to this lens, adjustments for local economic conditions.

Each lens is computed via a weighted scoring of percentile ranks for its metrics , ensuring a balanced contribution of factors (roughly 50% weight to capital investment metrics, 25–30% to value creation/unicorn metrics, and the remainder to talent/patent and economic adjustment metrics in their respective lenses). We complement this with external data (academic studies, industry reports) for interpretation and to formulate policy suggestions.

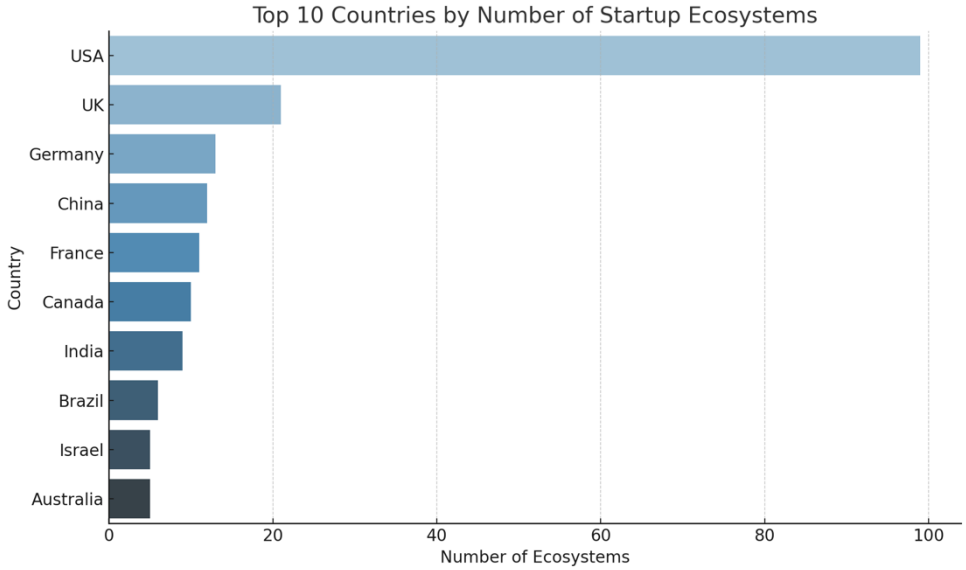
Data Analysis Approach: We dissect the Index results in three steps, we examine the Global Champions, we analyze Density Leaders to see which ecosystems outperform relative to population, and inspect the Rising Stars list of fastest-growing ecosystems, focusing on the mix of countries/regions it features and what that signals. We use simple statistical comparisons to illustrate insights, and we preserve important quantitative findings from the Dealroom report as cited evidence.

3. RESULTS

The 2025 Dealroom Index underscores the global startup activity while also revealing its concentration in certain countries. In total, 69 countries host the 288 qualified startup cities. However, some nations dominate: the United States alone accounts for 99 of the ranked ecosystems, over one-third of the global total. Other top countries by count include the United Kingdom (21 cities), Germany (13), China (12), France (11), and Canada (10).

Figure 1 illustrates the top ten countries by number of startup hubs in the Index. This distribution highlights the outsized presence of the U.S., as well as the strong representation of major European and Asian economies, while many smaller nations have 1-4 cities featured.

Figure 1. Top 10 countries by number of startup ecosystem cities in Dealroom's Global Tech Ecosystem Index 2025



The United States far leads with 99 cities, reflecting its broad innovation geography. The UK, Germany, and China follow at a distant second tier. Many countries (not shown) have 1–4 qualifying cities each. Another notable aspect is the diverse stage of ecosystem development: 30 cities worldwide host 20 or more unicorns, whereas the majority (210 cities) have 0–5 unicorns (often newer ecosystems). This indicates a long "tail" of emerging hubs beyond the elite top tier.

Global Champions - The World's Largest Tech Hubs

Unsurprisingly, the Global Champions lens confirms that a few superstar cities stand at the summit of the tech world, with the Bay Area (San Francisco/Silicon Valley) ranked #1 by a wide margin. Table 1 (left column) lists the top 5 Global Champion ecosystems. The Bay

Area, encompassing San Francisco and the broader Silicon Valley, remains the "undisputed champion" in 2025. Its lead is driven by unparalleled venture capital investment, a massive concentration of unicorn startups, and trillions in enterprise value created by local companies (e.g. Apple, Google, Meta, and countless startups). New York City is ranked #2 globally, establishing itself as the second-largest tech ecosystem with a broad-based economy spanning finance, media, and tech. Notably, New York's startup ecosystem is valued around $1.3 trillion in enterprise value, making it the largest outside Silicon Valley. Boston (#3) follows, powered by its biotech and deep tech strengths and world-class universities (MIT, Harvard) feeding innovation.

Paris (#4) emerges as the top-ranked European hub on the Global Champions index, reflecting France's concerted efforts in the past decade to boost its tech scene ("La French Tech"). London, often considered Europe's tech capital, is slightly lower at #6. Austin, Texas appears at a remarkable #5 globally, exemplifying a "newer hub" that has quickly built a substantial ecosystem. Other cities in the top 10 include Seoul (#7), a leading Asian hub with strengths in electronics and IT, Los Angeles (#9), known for media-tech and biotech, and San Diego (#8) with life sciences. Tel Aviv (#10) ties as well, illustrating its outsized innovation economy.

Notably, the top 20 Global Champions span North America, Europe, and Asia (Table 1). China's biggest ecosystems Shanghai (#13) and Beijing (#18) appear in the top 20, though lower than perhaps expected, suggesting that in 2024 their growth was modest compared to Western peers. Stockholm (#15) is noteworthy as a mid-sized city making the global top 15, a testament to Sweden's prolific startup output (with unicorns like Spotify, Klarna) and strong per capita innovation.

Density Leaders (Per Capita Lens) - Ecosystem Productivity per Capita

The Density Leaders ranking yields a different but overlapping set of star performers. This lens elevates smaller, innovation-dense locales that might be overshadowed in absolute terms by megacities. Strikingly, the Bay Area ranks #1 here as well, despite a population of ~7.7 million, its output is so extraordinarily high that on a per capita basis it still leads the world. Boston is #2 in Density, reflecting the cluster's high concentration of research institutions and startups in a moderate-sized metro (~5 million). New York City appears at #3, even with 20 million residents, NYC's huge tech output gives it a high per capita rank.

Where the Density Leaders list becomes most interesting is in highlighting smaller university-centric ecosystems. Cambridge (United Kingdom) ranks #4 in the world on this per capita lens. Home to Cambridge University and a deep life-sciences and AI startup scene, Cambridge has only ~280,000 people but an exceptionally high number of startups and innovation outputs per resident. Similarly, Munich (#5) and Oxford (#7) make the top ten. Munich's strong tech economy (especially in mobility, enterprise software, and its two elite universities) and Oxford's biotech cluster each produce high innovation density. Stockholm (#10) appears again here, reaffirming that Sweden's capital combines significant output with only ~2 million population.

Other notable Density Leaders (rank 11–20) include London (#11), Europe's largest city still scores well per capita, though behind its smaller UK peers, Copenhagen (#15) and Amsterdam (#16), two relatively small capital cities with vibrant startup scenes and Zurich (#18). Ghent presence at #19 draws attention, a smaller Belgian city, it has fostered a robust startup community around its university, exemplifying how even off-the-radar locations can excel in density.

For Romania, this is an encouraging insight: it suggests that even without a huge metropolis, a city like Cluj-Napoca (with its universities and IT sector) could aspire to become

a high-density innovation hub if nurtured properly. However, currently no Romanian city appears among the top density ranks, indicating room for improvement in output relative to population.

Rising Stars (Growth Lens) - The Fastest Growing Ecosystems

The Rising Stars lens shines a spotlight on the ecosystems that have experienced the most rapid growth in recent years. Here, a very different set of cities tops the list, often from emerging markets. Lagos, Nigeria is ranked #1 among Rising Stars, a remarkable achievement for an African tech hub. Lagos has produced 5 unicorns (startups like Interswitch, Flutterwave, Andela, etc.) and grown its total startup ecosystem valuation 11.6× from 2017 to 2024.

Istanbul, Turkey is ranked #2. Turkey's ecosystem saw a flurry of unicorns and exits in 2021–2022 (e.g. gaming company Peak Games, e-commerce Trendyol, delivery app Getir), resulting in rapid valuation growth. Pune, India (#3) and Mumbai, India (#5) are two Indian cities in the top five. Pune, a secondary city known for IT and education, saw fast growth. Mumbai, India's financial capital, has seen its startup ecosystem (especially in fintech) expand significantly post-2017. Belo Horizonte, Brazil (#4) is another Rising Star top-five , reflecting strong growth in Brazil beyond São Paulo.

The list underlines that high growth is occurring "in a wide range of ecosystems from emerging markets such as Africa, India, Türkiye and Brazil". It also suggests that once an ecosystem reaches a critical momentum, often via a few breakthrough successes or influx of capital, it can scale very quickly.

Crucially, Romania is absent from the Rising Stars top cohort. Despite being an emerging EU economy, no Romanian city made the top 20 for growth. In contrast, peers in the CEE region like Vilnius and Zagreb are highlighted. This implies that Romania's ecosystem growth, while positive, has not matched the pace of the fastest movers. For example, Lithuania (population under 3 million) produced multiple unicorns (Vinted, Nord Security) in recent years, accelerating its ecosystem. Croatia saw companies like Infobip reach unicorn status. Romania's relative underperformance on this growth metric may be due to fewer major startup exits and slower capital accumulation in the period measured. This gap sets the stage for examining what Romania can learn from others' success.

4. DISCUSSION

The dominance of a few mega-hubs (but with nuance): The Global Champions list is topped by the expected heavyweights: Silicon Valley, New York, Boston, etc. These places have decades-long track records, deep capital pools, and dense networks of talent. Paris overtaking London indicates that policy and concerted effort (e.g. French tech visas, state-supported VC funds) can boost a city's standing, not just historical advantage. For Romania, their examples reveal what a fully developed ecosystem entails (strong universities, ample venture funding, big exits, supportive policy), which Romanian cities can gradually cultivate.

Small cities can have big impact: Cambridge UK will never match the absolute New York or Beijing, but they generate outsized innovation relative to their size. This is encouraging for countries like Romania with mid-sized cities, it's possible to achieve world-class innovation density by leveraging local strengths (e.g a major research university or institution and related research parks). Romania's universities (such as the Politehnica University of Bucharest, or Cluj's Technical University) could be creating high-density innovation zones if supported to spin out startups and collaborate with industry, and creating a startup campus or innovation park.

Rapid growth is geographically diverse and policy-influenced. The Rising Stars list is arguably the most novel output of the Index, spotlighting geographies often overlooked in tech discussions. Many of these rising ecosystems benefited from large domestic markets (Nigeria, Turkey, India), but policy also play a role. For example, Nigeria's fintech boom was aided by increasing mobile penetration and supportive Central Bank regulations for payment startups; Turkey's gaming sector benefited from governmental tech investment and a young, digital population; Lithuania's rise can be partly attributed to business-friendly reforms and targeted incentives that attracted startups (e.g., a startup visa, sandbox regulations for fintech). This suggests that smart policy can accelerate an ecosystem's trajectory, a relevant lesson for Romania. The absence of Romanian cities among current top Rising Stars reflects missed opportunities in recent years to capitalize on global tech growth trends.

Gaps and opportunities for Romania: When comparing Romania to the global findings, a few gaps are evident. Romania has strong technical talent (it consistently ranks high in programming skills globally) and some successful companies (e.g. UiPath, Elrond). Yet, it lacks the density of startups seen in smaller countries like Israel or Finland, and it has not yet achieved the growth momentum of peers like Poland or Lithuania in producing multiple high-value startups. The reasons align with what the literature and data suggest: education pipeline issues, insufficient local capital, and regulatory hurdles. The data from Vestbee Report (Groszkowska, 2024) notes "issues with the tax system, permits, labor regulations, and administrative complexities" impeding startups in Romania.

5. ROMANIA-FOCUSED POLICY RECOMMENDATIONS

To transform Romania's tech ecosystem into an internationally competitive hub, a coordinated strategy is required. We propose the following policy recommendations for Romania:

- Reform Entrepreneurial and Tech Education for a New Generation. A critical foundation is human capital, Romania must produce more entrepreneurs and tech talent ready to build startups. We recommend to integrate practical entrepreneurship and coding/tech programs at all education levels, and promote alternative training pathways. This means introducing entrepreneurship modules, innovation labs, and startup internships at universities (and even in secondary schools) to give young people hands-on experience. Additionally, support the growth of accelerators, incubators, and online bootcamps that provide intensive, market-driven training. For example, Romania could support local programs (e.g. Venture Accel or Innovation Labs) with government grants. By updating educational approaches, Romania can cultivate an entrepreneurial mindset and skills base in its youth.

- Mobilize Domestic Capital for Innovation. A thriving startup ecosystem requires abundant, smart capital at every stage, from angel and seed funding to late-stage growth capital. Romania's financing landscape for startups remains underdeveloped, relying heavily on a few local funds and foreign investors. We recommend a set of policies to unlock domestic capital:

- Enable pension and institutional funds to invest in venture capital. Romania's large pension funds and insurance firms mostly invest in conservative assets domestically

- Tax incentives for venture investors (LPs and angels): To attract more investors into Romanian VC funds, introduce tax credits or deductions for individuals or corporations (Limited Partners) who commit capital to approved venture funds. For instance, a 30% tax credit on investments into certified VC funds (up to a cap) could entice high-net-worth individuals or companies to become LPs. Likewise, enhance the existing Business Angels Law, current incentives in Romania (a tax exemption on capital gains for angel investments held 3+ years) could be expanded to include upfront income tax relief on angel investments, mirroring the UK's very successful SEIS/EIS programs.

- Simplify and support VC fund formation: The government can reduce red tape for setting up new venture funds or incubators. This might include easing licensing requirements, providing legal templates, and possibly public co-investment. For example, creating a Fund-of-Funds program using EU structural funds or state budget to invest in private VC funds (as LP) could anchor new funds.

- Implement Legal and Regulatory Reforms to Incentivize Startups and Investors. Romania's regulatory environment must actively encourage entrepreneurship rather than inadvertently hinder it. Key reforms include a cler legal framework for Employee Stock Ownership Plans (ESOPs) and taxation of stock options, and reduce bureaucracy and improve ease of doing business for startups as time is of the essence for startups, and cumbersome procedures can be debilitating for a small, fast-moving team.

Collectively, these legal reforms would send a strong signal that Romania is "open for business" for startups. Removing administrative obstacles and aligning incentives with those in successful ecosystems can rapidly improve Romania's attractiveness to both founders and investors.

6. CONCLUSIONS

This study utilized the Dealroom Global Tech Ecosystem Index 2025 to assess where the world's startup ecosystems stand, and glean insights for Romania's aspirational journey toward tech hub status. The Index's multidimensional analysis revealed that global champions like the Bay Area and New York continue to dominate by sheer scale, density leaders like Cambridge show innovation efficiency regardless of size, and rising stars like Lagos and Istanbul prove that explosive growth is happening well beyond Silicon Valley's orbit. Romania, at present, is not prominently featured in these categories, highlighting the need for strategic interventions.

The government, academia, and private sector must collaborate closely to nurture the ecosystem's growth. If executed well, Romania can leverage its strengths (strong IT outsourcing sector, comparatively low costs, and talented engineers) to foster homegrown startups that compete globally. In time, success stories from Romania (e.g. future "unicorn" tech companies) will not only boost the economy but also inspire the next generation of entrepreneurs, creating a self-sustaining ecosystem. In conclusion, the global data analyzed here offers both a benchmark and a roadmap for Romania. The benchmark tells us where Romania stands relative to others, lagging in density and growth. The roadmap is drawn from those places that have succeeded: invest in people, unleash capital, and remove barriers. The success of rising ecosystems from Nigeria to Lithuania demonstrates that latecomers can rapidly ascend in the tech domain with the right mix of talent, capital, and supportive policy. With commitment and strategic focus, Romania can join the ranks of these rising tech nations, and perhaps one day its cities will appear among the Global Champions.

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TOWARDS ACTIVE AGEING IN ROMANIA

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ABSTRACT: *The paper analyses the active ageing in Romania as a potential solution within current demographic context. The paper is structured in three parts analyzing: introduction, the complex process of ageing, the social assistance for vulnerable elderly, and active ageing, and conclusions. From the methodological point of view, the paper is based on literature review and secondary analysis of two data bases: UN population division, and National Institute of Statistics. Conclusions emphases the key role played by active ageing in efficiently facing current demographic challenges.*

Keywords: *demography, elderly, active ageing, Romania,*

JEL Classification: *I31, I38, J14, J18*

1. INTRODUCTION

Worldwide, demographic ageing is mainly caused by three inter-linked factors: decrease fertility, massive migration, and reduced mortality of elderly (Rotaru, 1993, p. 319, Stăiculescu, 2002, p. 398) among which the fertility aspect is assessed as being of a key impact. Recent fertility global trends emphasize the general tendency of women at childbearing age to increasingly postpone the time when first child would arrive. Among various personal and interpersonal challenges linked to this situation, we mention: the opportunity of building a solid career path, or accessing an affordable house or a reliable health system. Pro fertility social policies design also plays a crucial role when deciding to become a parent. Increased public attention is paid by various stakeholders on one hand to increase fertility, and on the other hand cu protect elderly, especially the vulnerable ones in need of specific long-term care. At the same time, the current conflicts are no longer between various social classes, but rather between different generations. Practically, the proportion of elderly including retired people is higher than the ones active on the labour market (Gheţău, 2011, 876). Such demographic imbalance

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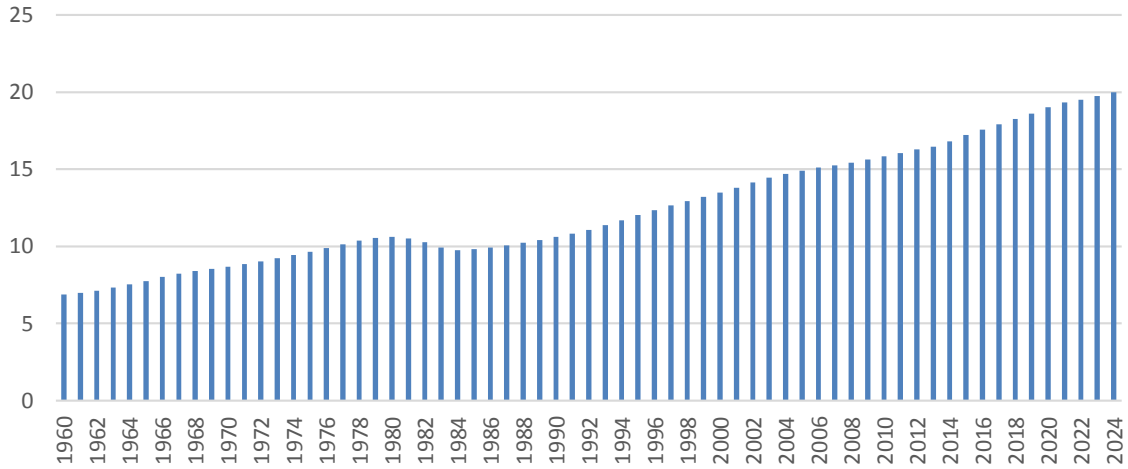
rises a series of questions to the capability of the social policy to efficiency support it on the lung run.

2. AGEING IN ROMANIA

Taking a close look at the population aged 65 and above as the share of the total population in Romania, one can notice a constant growing trend starting with 1960 (when it has represented 7% of the total population) till 2024 (20% of the total population). The only exception to this demographic trend is represented by the period starting with the year 1981 (10.5% of the total population) till 1984 (9.75% of the total population). For more details, please see the figure bellow.

Figure 1 Population ages 65 and above (% of total population) in Romania

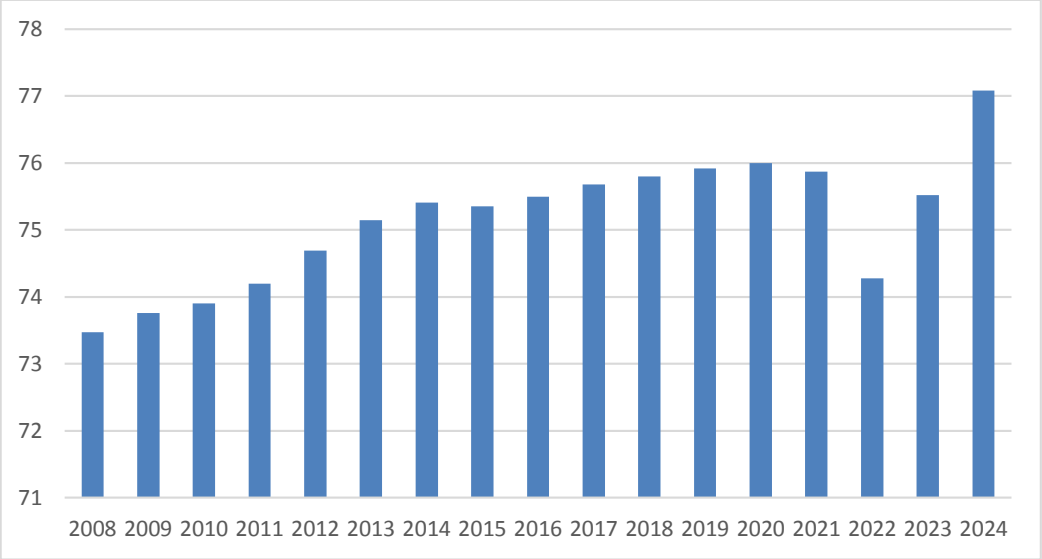


Source: UN Population division https://data.worldbank.org/indicator/SP.POP.65UP.TO.ZS

The public policy impact of the fact that a fifth part of the 2024 total population is represented by the people aged 65 and above is directly reflected on the pression on the social insurance system, mainly the pensions zone as well as the socio-medical services. In other words, less and less people are actively contributing to the labour market, while the number of elderly at the age of potential retirement is constantly increasing. This subject is even more nuanced approached in Romania due to possibility to earlier retirement for certain professional categories doubled by their possibility to continue working in either public or private organizations while still receiving the public pension. Cumulation of income and pension is subject of current political debates towards its ban but momently it is still possible. In this respect, we consider that specific research in the field is more than necessary and welcome in order to support based-evidence social policies. Besides demographic predictions, supporting fertility policies would also benefit from a better scientific understanding of the current dynamic on the labour market in Romania.

The analyze of average life expectancy in Romania highlights a constant increase since 2008 with some variations in the years of 2015, 2021, and 2022 as it can be seen bellow. Besides, in the average life expectancy in 2008 was 73.47 while in 2024 increased to 77 years.

Figure 2. Average life expectancy in Romania



Source: National Institute of Statistics Tempo database

When explaining the increase of average life expectancy in Romania, various reasons are involved including more individual attention paid to promoting a healthier life style, modernization and accessibility of medical facilities (still confronting challenges in rural areas). Besides, the access to modern technology and communication opportunities support a better globalized exchange of specific information on how to age healthier.

3. SOCIAL ASSISTANCE OF VULNERABLE ELDERLY IN ROMANIA

General regulations with direct impact on elderly are represented by the three adopted Laws on the national system of social assistance: 705/ 2001, 46/ 2006, and 292/ 2011. The latest define elderly as persons above 65 years.

Specific legal framework is represented by the Law 7/ 2000 on the social assistance of elderly with its subsequent modifications. Eligibility criteria for becoming a potential beneficiary of the social assistance system include the lack of a family or legal carers, lack of a house, lack of an income or even insufficient one. Besides, other criteria refer to the personal incapacity to manage on their own, request for specialized care of if the potential beneficiary is unable to provide for their socio-medical needs due to illness or physical or mental condition (Art. 3 a, b, c, d, e).

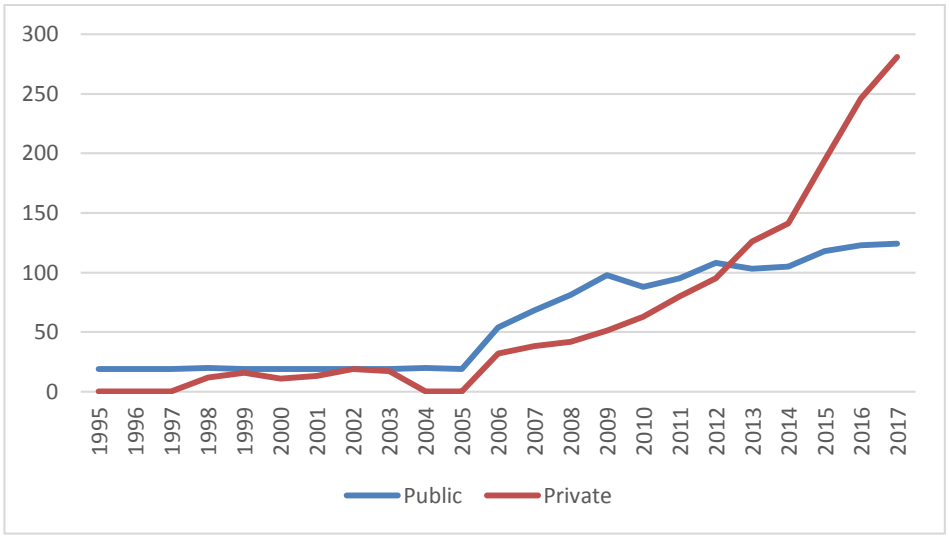
The 2015 – 2020 National Strategy for the Promotion of Active Ageing and the Protection of the Elderly has included among its objectives: prolonging and improving the quality of active life of older people; promoting active and dignified social participation of older people; and achieving greater independence and security for older people with long-term care needs. Besides, cross-cutting objectives for achieving a longer and healthier life include: delaying physical aging and the onset of chronic diseases; as well as preparing the health system for services provided to the elderly population. The National Strategy on Long-Term Care and Active Aging for the period 2023-2030 currently in force is focus on promoting active ageing in Romania.

As the social assistance of elderly includes provision of social services, and social benefits, we dedicate the current part of the paper to nursing houses due to their capacity to promptly respond to urgent ling-term care of vulnerable elderly.

Comparison between evolution of the total number of public nursing homes and the private ones is included in the figure bellow for the time interval 1995-2017 in line with the

National Institute of Statistics data set. While the beginning of private nursing houses was rather slowly developing, the 2017 situation shows a more than double number of the private ones compared to the public ones.

Figure 3 Public and private nursing homes in Romania

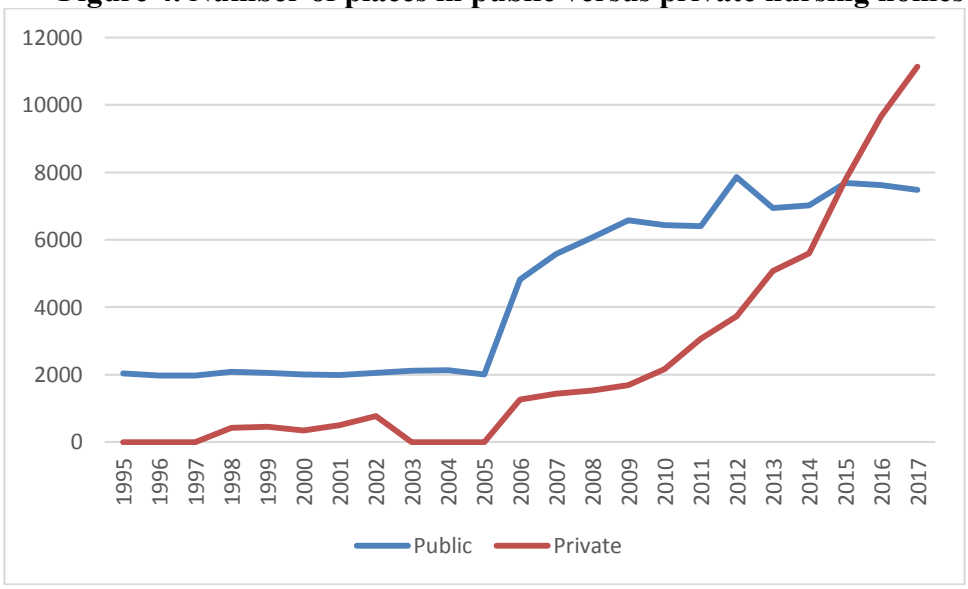


Source: National Institute of Statistics Tempo database

Follow up research taking into account the affordability of their prices and their accessibility especially in rural areas, would offer a more comprehensive picture on the capacity of vulnerable elderly to benefit of the private nursing homes.

The comparison of the total number of places in these nursing homes also reflect a better accommodation capacity in the case of the private ones in 2017 as shown in the figure bellow.

Figure 4. Number of places in public versus private nursing homes

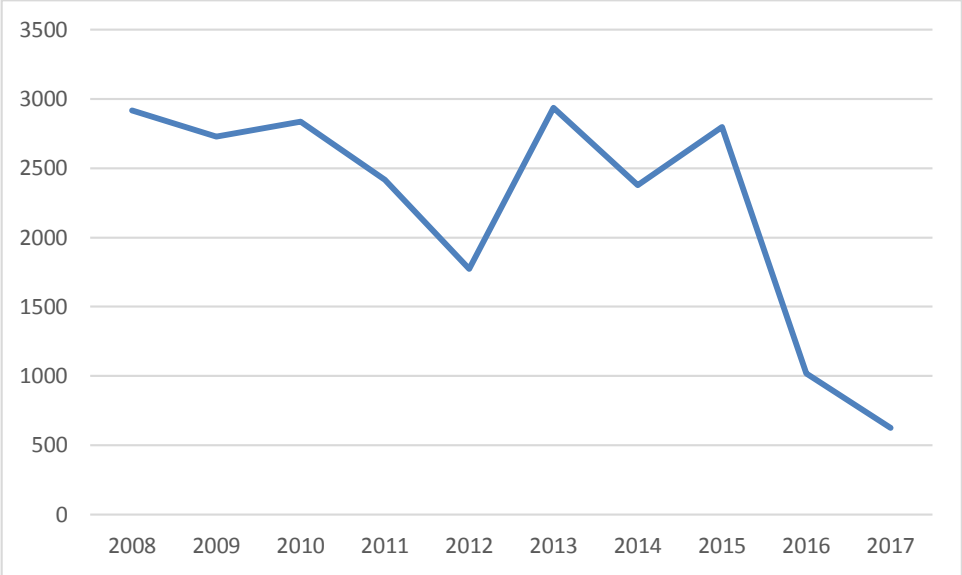


Source: National Institute of Statistics Tempo database

Another sensitive issue when approaching the subject of nursing homes is represented by the total number of pending applications as it is shown in figure 5 bellow. Their number substantially decreased in 2017 compared with 2008 but fluctuations were registered during

the time. Reasons behind this situation can be linked with potentially not affordable costs for the private nursing houses compared to the public ones.

Figure 5. Pending applications for public nursing homes



Source: National Institute of Statistics Tempo database

A research focus on the impact of 2007-2013 EU funds on the development of public social services for elderly showed their prevalence in urban areas (Stănculescu, Marin 2019). Increase absorption of available of EU funds crucially depends on the information and education of public stakeholders in writing such application, and monitoring their implementation.

The need to long term care of the ones in need in Romania, especially the elderly is confronted with a massive migration of the medical staff. Besides, high socio-economic vulnerability of informal carers for elderly is doubled by their massive migration namely in other EU member states. A qualitative sociological research focus on Romanian and Moldavian informal carers in Italy pointed out the impact of highly intensive24/7 specific work on their psychical and mental state (Țoc, Guțu, 2021). This happens in the conditions of no psychological support is provided for personal care givers.

4. ACTIVE AGEING

While failing in adopting efficient social policies for vulnerable elderly would directly impact their quality of life (Stănescu, 2018), active ageing represents a real underexploited gold mine.

Active ageing was defined as "the continued participation in social, economic, cultural, spiritual and civic activities, not merely the ability to be physically active or to participate in the labor market" (World Health Organization, 2002). Complementary concepts developed during the time were: successful aging (Venn and Arber 2011), productive aging (Hank, 2011), and healthy aging (Hung et al. 2010).

Social exclusion is associated with four interconnected domains: social relationships, material resources, services, and neighborhood/ social life (WHO, 2012). In this respect, the mental health of older people depends on their social inclusion (Precupețu, Aartsen, Vasile, 2019). Furthermore, within contemporary context ”the loneliness paradox was named because of the counter-intuitive finding that the loneliest older people live in countries where there are

high rates of co-residence and large, proximate networks" (Aartsen, Precupețu, Suanet, 2025, vi).

Various risks confronted by elderly request for setting up social policy adequate responses towards their specific support and protection as well as maintaining their decent life (Bogdan, 2002, 131).

A successful ageing is characterized by a minimum psychical deterioration caused by promotion of a healthy life style in terms of sport, diet, as well as social and intellectual stimulation (Curaj, 2010, 293). Additional factors of active *papy-boomers* are linked to increased levels of education, wealth, and health, more active roles in both consumer society (including technology and the digital world), and possibilities of leisure time (Segalen, 2011, p. 227).

5. CONCLUSIONS

One step forward in promoting a successful ageing is represented by a national public attention towards health education in terms of raising information and communication specific campaigns and programs. Besides, the design of a 2050 national strategy on population in line with sustainable development goals should further focus on:" improving health, decrease of mortality, increase of life expectancy at birth" (Alexandrescu, Istrate, 2021, p. 123) towards demographic recovery. Besides, support towards active aging is conditional on participation in the labor market, which maintains life satisfaction and happiness (Ramia, Voicu, 2020)

A paradigm shift should envisage the structural change from deficit, decline, disability, and dependence to well-being, activity, and independence (Precupețu, Aartsen, Vasile, 2019). Support of active ageing in Romania could be based on: a most detailed scientific knowledge regarding the situation of the elderly, implementation of social inclusion strategies for elderly, increasing the degree of access to basic services (medical, social assistance), and a better focus on the rural areas and marginalized communities including elderly.

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ECONOMIC EFFECTS OF ROMANIAN MIGRATION TO ITALY: A CASE STUD WITHIN EUROPEAN MIGRATION

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ABSTRACT: *Romanian labor migration to Italy, which accelerated after visa liberalization in 2002 and Romania's EU accession in 2007, has become one of the defining intra-European migration corridors. Romanians have formed the largest foreign community in Italy since the late 2000s, exceeding one million registered residents and heavily concentrating in sectors such as construction, domestic and elderly care, agriculture, logistics, and low- to mid-skill manufacturing [1][2].*

This paper examines the economic effects of that migration in a bilateral and European context. We focus on: (i) how Romanian workers have addressed structural labor shortages in Italy's aging economy; (ii) how remittances have shaped Romanian household income, consumption, and macroeconomic stability; and (iii) how sustained emigration has generated labor scarcity pressures in Romania itself. Drawing on Italian official statistics (ISTAT), remittance data from the World Bank and the National Bank of Romania, and analytical work by OECD, wiiw, and academic studies of Romanian migrants in Italy, we argue that this corridor is no longer a temporary "safety valve," but an embedded transnational labor regime. It reallocates demographic resources within the EU and transmits income, skills, and care labor across borders [1][2][3][4].

Keywords: *Romanian migration; Italy; remittances; EU labor mobility; demographic change; care economy*

JEL Classification: *F22, J61, O15, F24, R23*

1. INTRODUCTION

International labor mobility within Europe has become a core macroeconomic adjustment mechanism since the 1990s, especially between Central/Eastern Europe (CEE) and Southern/Western Europe. Romania, facing deep industrial restructuring, wage compression and high unemployment in the 1990s, produced a sustained labor outflow. Italy, characterized by rapid population ageing, chronic shortages in certain low- and medium-skill occupations,

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and rising care needs, became one of the most important destinations for Romanian workers [1][2][5].

By the late 2000s and throughout the 2010s, Romanians were the single largest foreign nationality resident in Italy, approaching or exceeding one million individuals according to ISTAT population registers [1]. This was not a marginal phenomenon. Romanian workers became integral to Italian households (especially in domestic and elder care) and to Italian firms (construction, seasonal agriculture, logistics), filling jobs that Italy's own demographic structure struggles to supply [2][5].

At the same time, the Romanian economy became structurally dependent on remittances. Remittance inflows, reaching an estimated USD 9.3 billion in 2008 (~5–6% of GDP), rivaled or even surpassed foreign direct investment as external financing for households and local development in certain regions [3][4]. This had two effects: (i) it lifted household income and consumption capacity in emigration-sending regions; and (ii) it masked structural weaknesses in Romania's labor market and wage-setting institutions.

The central claim of this paper is that Romanian migration to Italy is now best understood as a stable transnational labor regime: a bidirectional system in which Italy imports labor and services (especially care labor), while Romania imports income in the form of remittances — and increasingly faces the domestic consequences of exporting part of its workforce [2][4][6].

2. LITERATURE REVIEW AND CONCEPTUAL FRAMING

Classic migration theory models migration as an individual/household decision driven by expected wage differentials, employment probability, and risk diversification (new economics of labor migration). In the Romanian case, qualitative and survey-based research consistently shows that migration in the 1990s and early 2000s functioned as a household strategy to secure liquidity, stabilize consumption, finance housing improvements, and invest in children's education [2][6][7].

After EU accession (2007), and once formal hiring channels opened in Italy, migration became less episodic and more embedded. Studies by Mara et al. at the Vienna Institute for International Economic Studies (wiiw) document how Romanian migrants in Italy developed identifiable labor market niches and patterns of partial or full regularization, with women strongly represented in domestic and elder care services, and men more present in construction and certain industrial tasks [2]. This segmentation is echoed in ethnographic work on Romanian care workers in Italy, which emphasizes the feminization of transnational care work and its role as an informal pillar of Italy's elderly-care regime [5][7].

From a macroeconomic angle, OECD and World Bank analyses place Romania among Europe's top remittance-recipient economies of the 2000s, with inflows playing a dual role: poverty alleviation and local investment funding on one hand, and indirect support of national external balances on the other [3][4]. The OECD also emphasizes a structural tension: while remittances raise living standards in origin communities, sustained emigration can erode the domestic labor force, especially in key occupations such as construction, transport, healthcare support, and personal services [4][6].

We adopt the "transnational labor regime" framing: migration is not a one-off exit but an institutionalized circulation of labor and income. Italy's care and low-wage service economy and Romania's household income model are now partially co-dependent [2][5][6].

3.DATA, METHOD, AND LIMITATIONS

This paper uses: ISTAT (Istituto Nazionale di Statistica) data on foreign residents in Italy by nationality, by region, and by sectoral employment where available. These registers provide consistent time series from 2001 onward and allow us to trace the quantitative growth and stabilization of the Romanian community [1].

Survey and research reports from wiiw (Vienna Institute for International Economic Studies) on Romanian migrants before and after Romania's EU accession in 2007, focusing on labor market insertion, wage levels, regular/irregular status, and integration [2].

OECD country assessments of Romanian emigrants ("Talent Abroad: A Review of Romanian Emigrants") and related analyses of labor shortages in Romania, which discuss how sustained emigration affects domestic labor markets and wage pressures [4][6].

World Bank / National Bank of Romania estimates of remittance inflows, especially the surge between 2000 and 2008 and the stabilization afterward [3][4].

Despite the use of official and internationally recognized sources, this analysis faces several data limitations:

- First, pre-2000 migration figures for Romanians in Italy are only partially available and largely estimated, since many migrants worked in irregular or seasonal conditions not captured by administrative records [2][5].
- Second, the distinction between "Romanian citizens" and "Romanian-born residents" complicates longitudinal analysis: once migrants acquire Italian citizenship, they are no longer counted as foreign nationals in ISTAT data, leading to a statistical underestimation of the true Romanian-origin population after 2010 [1][2].
- Third, remittance data differ across institutions (World Bank, National Bank of Romania, IMF) due to variations in reporting methods and the significant share of informal cash transfers, which remain unrecorded. [3][4][7].
- Finally, sectoral employment data by nationality in Italy are only available intermittently and are sometimes aggregated, which constrains precise measurement of occupational specialization over time.

These limitations do not undermine the overall findings but indicate that quantitative estimates should be interpreted as lower-bound approximations of the true magnitude of Romanian migration and its economic effects.

4. HISTORICAL EVOLUTION OF ROMANIAN MIGRATION TO ITALY (1990–2024)

4.1.1990s: Informal and temporary labor migration

The 1990s saw the first substantial Romanian flows to Italy. The drivers were Romania's post-socialist industrial collapse, high unemployment, and wage arrears, combined with Italy's rising demand for low-cost labor in household services, elder care, agriculture, and construction [2][5][7]. Much of this movement was informal: circular stays of a few months, undeclared work, and limited legal pathways. Quantitative data from that period are incomplete, but qualitative studies describe tens of thousands of Romanians — especially women in domestic and care work — present in Italy by the late 1990s [5][7].

4.2. 2002–2007: Mobility shock

A turning point came with the progressive easing of short-stay travel for Romanians into the Schengen area in the early 2000s, followed by partial regularization measures in Italy.

ISTAT data show an extraordinary jump in officially registered Romanian citizens in Italy: from about 75,000 in 2001 to nearly 250,000 in 2004 and over 340,000 in 2006 [1].

During this period, migration diversified sectorally. Men were heavily recruited in construction and agriculture; women consolidated a crucial role in private elder care (badante), domestic services, and cleaning — sectors where Italian households faced rising demand due to demographic ageing and limited public long-term care provision [2][5].

4.3. 2007–2014: EU accession and settlement

Romania joined the European Union in 2007, which normalized labor mobility. The number of Romanian citizens legally resident in Italy doubled in very short order, surpassing 600,000 in 2007 and approaching 800,000 in 2008; by 2010, ISTAT data approach one million [1].

This marks the shift from temporary labor migration to community formation: family reunification, schooling of children in Italy, and, progressively, access to more stable contracts. Mara et al. (wiiw) document improved formalization of employment and higher rates of regular status in this phase, especially in Northern and Central Italy [2].

At the same time, remittances to Romania surged to historic highs (see Table 2), acting as private external finance for Romanian households and communities [3][4].

4.4. 2015–2024: Maturation, stabilization, and structural feedback

From the mid-2010s onward, the stock of Romanian citizens in Italy stabilizes at around or slightly above one million according to ISTAT [1]. Two deeper structural dynamics emerge:

(i) Naturalization and integration. A large number of Romanian-born residents acquired Italian citizenship in the 2010s. As soon as they naturalize, they are no longer counted as "Romanian citizens" in official foreign-resident statistics, even though they continue to participate in the same labor markets. This means the real Romanian-origin labor contribution is undercounted in later years [1][2].

(ii) Labor shortages in Romania. Continuous out-migration, particularly of working-age adults in construction, logistics, care, and certain industrial trades, has generated persistent labor scarcity in Romania. OECD analyses of Romanian emigrants describe domestic sectors struggling to fill vacancies without foreign labor inflows, especially after 2015 [4][6].

In other words, Romania has partially internalized a "labor hole" created by its own emigration, while Italy has internalized Romanian labor into its demographic model.

Table 1. Romanian citizens officially resident in Italy (selected years)

Year	Romanian citizens resident in Italy	Notes
1990	< 10,000 (est., largely irregular)	Early post-socialist circulation; underreported [2][5]
1995	~20,000–30,000 (qualitative est.)	Concentrated in domestic work, agriculture, construction [2][5]
2001	74,885	ISTAT register of foreign residents [1]
2004	248,849	Rapid growth after easier mobility and partial regularizations [1][2]
2006	342,200	Consolidation of labor niches [1]
2007	625,278	Romania joins EU (Jan 2007) [1]
2008	796,477	Family reunification accelerates [1]

Year	Romanian citizens resident in Italy	Notes
2010	968,576	Approaches 1 million. [1]
2014	1,131,839	Long-term settlement phase. [1]
2018	~1.14 million	Slight decline due to naturalization and secondary migration to other EU states. [1][4]
2022	~1.07–1.08 million	Stable stock; Romanians remain Italy's largest foreign community. [1]
2024	~1.07 million	Continuing structural presence in key sectors. [1]

Source: ISTAT, "Stranieri residenti per cittadinanza," various years [1]; wiiw, Mara et al. [2].

The data presented in Table 1 illustrate the evolution of Romanian migration to Italy over more than three decades, highlighting three major structural phases: the **informal and exploratory migration of the 1990s**, the **institutionalized expansion of the 2000s**, and the **mature stabilization period after 2014.** In the early 1990s, Romanian migration to Italy was small-scale, largely irregular, and poorly captured by official statistics. Fewer than 10,000 Romanian citizens were estimated to reside in Italy in 1990, mostly through circular and temporary movements. By 1995, the estimated number had risen to roughly 20,000–30,000 individuals, with migrants primarily employed in **domestic services, agriculture, and construction** — sectors characterized by informal employment and high demand for low-cost labor [2][5].

This period coincides with Romania's post-socialist economic transition, marked by industrial downsizing, unemployment, and real wage declines. Italy, facing opposite demographic pressures — an aging population and labor shortages in low-skill sectors — became an attractive destination even before formal migration channels existed.

The first official benchmark provided by ISTAT in 2001 registered **74,885 Romanian citizens**, marking the starting point of documented large-scale presence. Over the next few years, the number grew exponentially: **248,849 in 2004** and **342,200 in 2006.**

This surge reflects two interrelated developments:

- Easier mobility: the progressive relaxation of visa restrictions (2002) drastically reduced entry barriers for Romanians seeking work in Italy.

- Italian amnesty programs and legalization measures (e.g., 2002's Bossi-Fini provisions) allowed previously undocumented migrants to obtain residence permits and enter official statistics [2].

- Between 2001 and 2006, the officially registered Romanian population in Italy increased more than fourfold, signaling the formation of a sustained migration corridor. During this phase, distinct **labor niches** emerged: Romanian men in construction and agriculture, and Romanian women in domestic and care services. These patterns persisted throughout the following decades.

EU accession and consolidation (2007–2010): Rapid institutionalization. Romania's accession to the European Union in January 2007 transformed migration dynamics. Romanian citizens gained the right to move and work within the EU, greatly reducing administrative barriers.

The number of Romanian residents in Italy jumped from **342,200 in 2006** to **625,278 in 2007**, and to almost **800,000 in 2008** — a historical acceleration. Within two years of accession, the Romanian population in Italy more than doubled.

This wave also coincided with **family reunification**, as migrants who had worked temporarily began to bring spouses and children. By 2010, nearly **one million Romanians** were legally resident in Italy [1]. Economically, this phase corresponds with peak remittance

inflows to Romania (≈USD 9 billion in 2008), demonstrating how labor migration became an established economic linkage between the two countries.

Maturity and settlement (2010–2014): From temporary labor to community formation

After 2010, migration flows stabilized at high levels. In 2014, ISTAT recorded **1,131,839 Romanian citizens**, representing around 23% of all foreign residents in Italy. Qualitative studies indicate a shift from short-term or circular migration toward **long-term settlement:** migrants invested in housing, education for their children, and business creation in Italy [1][2].

This stage also marks the consolidation of **transnational family structures** — many households became bi-local, maintaining economic and emotional ties to Romania while integrating socially in Italy. The permanence of the Romanian community had multiplier effects on local Italian economies, sustaining entire subsectors of domestic services and construction even during the post-2008 economic slowdown.

Stabilization and structural presence (2014–2024): Integration and demographic feedback. After reaching the 1.1 million mark, the number of Romanian citizens in Italy began to stabilize. By **2018,** estimates show approximately **1.14 million**, followed by a gradual decline to **around 1.07 million in 2022–2024**. This apparent reduction is not due to large-scale return migration, but to **naturalization processes**: tens of thousands of Romanians acquired Italian citizenship, thereby disappearing from the "foreign resident" statistics [1][4]. At the same time, some secondary migration occurred toward other EU countries (Germany, UK, Spain), where wage levels were higher or labor markets more dynamic.

Despite these demographic adjustments, Romanians have remained **Italy's largest foreign community** for more than a decade. The stabilization around one million residents indicates that Romanian labor has become a **structural component** of Italy's economy, particularly in sectors such as construction, logistics, domestic services, and elder care.

Across the full period (1990–2024), the Romanian population in Italy increased by roughly **100-fold**, from a few thousand to over one million residents. This growth trajectory reflects not only economic push–pull factors, but also **policy transformations**: visa liberalization, EU accession, and successive Italian regularizations.

The trend can be summarized as follows:

1990–2001: Formation and exploration phase – low volume, high irregularity.

2002–2007: Acceleration – institutional entry and legalization.

2007–2014: Expansion and consolidation – formalization and family settlement.

2014–2024: Maturation – integration, naturalization, and statistical stabilization.

Quantitatively, this pattern reveals that Romanian migration to Italy is no longer cyclical or crisis-driven, but **structurally embedded** within European labor mobility. Qualitatively, the transformation from irregular to regularized, settled migration mirrors the Europeanization of labor markets: what began as temporary coping migration has evolved into a permanent reallocation of human capital across the EU.

Table 2. Remittance flows to Romania and macroeconomic relevance (2000–2020 reference points)

Year / period	Estimated remittances to Romania	Macro significance
2000	≈ USD 0.1 bn	Early stage of large-scale out-migration; heavy use of informal transfer channels. [3][4]
2004–2007	Rapid annual increases	Migration to Italy and Spain intensifies; remittances become central to household budgets in Romania. [2][3]

Year / period	Estimated remittances to Romania	Macro significance
2008	≈ USD 9.3 bn	≈5–6% of Romania's GDP; comparable in magnitude to, or exceeding, net FDI inflows in some years. [3]
2010–2013	High but more stable	Remittances finance consumption, home construction/renovation, and small business start-ups in high-emigration counties. [2][4][7]
2017	≈ EUR 3.8 bn	≈2% of GDP; still macro-relevant despite gradual wage convergence in Romania. [4]
2020	Slightly lower vs 2008 peak, but persistent	Remittances remain structurally embedded as a private safety net for Romanian households. [4][6][7]

Sources: World Bank Migration and Remittances data; National Bank of Romania balance of payments; OECD (2019); wiiw analyses of Romanian migrants in Italy [2][3][4][7].

The data presented in Table 2 reveal the remarkable expansion, stabilization, and structural persistence of remittance inflows to Romania over the past two decades. These transfers, primarily originating from migrant workers in Italy, Spain, and other EU countries, have played a **central role in Romania's external financing, household welfare, and regional development.**

1. Initial stage (around 2000): Minimal flows and informality

At the beginning of the 2000s, recorded remittances to Romania were modest — approximately **USD 100 million** according to World Bank and National Bank of Romania data [3][4]. This reflected both the relatively small size of the Romanian diaspora at the time and the **predominance of informal transfer methods** such as cash carried home or sent through acquaintances.

Despite their small recorded volume, these early flows marked the transition from survival migration in the 1990s to the first **organized migration networks**, especially toward Italy and Spain. Remittances in this stage served mainly to meet basic household needs, repay debts, and finance emigration costs for other family members — the so-called "migration multiplier effect."

2. Expansion phase (2004–2007): Rapid growth and household dependence

Between 2004 and 2007, remittance inflows increased dramatically in parallel with **mass migration to Italy and Spain**. Visa liberalization (2002) and Romania's EU accession expectations created an unprecedented outflow of labor.

During these years, remittances became **a core component of household budgets** in emigration-prone regions, functioning as both income replacement and informal insurance. Studies show that many Romanian households came to depend on transfers from abroad for consumption smoothing, housing improvement, and education expenditure [2][3]. At the macro level, these inflows began to appear in Romania's balance of payments as a significant external financing source, rivaling early-stage foreign direct investment.

3. Peak year (2008): Record inflows and macroeconomic significance

The year **2008** represents the historical peak of remittances to Romania, with an estimated **USD 9.3 billion**, equivalent to approximately **5–6% of national GDP** [3]. This made Romania one of the largest remittance recipients in Europe, alongside Poland and Ukraine. At that time, remittances were **comparable in magnitude to net FDI inflows**, underscoring their macroeconomic relevance. They contributed to maintaining domestic consumption and supported the real estate and construction booms of the pre-crisis years.
In many local economies — especially in Moldavia, Oltenia, and southern Transylvania — remittance income overtook wages from domestic employment, becoming the main driver of local demand and small-scale investment.

4. Post-crisis stabilization (2010–2013): Structural integration of remittances

Following the global financial crisis, remittance flows to Romania **remained high but became more stable**, fluctuating around 4–5 billion USD per year. While some migrants faced temporary income losses due to Italy's and Spain's recessions, most continued to send money home regularly. By this point, remittances were **structurally integrated into Romania's economic equilibrium**, financing private consumption, home renovation, and micro-enterprise formation in construction, retail, and transport [2][4][7]. The shift from one-time investments to recurrent support indicates that migration had become a **long-term household strategy,** not a temporary response to crisis conditions.

5. Adjustment phase (2017): Relative decline but continued importance

By 2017, recorded remittances reached approximately **EUR 3.8 billion** (around 2% of GDP) [4]. In relative terms, this represented a decline from the 2008 peak, due largely to **wage convergence** between Romania and Western Europe and to **partial migrant settlement** abroad — migrants increasingly spent a larger share of their income in host countries. Nevertheless, the continued 2% contribution to GDP demonstrates that remittances remained a **macro-relevant and stable inflow**, particularly valuable during external shocks or domestic slowdowns.

6. Persistence and resilience (2020): Enduring private safety net

Even by **2020**, more than a decade after the global crisis and during the COVID-19 pandemic, remittance inflows to Romania remained robust, only slightly below their earlier peaks. Their endurance highlights the **resilience of transnational family ties** and the diversification of income sources among migrants in Italy and elsewhere. Economically, remittances now function less as cyclical inflows and more as a **permanent private safety net**, cushioning households against local shocks and supplementing inadequate social protection systems in Romania [4][6][7]. This durability underscores that emigration and remittances have become **structural features of Romania's development model**, not temporary deviations from it.

The trajectory from USD 0.1 billion in 2000 to roughly USD 9 billion in 2008, and stabilization around EUR 3–4 billion afterward, demonstrates both the **magnitude and endurance** of remittance-driven linkages between Romania and its migrant destinations - particularly Italy.

Three broad conclusions emerge:

- **Remittances acted as private external financing,** substituting for limited domestic credit and social transfers in the 2000s.
- **They reinforced regional inequality**, as high-emigration regions benefited disproportionately from external income inflows.
- **They created a transnational dependency equilibrium** - households rely on migrants' earnings abroad, while Romania's economy indirectly relies on these private inflows to sustain consumption and growth.

In sum, the remittance data confirm that migration to Italy and other EU states has not only reshaped Romania's labor supply but also redefined its sources of economic resilience and household welfare.

5. ECONOMIC IMPACTS ON ITALY

5.1. Addressing structural labor shortages

Italy's demographic profile is marked by low fertility, population ageing, and a persistent need for labor in physically demanding, lower-paid, or care-intensive occupations. Research shows Romanian migrants have become central in construction, logistics, agriculture,

manufacturing support, and especially in domestic/elder care ("badanti"), where female Romanian workers are over-represented [2][5][7].

From an Italian production perspective, this inflow stabilizes sectors that might otherwise contract or face sharply rising labor costs. From a welfare-state perspective, Romanian care workers informally extend Italy's long-term care capacity by allowing elderly Italians to receive private in-home assistance instead of institutionalization, which would be costlier for families and the public budget [5][7].

5.2. Regional concentration and competitiveness

ISTAT regional breakdowns indicate that Romanian residents are highly concentrated in Northern and Central Italian regions (Lombardy, Veneto, Piedmont, Emilia-Romagna, Lazio), which are also Italy's industrial and service core [1].

This spatial match between migrant labor supply and Italy's productive heartland suggests that Romanian migration has not only filled "any job," but specifically supported Italy's competitive regions. It reinforces regional asymmetries within Italy: core regions absorb and benefit from migrant labor, while lagging regions in the South remain structurally weaker and continue to lose working-age population [1][2].

6. ECONOMIC IMPACTS ON ROMANIA

6.1. Household income and local development

Extensive empirical work on Romanian emigrants shows that remittances are used to finance current consumption, education, housing improvement, and local entrepreneurship (small retail, transport services, construction SMEs) in origin communities [2][3][7]. This created a remittance-driven development model in parts of Romania, especially in high-emigration counties in the North-East, South, and Moldova region, where formal employment opportunities were scarcer in the 1990s–2000s [2][3].

6.2. Macroeconomic stabilization

In the 2000s, remittances significantly helped Romania's external balances. By injecting hard currency equivalent to several percentage points of GDP, they reduced pressure on the current account and acted as private social transfers, complementing (and sometimes substituting for) weak domestic social protection in the early transition period [3][4]. This inflow was particularly valuable around EU accession, when domestic demand boomed but Romania's productive base and wage levels were still catching up.

6.3. Labor shortages and wage pressure

A structural downside repeatedly noted in OECD and wiiw analyses is that large-scale emigration depletes Romania's working-age population in sectors like construction, transport/logistics, agriculture, and low-wage services [2][4][6].

The result is chronic vacancy pressure and wage inflation in those occupations inside Romania, combined with difficulties in matching domestic demand for labor. In recent years, Romanian employers in these sectors began recruiting increasing numbers of non-EU workers (for example from South and Southeast Asia) to compensate for domestic shortages — a development highlighted in Romanian labor market policy discussions and OECD country work on Romania's emigration/employment nexus [4][6].

This indicates a feedback loop: exporting labor to Italy (and elsewhere in the EU) forces Romania itself to become a net importer of labor in specific, lower-wage segments. The Romania–Italy corridor thus indirectly internationalizes Romania's own labor market.

7. POLICY DISCUSSION

7.1. Intra-EU mobility as an adjustment valve

From an EU integration perspective, the Romania–Italy corridor demonstrates how free movement of workers acts as an automatic stabilizer for asymmetric shocks. Italy faces aging and sectoral shortages; Romania faces underemployment and wage gaps. Labor moves from surplus to deficit. Both economies benefit in the short-to-medium run: Italy receives essential labor; Romania receives external income [2][3][4].

7.2. Integration and regularization in Italy

Mara et al. show that regularization and access to contracts in Italy significantly improve migrants' job stability, wage security, and social protection [2]. Over time, many Romanian workers transition from informal/irregular status to formal employment and, eventually, citizenship. This improves their bargaining position, tax contribution, and access to services. Economically, Italy internalizes them as part of its long-term labor force, not just as temporary "guest workers" [2][5].

7.3. Sustainability concerns for Romania

For Romania, reliance on remittances is a double-edged sword. On one hand, remittances raise living standards, reduce poverty, and fund local development in high-emigration regions [3][7]. On the other hand, persistent outflows of working-age labor weaken Romania's own capacity to expand productive sectors domestically, and force it to replenish labor through inward migration, creating new integration challenges at home [4][6]. Romania therefore faces a strategic choice: continue competing on labor outflow/remittance inflow, or pivot toward wage, productivity, and industrial policies that retain/attract workers domestically.

8.CONCLUSIONS

Romanian migration to Italy since the 1990s should be understood as a mature and structured intra-EU labor regime. It is no longer simply "Romanians leaving to work abroad," nor is it adequately described as a one-way brain drain.

For Italy, Romanian migrants have become embedded in essential but structurally unattractive jobs (long-term care, domestic services, certain manual trades, seasonal agriculture, logistics, low-skill manufacturing). Without this labor, Italy's ageing society and segmented labor market would struggle to provide affordable household-level care and to maintain competitiveness in some traditional industries [2][5][7].

For Romania, the outflow generated massive remittance inflows that financed consumption, housing, local services, and even entrepreneurial ventures, while also stabilizing external balances in the 2000s and 2010s [3][4]. At the same time, large-scale emigration has tightened Romania's labor market in specific occupations, producing shortages that now must be filled by recruiting non-EU labor. This reveals a structural transformation: Romania is

simultaneously an exporter and importer of labor within an integrated European (and increasingly global) employment system [4][6].

At EU level, this corridor highlights both the strengths and vulnerabilities of free movement. It allows rapid reallocation of labor to where it is most demanded, but it can also entrench uneven development — reinforcing high-value regions in Italy's North and leaving parts of Romania dependent on income earned abroad.

Policy implications include:

(1) Italy's need to formally recognize migrant labor — especially in care — as part of its welfare and productivity model, ensuring legal protections and skill recognition.

(2) Romania's need to raise domestic wage floors, improve working conditions, and design targeted industrial policy to retain critical skills, reducing structural dependence on permanent emigration.

(3) An EU-level need to integrate cohesion policy (regional development funds) with labor mobility governance, acknowledging that labor mobility is now a core economic transmission channel inside the Union, not a side effect.

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analyses of Romanian migration patterns, remittance use, transnational family arrangements, and long-term settlement, including the Italy corridor. Highlights the role of remittances in local development and the shift from circular to more permanent migration.

DEMOGRAPHIC AGING OF THE POPULATION – IMPLICATIONS ON THE LABOR MARKET

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ABSTRACT: *One of the profound social and demographic challenges of contemporary society is the demographic aging of the population - an objective process, the result of the increase in life expectancy at birth and the reduction of fertility. This phenomenon covered most countries, especially the economically developed ones, having multiple implications on the economic, social, political, cultural, etc. level.*

Europe has the highest rate of demographic aging compared to other continents, and is considered to have already reached a critical stage. In the European documents, measures are provided to increase the legal and de facto retirement age, and to increase the employment rate of the older adult population (50-65 years). Currently, at the level of the European Union, the median age is 43.1 years, but according to the latest estimates made by Eurostat, in 2050 the average age of Union citizens will be 49 years.

The work wants to surprise what will be the implications of the demographic aging phenomenon on the labor market in the near future.

Keywords: *demographic aging, labor market, population.*

JEL Classification: *E24, J1, J18, J19, J21.*

1. INTRODUCTION

Demographic aging is a process that refers to groups, collectives of people (and not to the individual as a singular case) in terms of the structure, composition of the population in relation to the "age" characteristic, and is a risk factor related to the evolution of the population and of its structure. At the same time, population aging is a multidimensional problem: demographic, economic, social, political and cultural.

The demographic aging process is characterized by the increase in the proportions of adults and the elderly in a population, while the proportions of children and adolescents decrease, a characteristic fact for the reproduction of the narrow-type population and which leads to an increase in the median age of the population. A significant amount of scientific research is dedicated to the problems of population aging, its multiple consequences, as well as the demographic aspects and economic consequences of aging (the impact on the labor market, the pension system and the social assistance system for the elderly). The causes that explain the aging of the population are the decrease in the birth rate, advances in medicine and the increase in the standard of living, which increase the numerical growth rate of the elderly population by reducing morbidity and mortality.

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2. THEORETICAL APPROACHES

The migration flow, having a double meaning, can contribute to the deepening of demographic aging, or vice versa - it leads to the rejuvenation of the population. The demographic process around the globe is determined by two basic patterns:

1) the "elderly population" model, which corresponds to areas with a low level of birth and infant mortality and, respectively, with a higher level of life expectancy at birth;

2) the "young population" model, which is valid for areas with high birth and mortality rates, including infant mortality, with increasing natural growth, as well as low life expectancy at birth. The aging of the population is considered mobile, when the share of people over 60 constitutes 12 - 14% in the total population; stable, with the share of people of this age at the level of 15-19%; the aging of the population causing depopulation, with the share of people aged 60 and over over 20%.

Demographic aging is a firm and long-lasting process, which, once established, continues its evolution in the sense of its emphasis. The analyzes and studies carried out at a given moment have a limited value and their conclusions are valid for not too long periods, a fact that convinces that aging is a process of both actuality and perspective. The aging of the population, as a phenomenon, constitutes a challenge not only as a biological process, which takes place at an individual level, but also as a social phenomenon, with an impact on all sectors, such as public finances, social-economic policy, the labor market, infrastructure, social relations, and so on.

The increase in life expectancy, as a determining factor of population aging, is linked to success in medicine and economics, in particular it is due to the improvement of living conditions, the modification of the morbidity structure and the reduction of the impact of external factors on mortality. Life expectancy is a "barometer of social progress"3, but its extension is a reflection of living conditions, working conditions, food, habits, environment, health and education. The aging of the population has a socioeconomic importance and a significant impact both on society as a whole and on the elderly, in particular, a positive assessment of the elderly and their role in society contributes to the progress of the economic potential and favors the effective and comprehensive integration of the elderly in society.

According to the demographic aging scale of J. Beaujeu-Garnier – E. Rossett, the aging threshold is determined at the age of 604. Taking this criterion into account:

• countries where the share of people aged 60 and over, in the total population, is less than 8%, are classified, from a demographic point of view, as "young" countries;

• countries in which the share of this group varies between 8-12% are characterized as countries in the "pre-aging" period;

• countries with a 12% or more share of people aged 60 and over are classified as "aged" countries.

With reference to the countries in the "aged" group, the classification of the level of aging is as follows:

- the "initial level of aging" in the case of the share of the elderly between 12-14%;
- the "average level of aging" in the case of the share of the elderly between 14 -16%;
- "advanced level of aging" in the case of the share of the elderly between 16-18%;
- "very high level of aging" - in the case of the share of the elderly over 18%.

At the same time, according to J. Sandberg's classification, the determination of the level of demographic aging is carried out based on the changes that appear in the structure of the three main age groups: 0-19 years, 20-59 years, 60 years and over. According to J.Sandberg's scale, the aging of the population is manifested when the share of people belonging to the first age group (0-19 years) is less than 30%, while the share of people from the third group (60 years and over) exceeds the 15% level. So, the main indicators that

characterize the demographic aging of society are the number of the population aged 19 and the number of the population aged 60 and over.

In the age structure of the population, demographic aging is manifested by: the aging of the "bottom" population, in the case of low fertility (A. Boiarski, Russia, Jean Bourgeois-Pichat and A. Sauvie, France; Ansley Johnson Coale, USA, etc.), and aging "from above", as a consequence of the reduction of mortality in the elderly and in the category of the elderly, which is a result of advances in the field of medicine, and, therefore, the increase in life expectancy. Thus, the reduction of mortality contributes to aging in the following cases: more people reach old age and the life expectancy of the elderly increases.

The demographic aging process of the population has multiple consequences in the social, economic, political, cultural, etc. fields. Thus, in the economic field, this process can have an impact on economic growth, investments, savings, the labor market, the change in the structure of consumption. In the social field, the aging of the population has an impact on the change in the composition of the family, the standard of living, the demand for housing, social and medical services, education, pension insurance, etc., and in the political sphere - on the results of the elections, the system of political representation, etc. The analysis of the process of quantitative and qualitative changes in the structure of the population is a necessity for the development of programs, which include directions of a social and economic nature, as well as for making decisions in the field of health care, education, social security, employment, etc.

Demographic aging is an almost global phenomenon that faces, or threatens to affect, all countries at a more advanced stage of development. It appears against the background of the decrease in the birth rate of the population, doubled by the increase in life expectancy. It is a phenomenon that begins to raise problems after a rather long interval since its appearance, and for this reason there is a risk of not treating it with sufficient seriousness. And the reverse is true, from the moment the population starts growing again, the effects of population aging take a long time to disappear. The implications of this phenomenon are multiple, in many spheres of economic and social life, but in this chapter only the effects on the labor market will be discussed.

The implications that the aging of the population has on the labor force is a less publicized topic, although as will be seen they are multiple, but they are more difficult to quantify. Population aging implies a reduction in the number of young people, we are mainly referring to people aged between 15-29, who enter the labor market, and who are the future workforce, which in fact boils down to the reduction of the workforce, under conditions of constant participation rates. The aging of the population actually also means an aging of the labor force, which has implications in the field of qualifications, as well as the expenses for the continuous training of employees. Demographic aging also affects labor costs, as there is a positive correlation between age and salary, which implies an increase in average salary only due to the increase in average age. On the total economy, this implies an increase in the expenses with wages, so in the unit costs, in the conditions of similar productivity of the two categories of labor force. These topics will be detailed below.

In this work, it is aimed to highlight the effects that the aging of the population will have in the future on the available labor force.

3. THE EFFECTS OF POPULATION AGING ON THE LABOR FORCE IN ROMANIA

In the case of Romania, the aging of the population is a very serious phenomenon, for several reasons, first of all due to the fact that in our country the phenomenon of demographic decline has been established for a long time, and secondly, the budgetary implications are more serious, especially due to the poor representation of the pension/health system alternative to

the state one. The year 1990 is the moment when Romania's population began to decrease, a decrease accelerated in recent years by the phenomenon of external migration and the sharp decrease in the birth rate.

Table 1 presents an evolution of Romania's population, and based on this evolution, a whole series of future projections of the population number were penciled, projections that are not very gratifying.

Any population forecast is based on a series of assumptions related to the value of some rates related to birth, mortality, life expectancy, by age category, therefore they must be taken as informative, and may be disproved by the subsequent demographic evolution in the case of some rate developments not anticipated by the respective forecast. Having said that, the differences between different forecasts are not very substantial, especially from the point of view of long-term trends.

Table 1 The demographic evolution of Romania's population

	1990	2005	2010	2019	2020	2021	2022
Total	23211395	21382354	20294683	19425873	19354339	19229519	19042455
0-14 years	5508479	3735907	3206067	3056051	3058900	3056590	3089023
% of the total	**23.7**	**17.5**	**15.8**	**15.7**	**15.8**	**15.9**	**16.2**
15-29 years	5229133	4972314	3829423	3180455	3083637	3042004	2951926
% of the total	**22.5**	**23.3**	**18.9**	**16.4**	**15.9**	**15.8**	**15.5**
30-49 years	6072530	6047504	5920312	5779333	5714156	5613516	5404506
% of the total	**26.2**	**28.3**	**29.2**	**29.8**	**29.5**	**29.2**	**28.4**
50-64 years	4017818	3600473	4064182	3814553	3837104	3814273	3890679
% of the total	**17.3**	**16.8**	**20.0**	**19.6**	**19.8**	**19.8**	**20.4**
65 years and over	2383435	3026156	3274699	3595481	3660542	3703136	3706321
% of the total	**10.3**	**14.2**	**16.1**	**18.5**	**18.9**	**19.3**	**19.5**

Source: INS, Tempo-online database, http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table

The age distribution between women and men is quite different, thus, although the total number of women is higher than that of men, at ages up to 50, men are more numerous, the situation changing for older ages.

In the conditions of the predicted demographic changes, it is interesting to see what the effects are on the workforce. Most obviously, demographic aging will affect the workforce quantitatively, as participation rates are different for different age groups.

As can be seen from table 2, the 35-44 age group has the highest participation rates, with over 80% of the active population. At the opposite pole is the population over 65 years old, which has participation rates of 11.9%. The population aged 55-64 also has low participation rates, at approximately 38%. As the aging of the population reduces the population aged up to 45, which has the highest participation rates, in the long term a de facto decrease in the labor force will also be observed at unchanged participation rates.

In the context of a fairly low unemployment rate in Romania, the only reserve to at least maintain, if not increase, the number of employees remains the increase in participation rates. And from this point of view, the objectives of the Lisbon Agenda to obtain participation rates of 70% for the working-age population, as well as participation rates of 60% for women and 50% for the elderly. In the long term, when the participation rates for people up to the age of 45 cannot be increased, there will be a substitution of the young labor force with the older labor force.

Table 2 Participation and employment rates of the population by age category, in 2022

	Activity rate	Occupancy rate
Total	51.8	50.5
15-25	27.8	22.0
25-34	80.2	75.0
35-44	84.6	80.1
45-54	79.8	77.2
55-64	39.4	35.1
over 65	11.9	9.8

Source: INS, Tempo-online database, http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table

In this context, we must identify the effects that population aging has on the availability of labor in Romania, in order to study how affected it will be in the medium and long term. However, this can only be studied under the conditions of some assumptions related to the various participation rates of the different age categories. Table 2 presents the participation rates of the various age categories at the level of 2022, the most recent year for which the respective data exists.

4. CONCLUSIONS

The aging of the population strongly influences the labor supply. A series of measures are becoming necessary now and in the next period, for the labor market. They look at several aspects:

– Reforms that generate employment and growth rates will allow better resistance to the pressure of population aging and to maintaining the level of social benefits in Europe. Extending active life is a response to a major political challenge. The promotion of an active old age of the population, the postponement of retirement, calls for changes in attitude on the part of elderly workers, but also on the part of entrepreneurs (regarding, for example, the conversion of the elderly workforce).

- Favoring a transition between work and retirement, in favor of a progressive withdrawal.

- Women are, in the future, the main source of growth of the active population. The aging of the active population poses problems related to equal opportunities between men and women, progress in dividing roles and responsibilities in the family.

- The integration of the inactive (women, unemployed) into activity and the reduction of retirements can alleviate, temporarily, the reduction of the labor force. The concentration of the unemployed among the less skilled and less competent indicates that, in a culture of technological progress, a labor shortage can coexist with a significant number of unemployed.

– The early retirement system proved ineffective and very costly for society. The retirement of elderly workers was operated at the price of long-term public financing. Early retirement policies benefited the private sector, which restructured and reduced the workforce without replacing older workers with younger ones.

– Current retirement age policies need to be reviewed. An increase in the retirement age has a positive effect on public spending and allows maintaining the job offer in the following decades.

– Work methods must be reconfigured for all age groups, within a global policy regarding work, family, social protection, retirement.

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